WPI

Perceptions of Climate Change in Iceland

Iceland Project Center

October 11, 2018

Matthew Jalbert, James McClung, Benjamin Seibert & Pheobe Yeung
Submitted to Assistant Teaching Professor Dr. Melissa Belz
Sponsor: Associate Teaching Professor Dr. Ingrid Shockey

Perceptions of Climate Change in Iceland

An Interactive Qualifying Project Report
Submitted to the Faculty of
WORCESTER POLYTECHNIC INSTITUTE
in partial fulfillment of the requirements
for the Degree of Bachelor of Science

by
Matthew Jalbert
James McClung
Benjamin Seibert
Pheobe Yeung

11 October 2018

Report Submitted to:

Assistant Teaching Professor Melissa Belz
Associate Teaching Professor Ingrid Shockey
Worcester Polytechnic Institute

Abstract

Scientific research is often prioritized over social research in climate change studies. Personal stories convey perceived vulnerabilities, adaptations and resiliencies while discerning societal influences. To better understand climate change perceptions, we collected stories of environmental changes from lifelong residents of Iceland. We conducted in-depth interviews with residents in four locations of interest. Stories from residents supported the climate change indicators researched by experts. Overall, Icelanders did not feel vulnerable to environmental changes but did worry for future generations. We also produced a documentary to share the stories. Future climate change perception studies should consider societal implications to gain a more holistic view of climate change impacts.

Executive Summary

Climate change is a global issue that is transforming the environment and society alike. Many impacts of climate change can be seen in Iceland. The loss of its two largest glaciers by 2200 (Aðalgeirsdóttir, Jóhannesson, Björnsson, Pálsson, & Sigurðsson, 2006) is expected to seriously impact the Icelandic environment (Pagli & Sigmundsson, 2008). Offshore, fish migration will have major ramifications for the fishing industry (Poloczanska, 2016) and Icelandic traditions. Despite these adverse effects, Iceland also experiences positive effects of climate change. The increased glacial runoff has temporarily boosted the generation of hydroelectric power (Aðalgeirsdóttir et al., 2006). The warmer climate attracts more tourists (Jones & Phillips, 2018) and allows farmers to explore new crops (Gewin, 2017). To fully understand climate change, we explored the physical effects through three key terms: vulnerability, adaptation and resilience (Janssen, Schoon, Ke, & Börner, 2006). These have been studied extensively but research into social changes has been less thorough.

Understanding climate change through scientific terminologies explains observable effects but offers a shallow insight into experiences. It is crucial to explore cultural worldviews and social environments to understand climate change perceptions (Akerlof, 2013). In focusing on the science of climate change, valuable insight may be overlooked. Researching the stories of others grants a new or different understanding and is an effective way of meeting at the crossroads of perceptions between author and interpreter (Koch, 2012). This profound aspect of storytelling has been utilized as a powerful tool over many media platforms. The cultural significance of storytelling, specifically in Iceland, makes collecting stories effective at gathering societal influences on perceptions. This deepened our understanding of climate change vulnerabilities, adaptations and resilience.

Cultural insights manifest in the stories of individuals. A study on narrative methods by Erol Isik (2010) argues that people create narratives from their own self-image, but there is no dualism between self and society. Empathy is another important factor present in stories. It heightens an interpreter's understanding of what an individual is trying to convey (Koch, 2012). Isik (2010) also found that storytellers live in a story's moment, so the information recalled is more accurate and vivid.

The goal of this project was to collect stories of how changes in the environment have impacted lifelong residents of Iceland. With these stories, we explored similarities and differences between what residents perceived and what science has established. To complete this goal, we first interviewed climate change scientists to learn about Iceland's climate change indicators and to identify towns most impacted by those indicators. Second, we used in-depth interviews to gather stories of experiences. We then used the gathered data to conceptually compare the perceptions between Icelandic residents with scientific findings.

Our first interviews with climate change scientists took place in Háskóli Ísland. We talked to Dr. Guðfinna Aðalgeirsdóttir, Dr. Þröstur Þorsteinsson, and Dr. Brynhildur Davidsdóttir (see Figure A below) and learned about glacial melt, ocean acidification and isostatic rebound. Based on those indicators, we were advised to visit Höfn, Vík and Vestmannaeyjar for interesting climate change perceptions. We also learned about government adaptation policies and the scientists' concern for

Iceland in the next decade. These interviews allowed us to learn about climate change impacts specific to Iceland and provided a sturdy foundation for our data collection.

Figure A. Picture (left to right) of Pheobe Yeung, Dr. Brynhildur Davidsdóttir, and Ben Seibert.

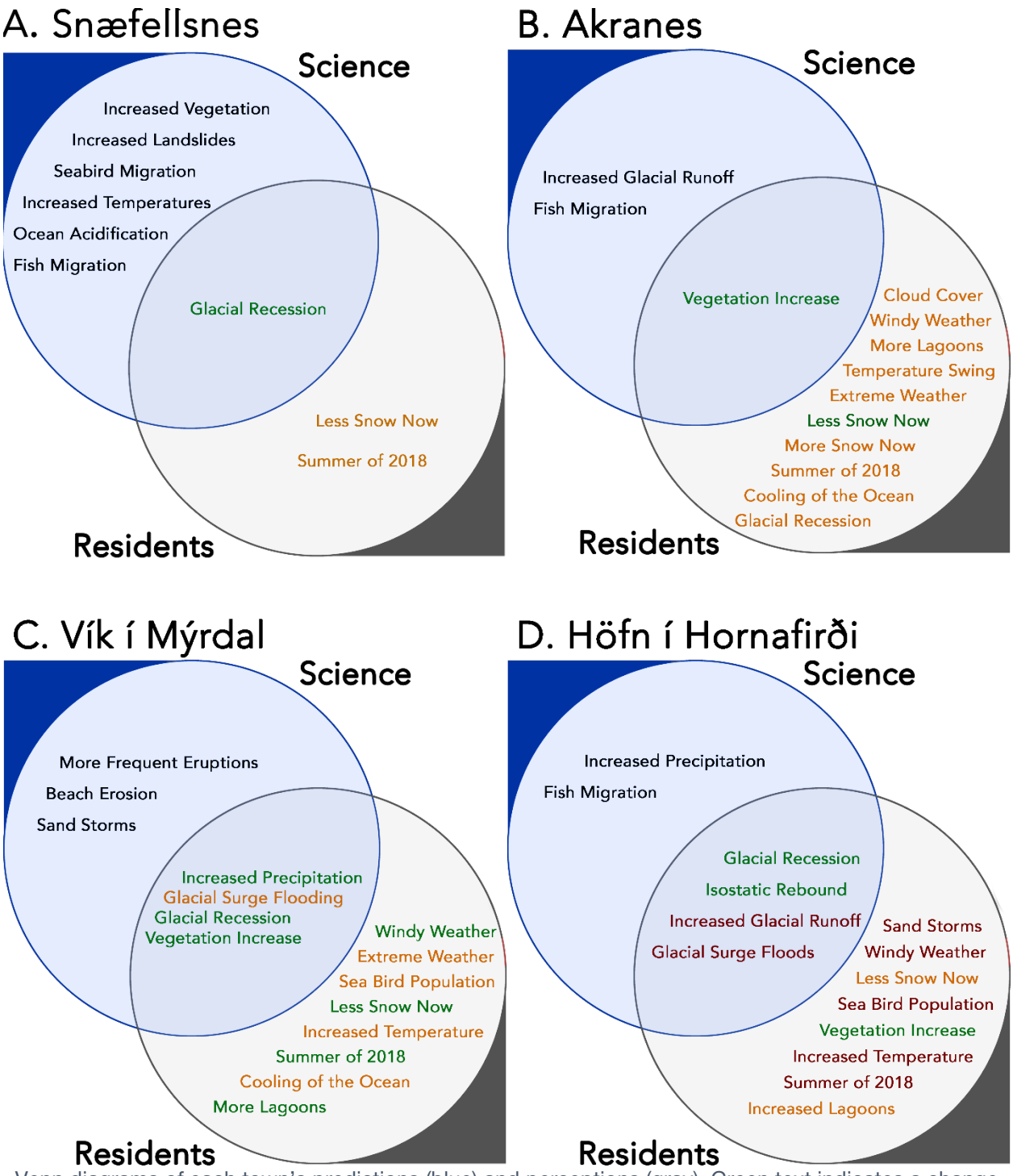
We went to Akranes, Vík, Stykkishómur and Höfn to conduct in-depth interviews. Table A, below, shows the number of interviewees in each town. Early on, we preferred semi-structured interviewing but eventually switched to in-depth interviews for more open conversations. The interviews were guided conversations that targeted climate change indicators through the residents' hobbies, occupations and cultures. Each interview lasted between 10 to 25 minutes. The conversations varied greatly depending on the person but the information we gathered was similar.

Table A. Number of interviewees in each location.

Town	Snæfellsness*	Akranes	Vík	Höfn	**Total**
Sample Size	5	7	6	14	**32**

*Snæfellsness is a peninsula that includes the towns Stykkísholmur (n=3) and Snæfellsbær (n=2)

After transcribing interviews, we used content analysis to gather general codes and themes. The codes were generated by indicators mentioned by scientists and codes were added as we came upon new ideas. Because of Iceland's diverse topography, we divided indicators into applicable regions. This made comparisons between scientific data and collected stories more effective. From these comparisons, Venn diagrams were made to distinguish similarities in perceived vulnerabilities between residents and the scientific consensus (see Figure B).



Venn diagrams of each town's predictions (blue) and perceptions (gray). Green text indicates a change mentioned by 25% or more; yellow, 8-24%; and red, <8%.

Glacial recession proved to be the most noticed change, having been mentioned by 60% of all residents. This was unexpected; of the towns in which we interviewed in, only Vík and Höfn were located near large glaciers. This hints at a nationwide understanding that all of Iceland is affected by the loss of its glaciers. Glacial surge flooding was predicted to be a considerable threat to both Vík

and Höfn. However, only one respondent in each town mentioned the possibility for future larger floods. This could mean that the floods are not as detrimental to locals as scientists implied; that flooding is a part of local life, and is taken for granted; or that a minority of residents are impacted by flooding. Increased precipitation proved to only be noticed in Vík and was a main talking point of the people there. With Vík being such a naturally rainy area, it was surprising that half of our interviewees mentioned the increase. None of the other locations covered this point, so this could be indicative that Vík and the south coast experiences this change the worst.

Another interesting pattern lies in the disconnect between concern for climate change indicators. 68% of residents brought up glacial recession when asked what they have noticed in terms of climate change. However, no one was concerned about the direct effects of glacial recession. Instead, most interviewees expressed concern for their children and grandchildren. For example, a Vík tour guide was focused on being environmentally conscious but was not extremely worried about the effects of climate change in Iceland. She was more worried about her children not being able to experience the glaciers. The most widespread concern was the Gulf Stream. Nearly a quarter of the residents interviewed expressed worry for their country and explained that the disappearance of the Gulf Stream would render Iceland uninhabitable. This concern was often mentioned by residents in all four areas of focus.

While the vulnerability mapping is a good indicator of what people perceive, it does not utilize other valuable data from our interviews. To display the stories of residents experiences and concerns with climate change, we produced a fifteen-minute documentary. Overall, there was not a linear correlation between what scientists emphasized and what Icelanders perceived (Figure 8). The R^2 value of .006 is extremely low. The lack of correlation indicates that scientific data alone cannot predict how residents perceive climate change. Therefore, social research is crucial to understand how to help communities adapt.

Iceland is a kaleidoscope of perspectives and phenomena, and our research is just the tip of the iceberg. We gathered stories from four distinct communities, with each one adding insight into how people are impacted. By better understanding the experiences and concerns of each community, future adaptation strategies can more fully address the multitude of interconnections between environment and civilization.

Acknowledgements

We would like to thank the following people and institutions for their support of this project:

Our sponsor, **Dr. Ingrid Shockey** for her guidance and her financial assistance in traveling to Höfn and Vìk.

Our advisor, **Dr. Melissa Belz** for her guidance and support.

The **Interdisciplinary Global Studies Department** of Worcester Polytechnic Institute for financial assistance in traveling to Höfn and Vík.

The faculty of the University of Iceland, especially **Dr. Guðfinna Aðalgeirsdóttir**, **Dr. Þröstur Þorsteinsson**, and **Dr. Brynhildur Davidsdóttir**.

The researchers of the South East Iceland Nature Research Center (Náttúrustofa Suðausturlands), for aiding our research, especially **Kristín Hermannsdóttir** and **Snævarr Guðmundsson.**

Table of Contents

List of Figures

Team Contributions

Matthew Jalbert wrote sections 2.1, 2.2 and 3.1; edited the entire report; conducted, transcribed and coded several interviews.

James McClung wrote sections 1.1, 1.2, 1.3 and chapter 4; edited the entire report; performed clerical duties; and conducted, transcribed, and coded several interviews.

Benjamin Seibert wrote sections 1.2, 1.2, 2.3 and 3.2; edited the entire report; organized travel; and conducted, transcribed, and coded many interviews.

Pheobe Yeung wrote abstract, sections 1.2, 1.3, 3.1and 3.3; edited the entire report; organized travel; conducted, transcribed, and coded many interviews; and produced the documentary.

Left to Right: Pheobe Yeung, James McClung, Matthew Jalbert, and Benjamin Seibert

Chapter 1: Literature Review

1.1 Overview of Climate Change in Iceland

Climate change is a global issue that is transforming the environment and society alike. Many of the impacts of climate change can be seen in Iceland. The loss of two of its largest glaciers by 2200 (Aðalgeirsdóttir, Jóhannesson, Björnsson, Pálsson, & Sigurðsson, 2006) is expected to seriously impact the environment and human activity (Pagli & Sigmundsson, 2008). Offshore, fish migration will have major ramifications for the fishing industry (Poloczanska, 2016) and Icelandic traditions.

Despite these adverse effects, Iceland also experiences positive effects of climate change. The increased glacial runoff has temporarily boosted the generation of hydroelectric power (Aðalgeirsdóttir et al., 2006). The warmer climate also attracts more tourists (Jones & Phillips, 2018) and allows farmers to explore new crops (Gewin, 2017). These physical changes have been studied extensively, but research into social changes has been less thorough.

Like Iceland's physical changes, Icelandic perceptions of climate change have proven to be unique. A study from 2009 found Icelanders to be the least concerned people in the western hemisphere, despite being highly aware of climate change (Pelham, 2009). The only studies that go into more personal detail are small and very limited in scope (Sigurvinsdóttir, Halapi, & Ólafsson, 2013; Halapi, 2013). Furthermore, no study has analyzed experiences, a major component of perception (Lee, Markowitz, Howe, Ko, & Leiserowitz, 2015).

The goal of this project was to assess how Icelandic communities interact with the effects of climate change by documenting the personal experiences of lifelong residents. The following sections highlight some of the key dimensions of climate change in Iceland. First, we frame the interaction between people and climate change in terms of vulnerability, adaptability, and resilience. We then present story analysis as a means of understanding the changes from the point of view of affected residents. Finally, we discuss why stories are valuable.

1.2 Physical Impacts of Climate Change in Iceland

To describe the effects of climate change in relation to people, we use the concepts of vulnerability, adaptation, and resilience. These concepts, although applicable to many fields of study, are frequently used in climate change research (Janssen, Schoon, Ke, & Börner, 2006). Similarly, we focus only on the vulnerabilities, adaptations, and resiliencies concerning climate change in Iceland.

Vulnerabilities

Vulnerability refers to how much an area's geography, ecology, and other factors are at risk from climate change (Schneider et al., 2007). It is often described through tangible indicators such as landscape features and any negative repercussions on a community. Many of Iceland's most prominent natural features are sensitive to changes in climate. Therefore, people who are dependent on such features are potentially vulnerable to any transformations.

Glacial recession is the most discernible vulnerability. Iceland's two largest glaciers, shown in Figure 1, are projected to completely disappear by 2200 (Aðalgeirsdóttir et al., 2006; Hannesdóttir, Björnsson, Pálsson, Aðalgeirsdóttir, & Guðmundsson, 2015). Concurrently, another glacier has seen a 500-meter recession since 1996 (Flett, 2017). Over the past two decades, the rate of retreat has more than doubled (Flett, 2017). This alarming rate of glacial melt will cause a 50% increase in size of the glacial runoff rivers by the end of the century (Aðalgeirsdóttir et al., 2006; Hannesdóttir et al., 2015). The magnified runoff can cause flooding and increased material deposition, negatively affecting residents living near glaciers.

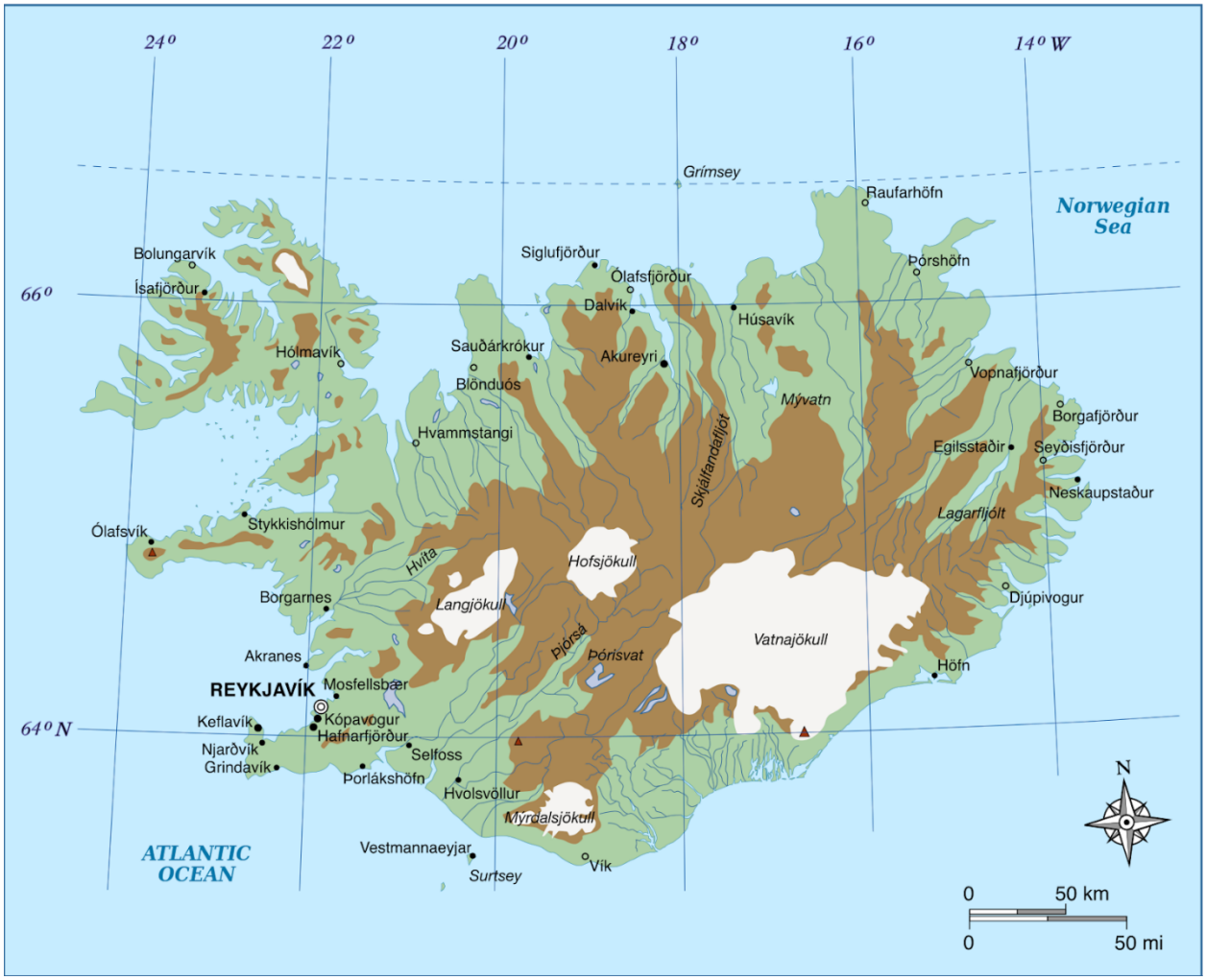


Figure 1. Glaciers (white), highlands (brown), and lowlands (green) of Iceland. Vatnajókull and Langjókull are the largest glaciers. Glacial runoff rivers and towns are also shown (Pethrus, 2010).

Climate change is also causing changes in the aquatic ecosystem, affecting the entire country. The fishing industry in Iceland accounts for 25% of national exports (Organisation for Economic Co-operation and Development, 2014), so migrating fish represent a major economic vulnerability. Arctic and subarctic species in the North Sea are diminishing in number and migrating elsewhere. These changes are directly correlated to warming waters. Young cod, for example, are starving due to plankton peaking earlier in the year (Poloczanska, 2016). These changes are reflected in the decreased fishing yield (Figure 2). Without the fish to support this influential industry, Iceland's total

employment, economy and culture are drastically changing (Einarsson, 2011, p. 19). Icelandic fishers may be able to recoup their losses by following the fish; this would be an adaptation.

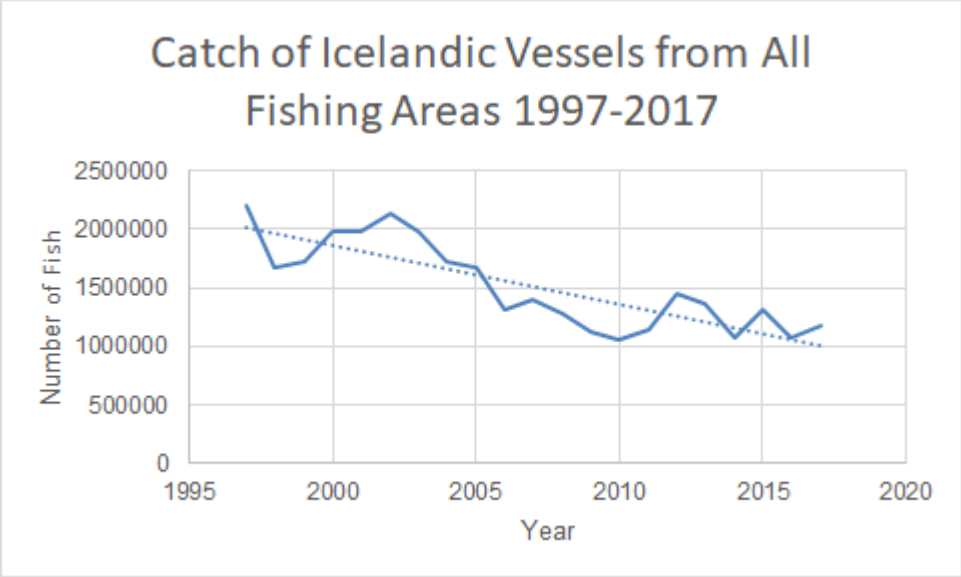


Figure 2. General reduction in fish yield 1997-2017. Data retrieved from The Icelandic Directorate of Fisheries. August 14 2018, retrieved from http://px.hagstofa.is/pxen/pxweb/en/Atvinnuvegir/Atvinnuvegir__sjavarutvegur__aflatolur__fiskveidisvaedi/SJA09005.px/t

.

Adaptations

Adaptations are the actions taken or changes undergone to address vulnerabilities. As the climate continues to change, communities will need to adapt more to preserve themselves (Schneider et al., 2007). In the absence of profitable fishing, many communities turned to tourism (Baum, 2010). Not all vulnerabilities can be sidestepped in this manner. Puffin hunting is an integral part of certain Icelandic cultures, comparable to surfing in Hawaii (Katz, 2017).

The disappearance of puffins represents a vulnerability for some Iceland communities that depended on the birds for food. Historically, puffins have been a staple food all over Iceland; 50 years ago, a single person could catch and eat up to 6,000 birds a year (Katz, 2017). Warming oceans are causing puffins' prey to migrate further north than the puffins can follow (Figure 3), contributing to a decline in puffin numbers (Auth, 2015). To adapt, people have reduced their consumption of puffin meat (Katz, 2017), limiting their yearly intake to a sustainable amount while preserving the strong cultural aspect of seabird hunting. This adaptation may be helping the puffin population recover in southern regions (Figure 4) (Icelandic Magazine, 2018; Sævarsson, 2018).

Figure 3. Puffin carrying the fish it depends on to survive (Preston, 2017).

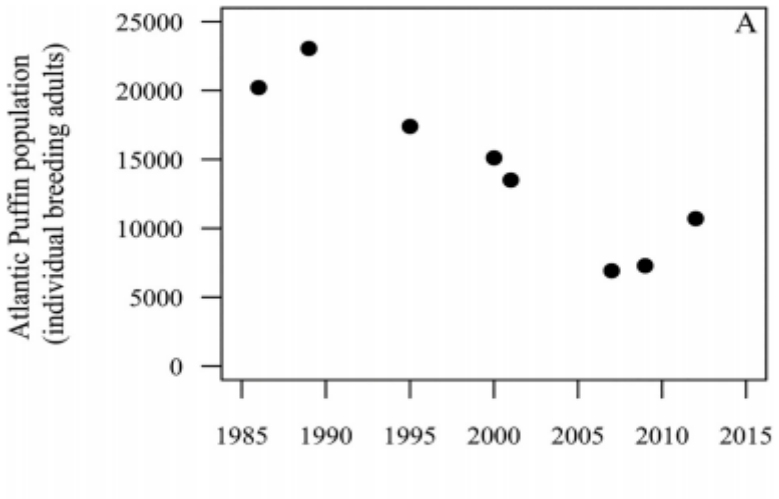


Figure 4. Population size estimates for Atlantic Puffin in Fair Isles over 30-year period. Population recently bounced back due to adaptive policies (Miles, 2015).

Some of Iceland's adaptations to climate change have actually benefited the country. Although the increased glacial melt poses a threat for nearby communities, the extra water can provide a vast amount of usable energy. Hydroelectric power companies have adapted to this by preparing their dams to handle the heightened influx of water (Aðalgeirsdóttir et al., 2006).

Additionally, warming climate and glacial retreat are allowing vegetation to flourish nationwide and farmers to experiment with new crops (Raynolds, Magnússon, Metúsalemsson, & Magnússon, 2015; Wreford, Moran, & Adger, 2010). Some crop species, such as barley, are being grown for the first time since the year 1000 (Jóhannesson, 2010).

Resiliencies

Not all communities will need to adapt. It is possible to possess an innate resistance to climate change. The measure of how well a community can withstand or recover from the impacts of natural changes is known as resilience (Folke, Carpenter, Walker, Scheffer, Chapin, & Rockström, 2010). Iceland's capital city, Reykjavik, is resilient to sea level rise. Most of the city is between two and thirty meters above the current sea level (Figure 5), well beyond the annual 5.5 millimeter increase (Ministry for the Environment, 2007, p. 72). Although the sewer system may need some adjustment (Hlöðversdóttir, 2010), the city as a whole will not be significantly impacted by rising sea levels.

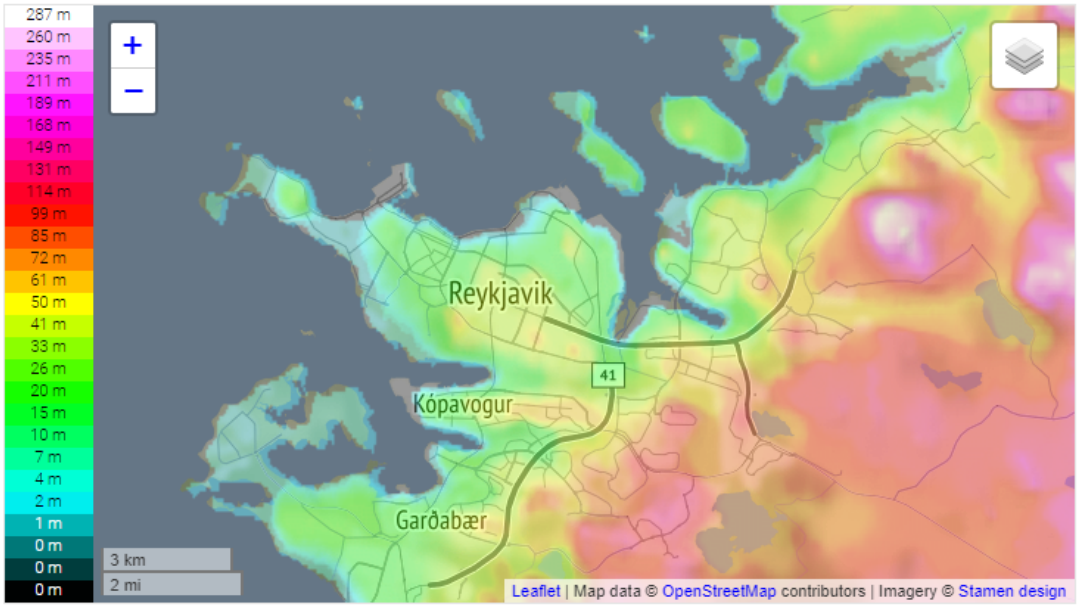


Figure 5. Topographical map of Reykjavik. Color indicates elevation; most of the city is high above sea level, making the city as a whole resilient to sea level rise, even though lower areas may experience problems (topographic-map.com, 2018).

Iceland is building resilience all over the country, not just in the capital city. In June of 2018, the World Health Organization (WHO) met in Reykjavik to discuss strategies for dealing with climate change. Iceland, a "world champion of resilience," (World Health Organization, 2018a) shared its expertise with the eight Member States of the European Region of WHO. The WHO (2018b) manifesto specifically addressed three vulnerabilities: freshwater availability, sea-level rise, and extreme weather. Iceland plans to fully implement climate-resilient water supplies and sewage systems by 2022 in response to the concern over limited water sources. The country is also one of many nations to raise awareness of the risks involved, and in developing preparedness-and-response protocols. Improving social services and education are adaptations that lead to human resilience, an important component of resilience as a whole (Keim, 2008).

1.3 Personal Experiences of Climate Change

Researching climate change through scientific terminologies explains observable effects but offers a shallow insight into experiences. Exploring cultural worldviews and social environments deepens our understanding of climate change because it exposes personal insights that might otherwise be

overlooked (Akerlof, 2013). This is especially true in Iceland, where a sense of inevitable unpredictability discourages long-term planning, perhaps due to the influence of Norse mythology (Einarsdóttir, Vilhjálmsdóttir, Sáradóttir, & Kjartansdóttir, 2015). This is evidenced by the popularity of the phrase "þetta reddast," meaning "it will all work out somehow." Einarsdóttir emphasizes that Iceland's many tight-knit communities have more potential to be adaptive, because individuals have a stronger sense of their own importance; thus, they are more proactive. In general, adaptation strategies that incorporate Iceland's unique cultural qualities will be more effective than those that do not (Besel, Burke, & Christos, 2014). However, a quantitative approach is ineffective at researching perceptions. One way to qualitatively understand a country's social environment is through stories.

Cultural insights manifest in the stories of individuals, ultimately because the line between person and society is blurry. A study on narrative methods by Erol Isik (2010) argues that people create narratives from their own self-image, but there is no dualism between self and society. Thus, the stories that individuals tell reflect greater cultural themes; essentially, they are ingrained into the culture itself. This may be due to the ability of storytelling to foster empathy between people (Robson, 2018), especially when providing a sense of solidarity in times of hardship (Isik, 2010).

Of course, empathy is also useful to researchers studying culture. It heightens an interpreter's understanding of what an individual is trying to convey (Koch, 2012). Isik (2010) also found that storytellers live in a story's moment, so the information recalled is more accurate and vivid. This profound aspect of storytelling has been utilized as a powerful tool over many platforms of media. In 2003, StoryCorps started in New York City's Grand Central station as a non-profit organization focused on collecting and preserving people's stories (StoryCorps, 2018). The project gained national importance; it won the Peabody Award in 2006 and is currently archived in the Library of Congress. Founder Dave Isay claims that StoryCorps is essential in sharing humanity and weaving a fabric of understanding into our culture.

Another movement that utilizes the effectiveness of storytelling is called the Humans of New York (HONY). Founder Brandon Stanton uses social media platforms to display the stories people tell. The Facebook page shares the perspectives and experiences of everyday people throughout the city and quickly rose to popularity worldwide. HONY's millions of followers are attracted to the idea that everyone has personal problems (Culzac, 2014). The blog has now expanded to documenting the stories of refugees and communities affected by war. Stanton's project allows millions around the world to see through the eyes of others.

From the first oral folklore to present-day media, storytelling remains an essential human behavior that broadens understanding and compassion. The rise of tale-telling is thought to have coincided with the development of human speech, though the specific origin of storytelling is unknown. Cave paintings and cuneiform tablets are a few pieces of evidence that show the development of storytelling throughout history (Robson, 2018). Researchers at the University of London studied storytellers in small communities and found that those identified as "good storytellers" were more desirable to live with than reputable hunters, suggesting that hearing a good story may sometimes be chosen over eating a good meal (Kluger, 2017). Icelanders in particular have always relied heavily on stories. Spoken and written word was the basis for Icelandic art until the 20th century, when other art forms slowly surfaced (Árnadóttir, 2010). Without many archaeological remains, the country uses myths and legends to explain the country's history and pass down cultures and traditions. The tales of witches, trolls and elves are an integral part of Iceland's culture and the use of these stories

enhance historic sites around the country. Some ruins are not even recognizable for what they are without an accompanying legend (Árnadóttir, 2010). Icelanders are highly familiar with the art of storytelling; thus, their stories may be exceptionally powerful tools for communicating their experiences to outsiders.

In asking for stories, we allowed our qualitative data to be dictated by our interviewee's narrative. This was the most effective way to gather their perceptions, for our data was not steered in the direction of our climate change research. Storytelling provided unbiased experiences to compare with our research. With this background in physical and social sciences, we began our project on collecting Icelanders' stories of climate change.

Chapter 2: Methods

The goal of this project was to collect stories of how changes in the environment have impacted lifelong residents of Iceland. With these stories, we explored discrepancies and similarities between what the residents perceived and what science has established. To achieve this goal, we completed the following three objectives.

1. Identify regions and communities in Iceland that are vulnerable to climate change according to scientific literature and expert opinion.
2. Collect lifelong residents' stories of how changes in the environment have impacted them over the course of their lives.
3. Map similarities and discrepancies between local perceptions and scientific findings.

Objective 1: Identify Regions and Communities in Iceland that Are Vulnerable to Climate Change According to Scientific Literature and Expert Opinion

To be able to best collect valuable stories of how Icelanders are impacted by climate change, it was first necessary to know how climate change affects Iceland and its communities. This understanding was built on our research of the unique ways Iceland is vulnerable, resilient, and adaptable. Many effects of climate change are subtle and slow moving. With this in mind, we interviewed scientists to learn where climate change was most prominent and noticeable. This helped us determine regions of interest.

First, we conducted semi-structured interviews with three climate scientists at the Háskóli Íslands to develop our understanding of how climate change affects Iceland. This approach allowed us to precisely identify interesting regions while leaving space for relevant but tangential knowledge (Jamshed, 2014). Interviews began with signing the preamble and asking preliminary questions (see Appendix A). Then we moved on to the interview questions (see Appendix B), where we learn about locations affected by prominent climate change effects in Iceland, how these effects impact resident and other topics geared toward the scientist's expertise. Each interview was filmed after gaining the scientists' permission to record.

The goal of each interview was to establish what regions of Iceland see the most drastic and noticeable effects of climate change. The scientists helped us pinpoint which communities were most vulnerable to climate change. Then, we asked questions about the resilience and adaptations of

these communities and Iceland as a whole. As we brought the interview to a close, we asked the expert if they had any contacts in the aforementioned communities. Having access to these contacts gave us a foothold in the communities if we decided to collect stories there.

Our first interview was with Dr. Guðfinna Aðalgeirsdóttir, a glaciologist at Háskóli Íslands. We conducted this interview to understand exactly how glacial runoff and other facets of glaciers affect communities in Iceland. Next, we interviewed Dr. Þröstur Þorsteinsson, who specialized in dust but had a broad understanding of the Icelandic environment. Our last interview with Dr. Brynhildur Davidsdóttir was intended to not only triangulate what we know about climate change but also to further our understanding on how the government interacts with the effects of climate change.

Objective 2: Collect Lifelong Residents' Stories of How Changes in the Environment Have Impacted Them over the Course of Their Lives.

Understanding how climate change physically affects a community fails to consider how people perceive and experience the effects. To deepen our understanding, we interviewed lifelong residents of Iceland to collect stories on changes over an extended period of time.

We found interviewees by using convenience sampling. This method was the most efficient and inexpensive compared to other methods (Bornstein, Jager, & Putnick, 2013. However, convenience sampling had a built-in selection bias for interviewing people who were interested in talking about climate change (Etikan, Musa, & Alkassim, 2015). Because we were looking for stories specific to climate change, this bias worked in our favor. To start this sampling, we headed to a location in a community where we could learn more about its people. For instance, we went to a library in Akranes and a town information center in Vík í Mýrdal. These locations had lifelong residents who made great interview subjects and could direct us to other residents.

In order to further increase our sample size, we used the snowball method of sampling whenever possible. Icelandic communities are usually close-knit, so snowballing was particularly effective in small towns (Palinkas, 2013). Lifelong residents will know other lifelong residents, so this method's tendency to skew data by leading to similar people also supported our purposes (Atkinson & Flint, 2001). To draw out their recollections of changes, we formed open-ended questions to guide the conversation towards specific aspects of their life.

When interviewing, we avoided directly mentioning the environmental changes we had studied to stay unbiased. This structure was chosen to make the interviewee feel more comfortable, thus allowing them to tell their stories more freely. Our research from objective one was integral to determining if a story the interviewee told connected to changes in the environment. If the focus shifted to a more valuable topic, we continued with that narrative. Our set of questions evolved as we discovered which ones yielded the most detailed and relevant responses.

Each interview began with introducing ourselves and presenting the preamble. All interviewees were provided with a copy of the preamble to sign. Then, we asked preliminary questions. These covered the legal procedures of our interviews, including our permission to film and the interviewees right to anonymity (see Appendix C). After introductions, we asked our research questions (see Appendix

D). Initially, we asked if they are willing to discuss their observations and perceptions of climate change for 5 to 15 minutes. If the interviewee was busy, we asked to set up an interview with them at a later time. We continued this process until we had 32 interviews.

Objective 3: Map similarities and discrepancies between local perceptions and scientific findings.

With the results from our interviews we were able to draw similarities and discrepancies between people's stories and scientific findings. To manage our interviews and prepare them for analysis, we transcribed them verbatim. To determine cross-referenceable themes as they appeared in our data, we coded using content analysis (Ratcliff, n.d.).

Scientific findings and local perceptions were respectively based on interviews of scientists and interviews of residents. With content analysis, we found emergent themes in the scientific and residential sets of data. We pulled predicted risks from the pool of scientist interviews; from the pool of resident interviews, we identified perceived risks. We defined "perceived risk" as any impact from climate change that is acknowledged as problematic, threatening, concerning, or requiring adaptation.

Some perceived risks were brought up completely independently while others were prompted by our questioning. Keeping in mind that the interviewee may have been quietly indifferent about the subject at hand, we attempted to distinguish between these levels of risk perception in our findings by specifying the independent-to-prompted ratio for each impact of climate change. To compare the predicted risks and perceived risks, we inserted them into four Venn diagrams.

Chapter 3: Findings and Discussion

In this chapter, we first present our findings from climate change experts. We compare the similarities and discrepancies between perceptions in communities and scientific perspective. Through Venn diagrams, we discuss interesting aspects in social and cultural trends in perception.

3.1 Findings from Scientists

According to scientists, all of Iceland experiences the effects of climate change. However, the indicators vary between different regions. Dr. Þröstur Þorsteinsson, the second climate scientist we spoke to, spoke about how Iceland was seeing and increase vegetation across the country. Professor Brynhildur Davidsdóttir, a glaciologist, built on this, saying that the southern and western regions were seeing a distinctively sharp rise in vegetation. In particular, the Icelandic birch tree, has been thriving in the west due to the warmer and rainier climate. Another result of the warmer climate is the increase in landslides, as mentioned by Professor Brynhildur Davidsdóttir, an expert on mitigation and adaptation. As the ground in the highlands of Iceland thaws, rocks and dirt slide down the mountains. This has the potential to be devastating for towns below. Professor Brynhildur Davidsdóttir cites pure luck as the reason that no one has been affected by these landslides, many of which have occurred on the Snæfellsness peninsula in western Iceland. Professor Brynhildur Davidsdóttir voiced her great concern for the fishing towns in Iceland. Changes in ocean

temperature have already caused the fishing industry difficulties and the professor cites that Iceland has yet to see the effects of ocean acidification.

From our interviews, we found that each town and region experienced climate change differently (Appendix E). Vík and Höfn proved to be two such locations that were vulnerable to the impacts of climate change in unique ways. Furthermore, Westman Island was the only location discussed that had a clear and imminent cultural vulnerability. Stykkishólmur's location, on the the Snæfellsness peninsula, puts it at the forefront of landslides and any effects climate change has had on the fishing industry. Lastly, the information Professor Brynhildur Davidsdóttir gave us on Iceland's western region made Akranes a viable location in which to conduct interviews.

Scientists emphasized that the effects of glaciers can be seen throughout all of Iceland. Their recession directly impacts nearby communities, with glacial runoff rivers spanning the entire country. According to Dr. Guðfinna Aðalgeirsdóttir, the town of Vík (Figure 6, point C) is a hotspot for flooding from increased glacial melt. Dr. Þröstur Þorsteinsson further elaborated on Vík's vulnerabilities. He mentioned that the town is seeing the effects of beach erosion. In the past, volcanic activity added sediment to balance out the beach deterioration. With less volcanic activity, beach erosion is the dominant force. Being adjacent to a volcano and glacier, Vík experiences many noticeable effects of climate change.

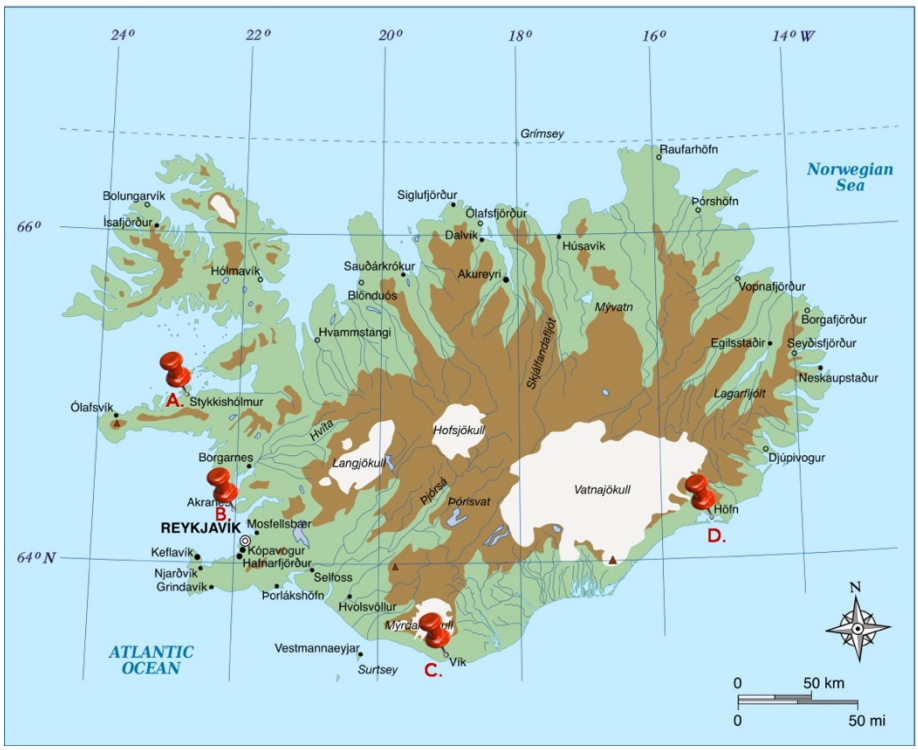


Figure 6. Glaciers, glacial rivers, towns, roads of Iceland. Vík and Höfn are on the south and southeast coast, respectively (Naylor, 2007).

Höfn's environment is affected by glacial melt in different ways. While the town does experience glacial flooding, the scientists we interviewed emphasized that Höfn experiences isostatic rebound. According to Dr. Guðfinna Aðalgeirsdótti, the sheer weight of the glaciers forces the land to sink down. Now that the glaciers are melting, the land is able to rise back up like a spring. Figure 6 clearly shows the immense size of Vatnajökull, the glacier closest to Höfn; as this glacier melts, Höfn will rise. Dr. Þröstur Þorsteinsson expressed further concern for Höfn. He speculated that the decreased weight on the land might lead to more frequent eruptions, as magma more easily breaches the surface.

Westman Island was another location that uniquely experiences climate change. This community was brought to our attention by Professor Brynhildur Davidsdóttir. As fish migrate in accordance with shifts in the ocean environment, the puffin population dwindles. Puffin hunting is embedded within the culture of the Westman Islands so any changes to the species is felt in this community.

3.2 Similarities and Discrepancies Between Local Perceptions and Scientific Findings

To accommodate Iceland's geographical diversity, our team split up findings by the towns in Figure 6. Each Venn diagram in Figure 7 (and individually shown in Appendix F) is labeled with a letter corresponding to one of these towns. The pin lettering follows chronological order, as we began interviewing at pin A (Stykkishólmur) and ended at pin D (Höfn). The following two subsections elaborate on the similarities and differences between what the scientists told us and what residents experienced.

It is important to note that our sample size is small. The length of in-depth interviews, combined with time and funding constraints, put a cap on the number of interviews we could have completed. This problem was exacerbated by the difficulty in finding willing interviewees, especially in the earlier locations. The small sample sizes severely limit the strength of our claims.

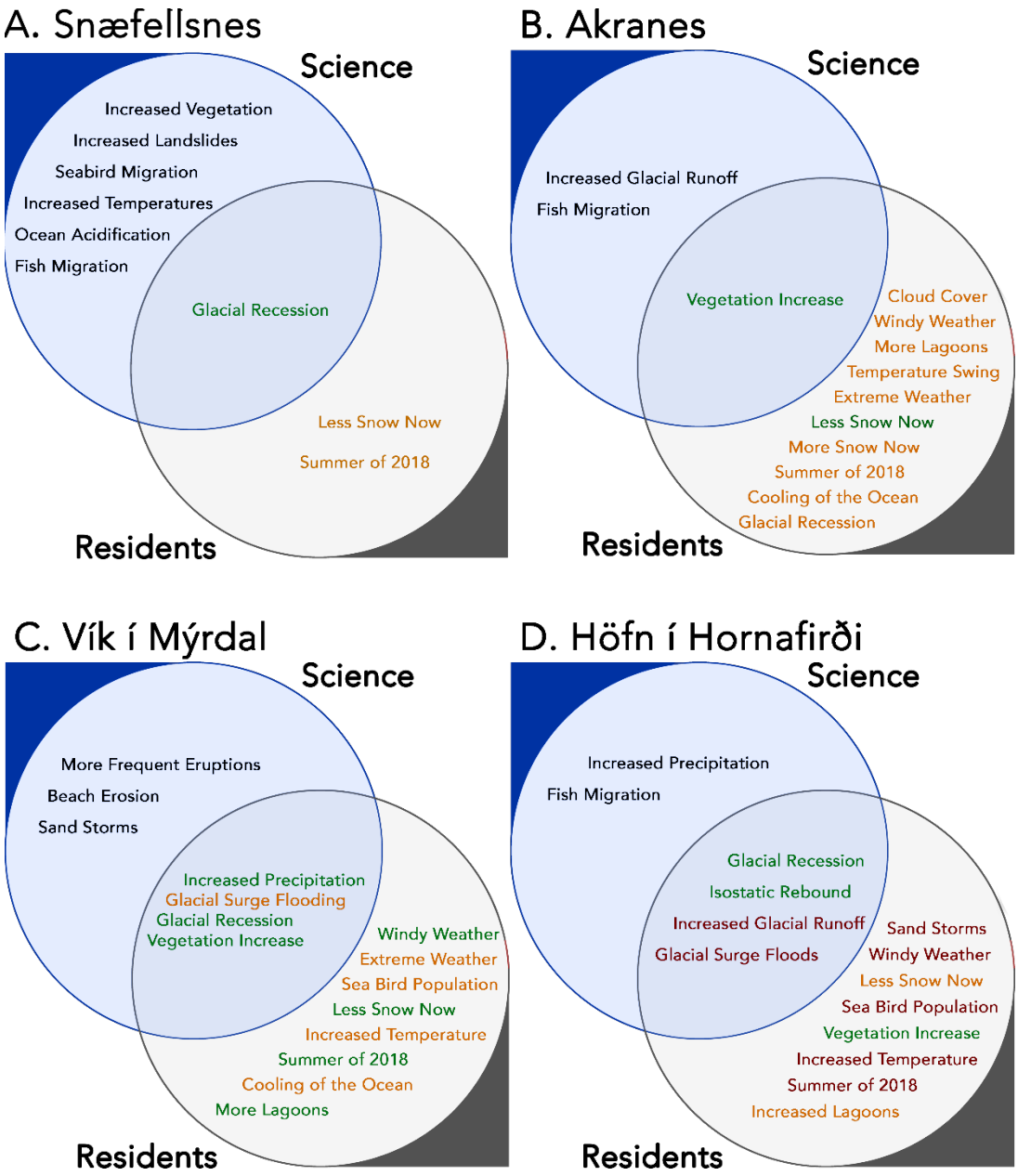


Figure 7. Venn diagrams of each town's predictions (blue) and perceptions (gray). Green text indicates a change mentioned by 25% or more; yellow, 8-24%; and red, <8%.

Similarities

Glacial recession proved to be the most noticed change, having been mentioned by 60% of all residents. This was unexpected; of the towns in which we interviewed, only Vík and Höfn were located near large glaciers. Even residents of Akranes considered glacial recession to be one of the primary changes affecting them. One man in Akranes went so far as to say "you have to be blind to

not notice the glaciers retreating." This hints at a nationwide understanding that all of Iceland is affected by the loss of its glaciers.

Glacial surge flooding was predicted to be a considerable threat to both Vík and Höfn. However, only one respondent in each town mentioned the possibility for future larger floods. This could mean that the floods are not as detrimental to locals as scientists implied; that flooding is a part of local life, and is taken for granted; or that a minority of residents are impacted by flooding. The first possibility is most likely in Vík, since flooding was mentioned by a tourism expert who was educated in the matter. In Höfn, it is more likely that only the farmers are affected. Regardless of the underlying reason, the lack of emphasis on flooding could indicate a resistance to adaptations thereof.

"My parents put a lot of work into [the bridge] because they run a guest house. And they own property at the other side of the glacier, so they wanted to make people make [the glacier] accessible to tourists. But the flood came, and just in a few minutes, the whole grassfield for our farm was covered in river."

Increased precipitation proved only to be noticed in Vík and was a main talking point of the people there. With Vík being such a naturally rainy area, it was surprising that half of our interviewees mentioned the increase. None of the other locations covered this point, so this could be indicative that Vík and the South coast experience this change the worst. An increase in precipitation for this area could prove detrimental for farmers, as one interviewee explained: "you need the grass to be dry before you cut it, so you need dry weather beforehand, and then you need it to be dry after you've cut it, so you can dry the hay and bale it. Because if you store it wet, it's just going to get moldy over the winter."

Höfn was one of the most notable towns due to the isostatic rebound. The impact of the phenomenon was well noticed as 50% of the interviewees discussed this. The landrise is so significant that islands have begun to appear in the harbor. These islands were visible from the local library so employees were able to watch this change unfold. When climate change indicators affect the everyday life and surroundings of residents, they are more likely to notice those changes.

In Akranes the only agreement between scientists and residents was with vegetation increase, with one interviewee saying that, "people just said…you can't grow trees in Iceland. It's impossible. Today we have a lot of trees." 28% of interviewees in Akranes noted this, as did 33% of Vík residents. While this is a consensus for Akranes and Vík, scientists did not emphasize this effect for other parts of Iceland. Despite this, 50% of interviewees from Höfn mentioned an increase in vegetation. Even though the change is less widespread in the south, it is more noticed.

Differences

Residents mentioned more changes than the scientists did. The decrease in snow during the winter proved to be an overarching difference, as every town had residents who mentioned this, with the exception of one person who had noticed more snow in recent years. Scientists did not mention this directly, but 26% of our interviewees discussed the decrease in snow. Many residents also noted that the weather tends to be windier and cloudier than previous years. These recollections may be due in part to the most recent summer. Nearly a third of the interviewed residents across all four towns mentioned that summers in recent years, particularly in 2018, have been less sunny and more rainy than they have in the past. Scientists mentioned an increase in precipitation as a climate change indicator, but this does not mention the intricacies noticed by residents. People noticed increased cloud coverage and more intense winds. A woman in Höfn specifically said that these weather changes affect the mood of her city, for the darker days added to seasonal depression. Overall, residents seemed to correlate changes in weather with climate change. The perceptions of climate change focus more on weather patterns than other indicators because it impacts people's every day lives.

Although the scientists emphasized how communities may be impacted by glacial runoff and recession, glacial lagoons were not a consideration of the scientific community. The experiences of some residents revolved around how these lagoons impacted tourism. Glacier tours increasingly required walking around bodies of water. One woman recounted how tourism companies adapted by starting kayaking programs.

Overall, there was not a linear correlation between what scientists emphasized and what Icelanders perceived (Figure 8). The R^2 value, which represents how well the points fit a line, was .006. This extremely low number means that the points do not line up at all. The lack of correlation indicates that scientific data alone cannot predict how residents perceive climate change. Therefore, social research is crucial for understanding how to help communities adapt.

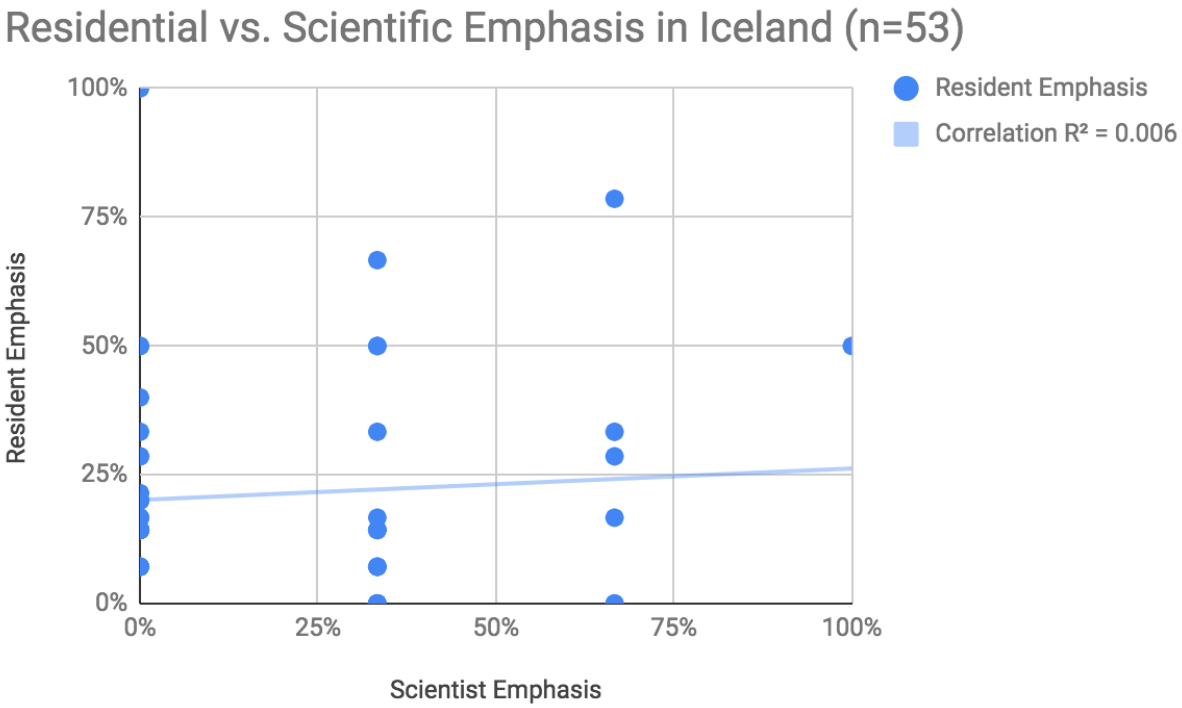


Figure 8. Each point is a specific indicator, such as "increased vegetation," that was mentioned by scientists and/or residents. Emphasis refers to how many people mentioned it. The extremely low R^2 value indicates that the data is not suited for a linear fit.

A notable exception to this was Höfn, with a positive trendline, an R^2 value of 0.433, and a sample size of 17 (Appendix G). This shows that scientists and residents agreed on the significance of the changes there, such as isostatic rebound. Snæfellsness also had a high R^2 value, 0.641, but with a negative slope. However, the low sample size of 7 is far too small to to represent statistical significance. Regardless, it is interesting that the correlation was negative there. It may be worth further investigation. Additional data may also suggest different regressions for each town and for Iceland as a whole. Input from more scientists would be especially helpful in determining whether or not there is a correlation.

3.3 Concerns and Stories of Residents

We gathered concerns of the citizens within different regions. The variant in Iceland's communities becomes apparent when looking into the effects mentioned by residents. Akranes was described by a local tour guide as a "sleepy town" and is a relatively urban area. When residents of the city were asked to explain what concerned them most, four out of seven residents mentioned the city's heavy dependence on vehicles. A school teacher specifically discussed her worry that Iceland will become "suffocating, with tall buildings and cars everywhere." Although car usage is not seen as an indicator of climate change, residents of Akranes feel that trend can impact their quality of life.

On the other hand, residents of a small fishing town surrounded by glaciers had a different story to tell. Seventy-eight percent of the residents we interviewed in Höfn mentioned the quickly receding

glaciers without any prompting. The concern in the town was more directly related to climate change than the worries in a city. Residents talked about the negative repercussions of the quickly disappearing Vatnajökull glacier. The most concerning aspect of the ice recession was isostatic rebound. As the land rises, pipes and bridges are beginning to bend and could break. Furthermore, this phenomenon makes entrance into the harbor more challenging. The mouth of the harbor is rising up, and larger boats that sit lower in the water are not able to enter anymore. Because fishing is a primary industry in Höfn, many residents questioned what the town would do if the company were forced to shut down.

"If the gulf stream stops coming because of the melting of the North Pole and glacier, it's probable and Iceland will not get warmer. It'll get a lot colder and it'll freeze through and it won't be livable and all the fish will be gone and we won't have anything to live on."

After collecting the residents' experiences with climate change indicators, we found that concern and culture were related. Perceptions of climate change effects varied in different parts of Iceland but the attitude towards changes remained relatively similar. Through our thirty interviews, interviewees followed up stories of their childhood by doubting their memory. Many people explained that their recollection may only be a result of the humanistic tendency to "only remember the good or bad days." Every resident talked the about changes he or she noticed. Overall, they were not worried by these changes. Icelanders may be simply accustomed to sporadic weather. Another social trend was the previously mentioned outlook of "þetta reddast." For example, a hotel manager in Vík talked about the emissions from one volcanic eruption surpassing the carbon dioxide emissions from driving. Though she expresses the importance of being environmentally conscious, she reiterated that nature always works itself out. This theme continued through roughly 70% of our interviews. From this, we found that many interviewees were not worried about indicators they directly noticed.

Another interesting pattern lies between noticed indicators and the reasons for concern. According to our data, 68% of residents brought up glacial recession when asked what they have noticed in terms of climate change. However, no one was concerned about the direct effects of glacial recession. Instead, most interviewees expressed concern for their children and grandchildren. For example, a Vík tour guide was focused on being environmentally conscious but was not extremely worried about the effects of climate change in Iceland. She was more worried about her children not being able to experience the glaciers. The most specific concern was the Gulf Stream. Seven out of thirty residents expressed worry for their country and explained that the lack of Gulf Stream would render Iceland uninhabitable. The Gulf Stream originates from the Gulf of Mexico and brings up warm air to offset the cold ocean around the island. This concern was often mentioned by residents in all four areas we interviewed. While experiences and stories changed greatly by region, this one story was discussed consistently through many interviews. The Gulf Stream is not limited to any region in Iceland; it could cause the entire country to drop five degrees Celsius.

Icelanders are fairly resilient to bad weather. In fact, one kindergarten teacher in Höfn jokingly said "I think that is what makes Icelanders. We're crazy in many ways and I think it's because of the weather." The general consensus regarding climate change in Iceland tended to refer back to nature. Long term residents grew up on sporadic weather so subtle changes and slightly more extreme weather patterns are not causes for concern. As a result, Icelanders do not perceive themselves as vulnerable.

Chapter 4: Concluding Thoughts

If given the time and resources, our team would have expanded our interviews into the northern and eastern coast of Iceland. If this project is ever repeated, we recommend focusing on the northern side of the country. Húsavík, as Brynhildur suggested, has the potential to be rich in stories. The Westman Islands also have unique climate change indicators and could add to our existing data regarding the south coast. These two areas would be a good start for future research.

Considerations

Our project encountered many roadblocks due to the nature of in-depth interviews. The first problem we noticed was that asking "how has climate change impacted your life" was too vague. Interviewees only rarely identified specific impacts in response to this question. By inquiring about climate change's impact on specific aspects of their lives, such as their jobs and culture, we were able to draw out relevant stories, and we recommend the same approach.

Using our interviews for documentary footage highlighted a second problem. We found that we were making too many sounds while interviewing. This rendered the majority of our footage unusable. By cutting out the "mmm"s and "uh-huh"s, we greatly improved video quality, and it came with an additional side effect: interviewees were more likely to elaborate. By not interjecting between silence, the interviewee is given more time to gather their thoughts and provide a more detailed response. Future groups will find that even if they are not producing a documentary based on footage from interviews, they will still benefit from minimizing vocalizations during them.

Every community had unique characteristics that affected its relevance to our research. For example, we met very few residents of Vík and Stykkishólmur; most of the people we encountered there were seasonal workers, and several residents did not speak English well. With this in mind, we recommend that future studies focus on larger communities. However, these larger cities tend to have commuters, making it difficult to find residents from the specific city. For instance, several people that we interviewed in Akranes lived in Reykjavik.. This is only a problem if the region where people live and the region where people work undergo sufficiently different changes. This was not the case for us because Reykjavik and Akranes are similar in both culture and geography. However, it is not inconceivable that a coastal inhabitant who commutes inland would have very different perceptions compared to inland residents.

There are many other factors that go into deciding which regions to study. Distance from the project center is a major limitation, but it is possible to reduce this by visiting multiple regions in a single trip. One week-long trip is much more cost- and time-efficient than returning to the center

after each region. We combined the Westman Islands and Höfn into such a trip, and even though we skipped the islands due to plane delays, we were able to go to Vík instead. Akranes was where we were based, so we went on many short interviewing sprees. The Snæfellsness Peninsula was close enough to make day trips there. Combining trips, having backup plans, and taking advantage of nearby places are all keys to successful interviewing.

If there is one strategy that supersedes all other recommendations, it is making contacts. Our contact in Höfn facilitated most of our interviews there, and was integral to our success. One contact in Vík even arranged to have a guide give us a tour of a glacier as we interviewed him. Because of this, we recommend relying on contacts whenever possible.

Conclusion

Iceland is a kaleidoscope of perspectives and phenomena, and our research is just the tip of the iceberg. We gathered stories from four distinct communities, with each one adding insight into how people are impacted. With a heightened understanding of the perceptions of each community, future adaptation strategies can better address the multitude of interconnections between environment and civilization.

Climate change is a global issue that is transforming the environment and society alike. As research into climate change advances on the physical front, the social front lags behind. This study, and many others across the world, are required to fully integrate natural adaptations with humanistic requirements. Ultimately, it is people, not the planet, at stake.

References

Aðalgeirsdóttir, G., Jóhannesson, T., Björnsson, H., Pálsson, F., & Sigurðsson, O. (2006). Response of Hofsjökull and southern Vatnajökull, Iceland, to climate change. *Journal of Geophysical Research, 111*. doi:10.1029/2005JF000388

Akerlof, K., Maibach, E. W., Fitzgerald, D., Cedeno, A. Y., & Neuman, A. (2012). Do people "personally experience" global warming, and if so how, and does it matter? *Global Environmental Change, 23*(1), pp. 81-91. doi: 10.1016/j.gloenvcha.2012.07.006

Atkinson, R., Flint, J. (2001). Accessing hidden and hard-to-reach populations: Snowball research strategies. *Social Research Update 33*. Retrieved from http://sru.soc.surrey.ac.uk/SRU33.html

Auth, K. (2015). The Oceans: Resilience at risk. doi: 10.5822/978-1-61091-611-0_6

Árnadóttir, B. (2010). Iceland country report: Storytelling at the Settlement Center of Iceland. *Icelandic Tourism Research Center*.

Baum, T. (2010). The decline of the traditional North Atlantic fisheries and tourism's response: The cases of Iceland and Newfoundland. *Current Issues in Tourism 2*(1). doi: 10.1080/13683509908667843

Besel, R. D., Burke, K., & Christos, V. (2014). A life history approach to perceptions of global climate change risk: Young adults' experiences about impacts, causes, and solutions. *Journal of Risk Research, 20*(1). doi:10.1080/13669877.2015.1017830

Bornstein, M. H., Jager, J., & Putnick, D. L. (2013). Sampling in developmental science: Situations, shortcomings, solutions, and standards. *Developmental Review, 33*(4), pp. 357-370. doi: 10.1016/j.dr.2013.08.003

Culzac, N. (2014, July 17). The HONY effect: How 'Humans of New York' is altering lives. *Independent*. Retrieved from https://www.independent.co.uk/news/world/americas/the-hony-effect-how-humans-of-new-york-is-altering-lives-9611015.html

Einarsdóttir, S., Vilhjálmsdóttir, G., Smáradóttir, S. B., & Kjartansdóttir, G. B. (2015). A culture-sensitive approach in the development of the Career Adapt-Abilities Scale in Iceland: Theoretical and operational considerations. *Journal of Vocational Behavior, 89*, pp. 172-181. doi:10.1016/j.jvb.2015.06.006

Einarsson, N. (2011). *Culture, conflict and crises in the Icelandic fisheries: An anthropological study of people, policy and marine resources in the North Atlantic arctic.* (doctoral dissertation). Retrieved from https://uu.diva-portal.org/smash/get/diva2:399170/FULLTEXT01.pdf

Etikan I, Musa, S. A., & Alkassim, R. S. (2015). Comparison of convenience sampling and purposive sampling. *American Journal of Theoretical and Applied Statistics, 5*(1). doi: 10.11648/j.ajtas.20160501.11

Flett, V., Maurice, L., Finlayson, A., Black, A. R.,m MacDonald, A. M., Everest, J., & Kirkbride, M. P. (2017). Meltwater flow through a rapidly deglaciating glacier and foreland catchment system: Virkisjökull, SE Iceland. *Hydrology Research, 48*(6), pp. 1666-1681. doi: 10.2166/nh.2017.205

Folke, C., Carpenter, S. R., Walker, B., Scheffer, M., Chapin, T., & Rockström, J. (2010). Resilience thinking: Integrating resilience, adaptability and transformability. *Ecology and Society, 15*(4), 20. doi:10.5751/es-03610-150420

Gewin, V. (2017, March 28). Climate change is a boon to tourism in Iceland. *The Atlantic*. Retrieved from https://www.theatlantic.com/science/archive/2017/03/we-all-scream-for-iceland-cream/520980/

Halapi, E. (2013). Climate change: Perceptions and knowledge among young adults in Iceland. *University of Akureyri*. Retrieved from https://www.rha.is/static/files/Espon_Enecon_project/Conference_Akureyri/Presentations/Eva_ClimateChangeNorthenTerr.pdf

Hannesdóttir, H., Björnsson, H., Pálsson, F., Aðalgeirsdóttir, G., & Guðmundsson, Sv. (2015) Changes in the southeast Vatnajökull ice cap, Iceland, between ~ 1890 and 2010. *The Cryosphere, 9*(2), pp. 565-585. doi:10.5194/tc-9-565-2015

Hlöðversdóttir, Á. Ó. (2010). *Impacts of climate change on wastewater systems in Reykjavík* (master's thesis). Faculty of Civil and Environmental Engineering, University of Iceland, pp. 99. Retrieved from https://skemman.is/bitstream/1946/9878/1/Impacts%20of%20Climate%20Change%20on%20Wastewater%20Systems%20in%20Reykjav%C3%ADk.pdf

Icelandic Magazine. (2018, June 20) Great news: 2018 looks like a good year for the puffin population in S. Iceland. *Icelandic Magazine*. Retrieved from https://icelandmag.is/article/great-news-2018-looks-a-good-year-puffin-population-s-iceland

Isik, E. (2010). The role of narrative methods in sociology: Stories as a powerful tool to understand individual and society. *Journal of Sociological Research, 18*(1), pp. 103-125. Retrieved from http://dergipark.gov.tr/download/article-file/117727

Jamshed, S. (2014). Qualitative research method-interviewing and observation. *Journal of Basic and Clinical Pharmacy, 5*(4), pp. 87-88. doi:10.4103/0976-0105.141942

Janssen, M. A., Schoon, M. L., Ke. W., & Börnere, K. (2006). Scholarly networks on resilience, vulnerability and adaptation within the human dimensions of global environmental change. *Global Environmental Change, 5*(3), pp. 240-252. doi:10.1016/j.gloenvcha.2006.04.001

Jóhannesson, T. (2010). Agriculture in Iceland: condition and characteristics. *The Agricultural University of Iceland, Reykjavik, Iceland*. Retrieved from http://www.lbhi.is/lisalib/getfile.aspx?itemid=4090

Katz, C. (2017, January 17). Disappearing puffins bring an Icelandic hunting tradition under scrutiny. *Smithsonian.com*. Retrieved from https://www.smithsonianmag.com/science-nature/uncertain-future-puffin-dinner-180961829/

Keim, M. E. (2008). Building human resilience: The role of public health preparedness and response as an adaptation to climate change. *American Journal of Preventive Medicine, 35*(5). doi: 10.1016/j.amepre.2008.08.022

Kluger, J. (2017, December 5). How telling stories makes us human. *Time*. Retrieved fro http://time.com/5043166/storytelling-evolution/

Koch, T. (2002). Story telling: Is it really research? *Journal of Advanced Nursing, 28*(6), pp. 1182-1190. doi:10.1046/j.1365-2648.1998.00853.x

Lee, T. M., Markowitz, E. M., Howe, P. D., Ko, C., & Leiserowitz, A. A. (2015). Predictors of public climate change awareness and risk perception around the world. *Nature Climate Change, 5*, pp. 1014-1020. doi:10.1038/nclimate2728

Miles, W. T. S., Mavor, R., Riddiford, N. J., Harvey, P. V., Riddington, R., Shaw, D. N., Parnaby, D., & Reid, J. M. (2015). Decline in an Atlantic puffin population: Evaluation of magnitude and mechanisms. *PLoS ONE, 10*(7), e0131527. doi:10.1371/journal.pone.0131527

Ministry for the Environment. (2007). *Iceland's fifth national communication on climate change*. Icealnd: Ministry for the Environment. Retrieved from https://unfccc.int/resource/docs/natc/isl_nc5_resubmit.pdf

Naylor, M. (2007, June 23). *Map of Iceland* [digital image]. Retrieved October 5, 2018, from https://commons.wikimedia.org/wiki/File:Map_of_Iceland.svg

Organisation for Economic Co-operation and Development. (2014). OECD environmental performance reviews: Iceland 2014. *OECD environmental performance reviews*. Paris: OECD Publishing. doi:10.1787/9789264214200-en

Pagli, C. & Sigmundsson, F. (2008). Will present day glacier retreat increase volcanic activity? Stress induced by recent glacier retreat and its effect on magmatism at the Vatnajökull ice cap, Iceland. *Geophysical Research Letters, 35*(9). doi:10.1029/2008GL033510

Palinkas, L., Horwitz, S., Green, C., Wisdom, J., Duan, N., & Hoagwood, K. (2013). Purposeful sampling for qualitative data collection and analysis in mixed method implementation research. *Administration and Policy in Mental Health and Mental Health Services Research, 42*(5), pp. 533-544. doi: 10.1007/s10488-013-0528-y

Pelham, B. W. (2009). Awareness, opinions about global warming vary worldwide. *Gallup*. Retrieved from http://news.gallup.com/poll/117772/Awareness-Opinions-Global-Warming-Vary-Worldwide.aspx

Pethrus. (2010, March 22). Map of Iceland highlands [digital image]. Retrieved October 2, 2018, from https://commons.wikimedia.org/wiki/File:Map_of_Iceland_highlands-fr.svg

Phillips, M. R., Jones, A., & Thomas, T. (2018). Climate change, coastal management and acceptable risk: Consequences for tourism. *Journal of Coastal Research, 85*, pp. 1411-1415. doi: 10.2112/SI85-283.1

Poloczanska, E. S., Burrows, M. T., Brown, C. J., García Molinos, J., Halpern, B. S., Hoegh-Guldberg, O., Kappel, C. V., Moore, P. J., Richardson, A. J., Schoeman, D. S., & Sydeman, W. J. (2016). Responses of marine organisms to climate change across oceans. *Global Change and the Future Ocean.* doi:10.3389/fmars.2016.00062

Preston, I. (June 18, 2017). *Puffin P1220772* [photograph]. Retrieved from https://www.flickr.com/photos/9750464@N02/35611257062/

Ratcliff, D. (n.d.). 15 methods of data analysis in qualitative research. Retrieved from http://www.psychsoma.co.za/files/15methods.pdf

Raynolds, M., Magnússon, B., Metúsalemsson, S., & Magnússon, S. H. (2015). Warming, sheep and volcanoes: Land cover changes in Iceland evident in satellite NDVI trends. *Remote Sensing, 7*(8), pp. 9492–9506. doi: 10.3390/rs70809492

Robson, D. (2018, May 3). Our fiction addiction: Why humans need stories. *British Broadcasting Company*. Retrieved from http://www.bbc.com/culture/story/20180503-our-fiction-addiction-why-humans-need-stories

Schneider, S. H., Semenov, S., Patwardhan, A., Burton, I., Magadza, C. H. D, Oppenheimer, M., Pittock, A. B. Rahman, A., Smith, J. B, Suarez, A., & Yamin, F. (2007). Assessing key vulnerabilities and the risk from climate change. *Climate change 2007: Working group II: Impacts, adaptation and vulnerability* (19.1.2). Cambridge, UK: Cambridge University Press. Retrieved from https://www.ipcc.ch/publications_and_data/ar4/wg2/en/ch19s19-1-2.html

Sigurvinsdóttir, A. L., Halapi, E., & Ólafsson, K. (2013). Awareness, perception and attitudes on global climate change among adults in Iceland. *University of Akureyri.* Retrieved from https://www.rha.is/static/files/Espon_Enecon_project/Conference_Akureyri/Presentations/Anna_Lilja-ClimateChange.pdf

StoryCorps. (2018). Retrieved from https://storycorps.org/

Sævarsson, S. B. (2018, June 20). Eyjamenn geta fagnað rallinu í ár. *Morgunbladid.* Retrieved from https://www.mbl.is/frettir/innlent/2018/06/20/eyjamenn_geta_fagnad_rallinu_i_ar/

topographic-map.com. (2018). *Topographic map Reykjavik*. [digital image] Retrieved October 7, 2018, from http://en-dk.topographic-map.com/places/Reykjavik-3563332/

Wreford, A., Moran, D., & Adger, N. (2010). *Climate change and agriculture: Impacts, adaptation, and mitigation.* OECD Publishing. Retrieved from http://www.fao.org/fileadmin/user_upload/rome2007/docs/Climate%20Change%20and%20Agr.pdf

World Health Organization. (2018a). Climate change increasingly affects small countries. *World Health Organization, Europe*. Retrieved from

http://www.euro.who.int/en/countries/iceland/news/news/2018/6/climate-change-increasingly-affects-small-countries

World Health Organization. (2018b). Ensuring safe and climate-resilient water and sanitation: The Iceland statement. *World Health Organization, Europe*. Retrieved from http://www.euro.who.int/__data/assets/pdf_file/0006/375963/iceland-manifesto-20180703-h1015.pdf

Appendices

Appendix A: Preamble for Scientists

We are a group of students from Worcester Polytechnic Institute in Massachusetts. We are conducting interviews to learn more about local observations and opinions regarding climate change and how it affects small Icelandic communities. We believe an interview with an authority like yourself will guide us in deciding where and how to interview residents. Your participation in this interview is completely voluntary, and you may withdraw at any time for any reason. Your answers will be kept anonymous and confidential unless you permit otherwise. If any question is unclear, please ask for clarification. If you are interested, a copy of our results can be provided upon the conclusion of the study.

Do we have your permission to include your name and other specific identifying information? Yes ☐ No ☐

Do we have your permission to take notes, and publicly quote you, with your pre-approval for each quote, in this interview? Yes ☐ No ☐

Do we have your permission to record this interview? Yes ☐ No ☐

Appendix B: Questions for Scientists

1. Preliminary questions, so we know who we are talking to
    a. As we understand it, your area of expertise is _____. Would you like to elaborate on this?
2. Questions about Iceland climate
    . We are currently interviewing climate scientist to learn more about potential climate change markers we will see when interview rural Icelandic towns. Based on your knowledge of climate change, which regions have seen the effects most drastically?
    a. Based on your research, which livelihoods do you foresee being most at risk in the next century?
3. Observations
    . Part of our project is gathering the experiences of citizens. Can you recall a specific instance where you noticed climate change directly affecting your everyday life?
4. Postliminary questions
    . Do you know of any local communities who would be interested in speaking with us?

Appendix C: Preamble for Residents

We are a group of students from Worcester Polytechnic Institute in Massachusetts. We are conducting interviews to learn more about local observations and opinions regarding climate change and how it affects small Icelandic communities. Your participation in this interview is completely voluntary, and you may withdraw at any time for any reason. Your answers will be kept anonymous and confidential unless you permit otherwise. If any question is unclear, please ask for clarification. If you are interested, a copy of our results can be provided upon the conclusion of the study.

Do we have your permission to include your name and other specific identifying information?	Yes ▢	No ▢
Do we have your permission to take notes, and publicly quote you, with your pre-approval for each quote, in this interview?	Yes ▢	No ▢
Do we have your permission to record this interview?	Yes ▢	No ▢

Appendix D: Questions for Residents

Questions:

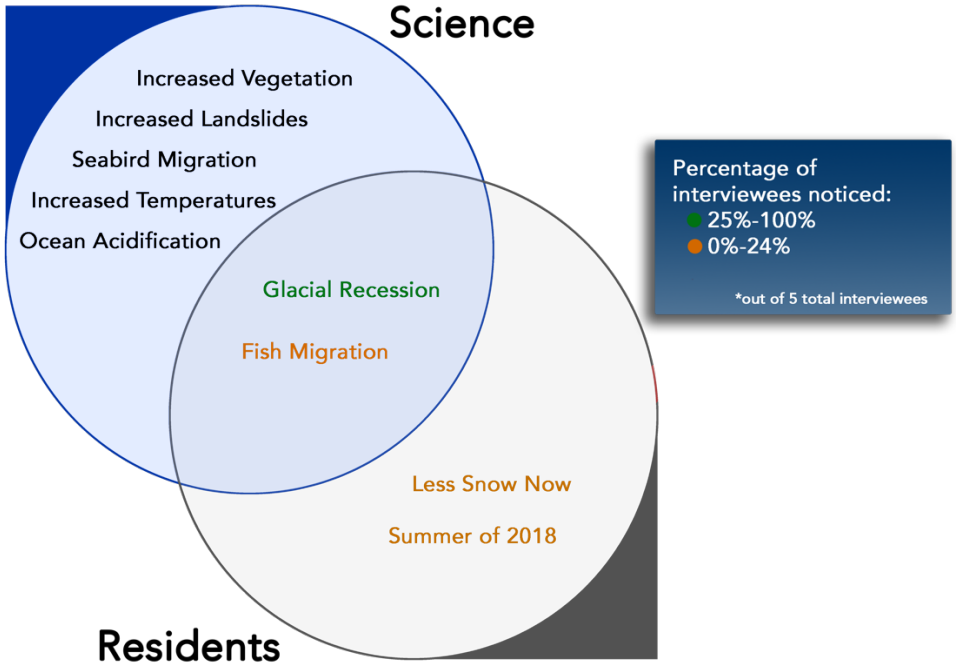
1. Warm-up Questions
    a. What is your name?
    b. How long have you lived in Iceland?
    c. What have you done for a living?
    d. How is growing up in Iceland different today than when you were a child?
2. General Questions (these are malleable)
    . Has your livelihood ever been affected by climate change?
        i. What about hobbies?
    a. Has climate change affected the culture of your community?
    b. Have you noticed any changes in the environment over the course of your life?
    c. How do you think these changes will affect you or your community in the future?
    d. Are you worried about any of these changes?
3. Follow-up Questions
    . Have any of your immediate family or friends been affected by climate change?
        . Could we talk to them?

Appendix E: Climate Change Indicators by Region

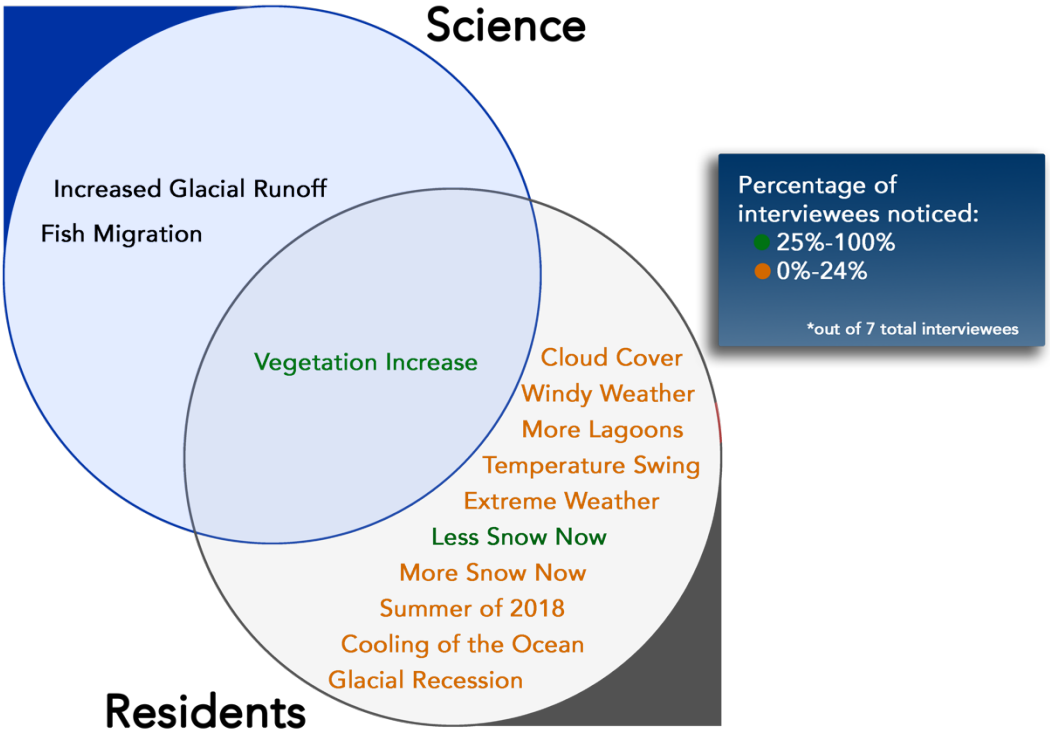
Change	Region or Town					
	Snæfellsness Peninsula	Akranes	Vík	Höfn	Westman Islands	Húsavík
More vegetation	2	2	1	1	1	1
More landslides	1	1	1	1	1	1
Seabird migration	1	1	1	1	3	1
Temperature change	1	1	1	1	1	1
Fish migration	1	1		1	3	
Glacier recession	1		1	2		
Increased tourism	1		1	1		
Cleaner industries		1				
More precipitation			1	1		
Isostatic rebound				3		
More dust			1			
Beach erosion			2			
Increased glacier melt			2	1		
More eruptions			1			
Whale decline						3
Total Score	**8**	**7**	**13**	**13**	**9**	**7**

Appendix F: Venn Diagrams by Research Towns

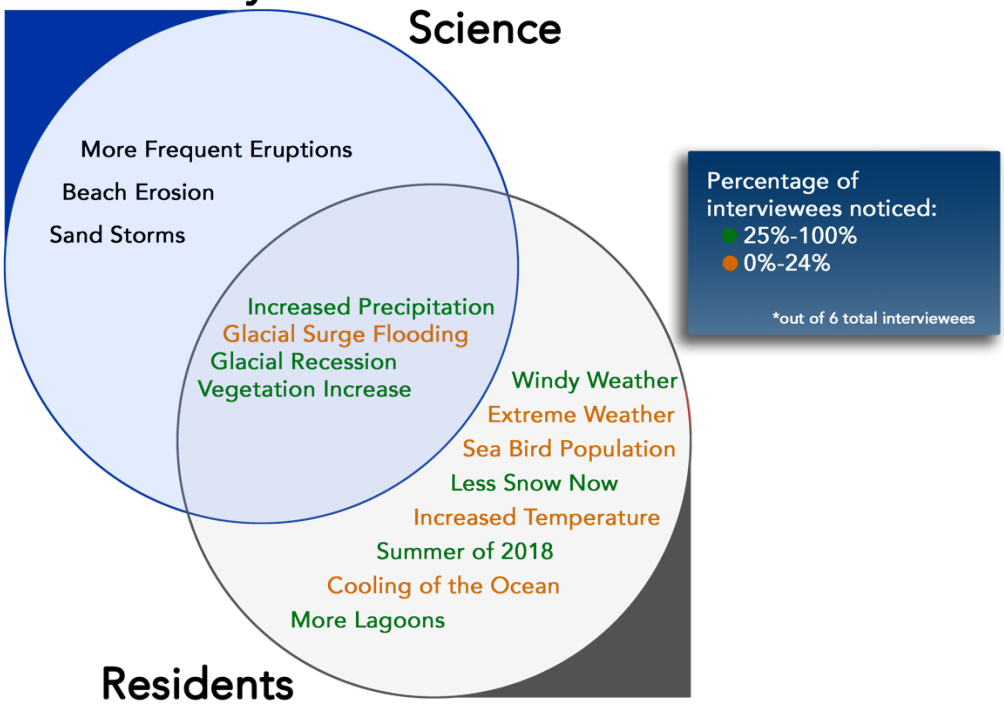
A. Snæfellsnes



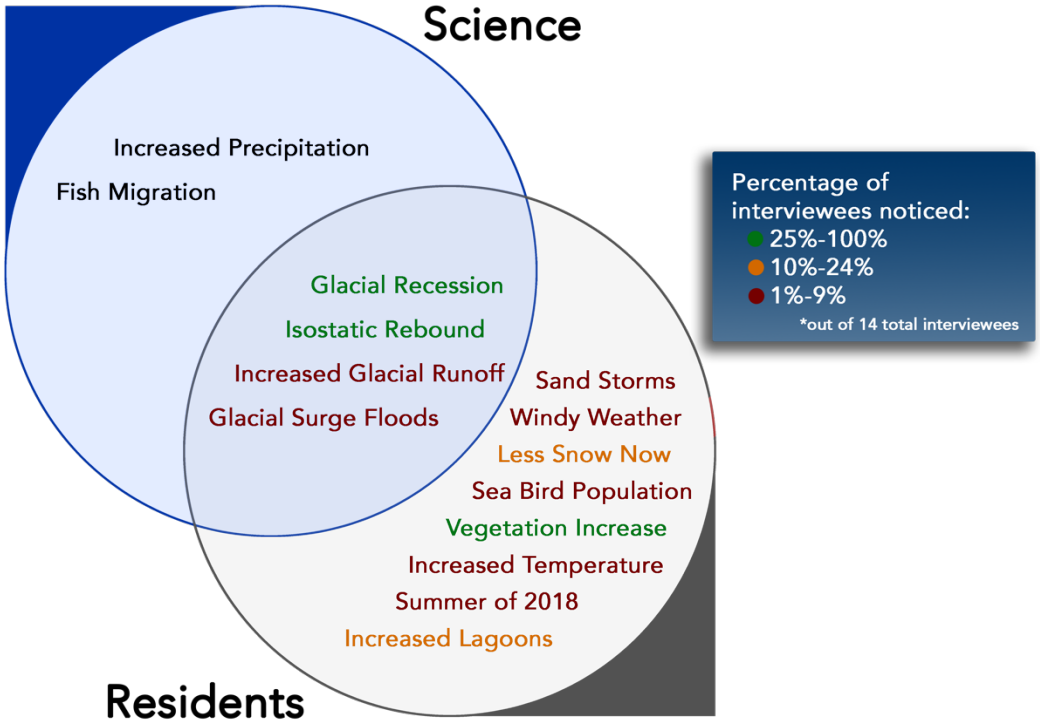
B. Akranes



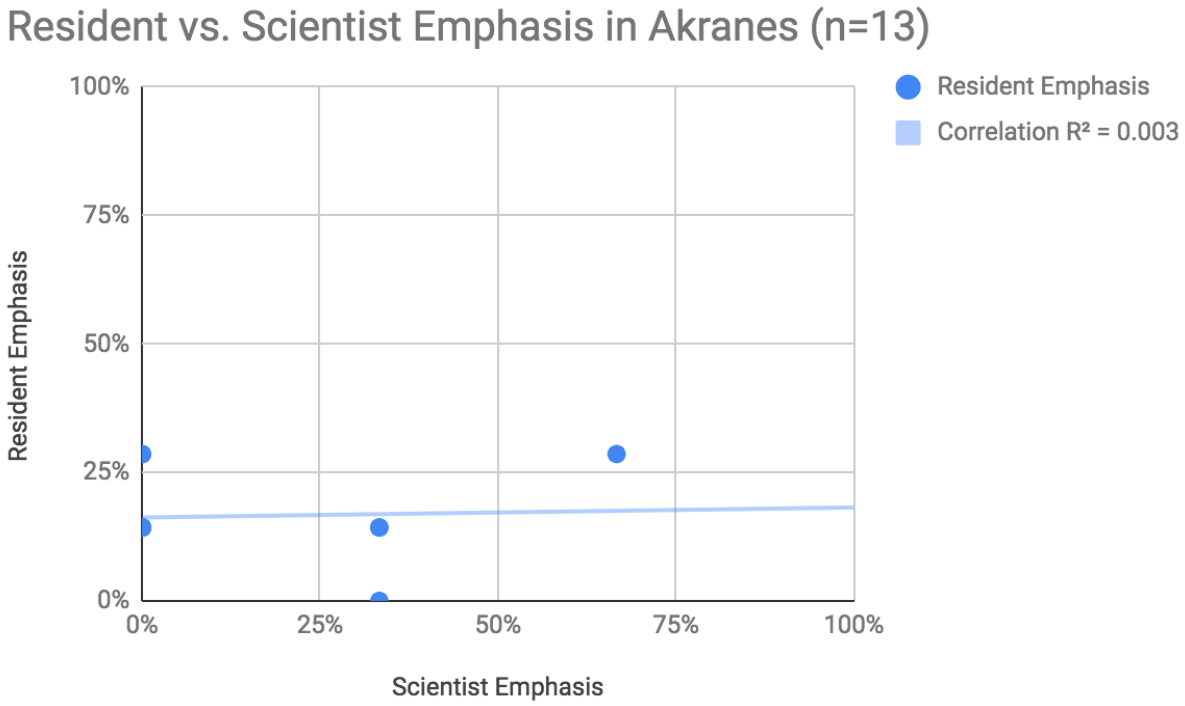
C. Vík í Mýrdal

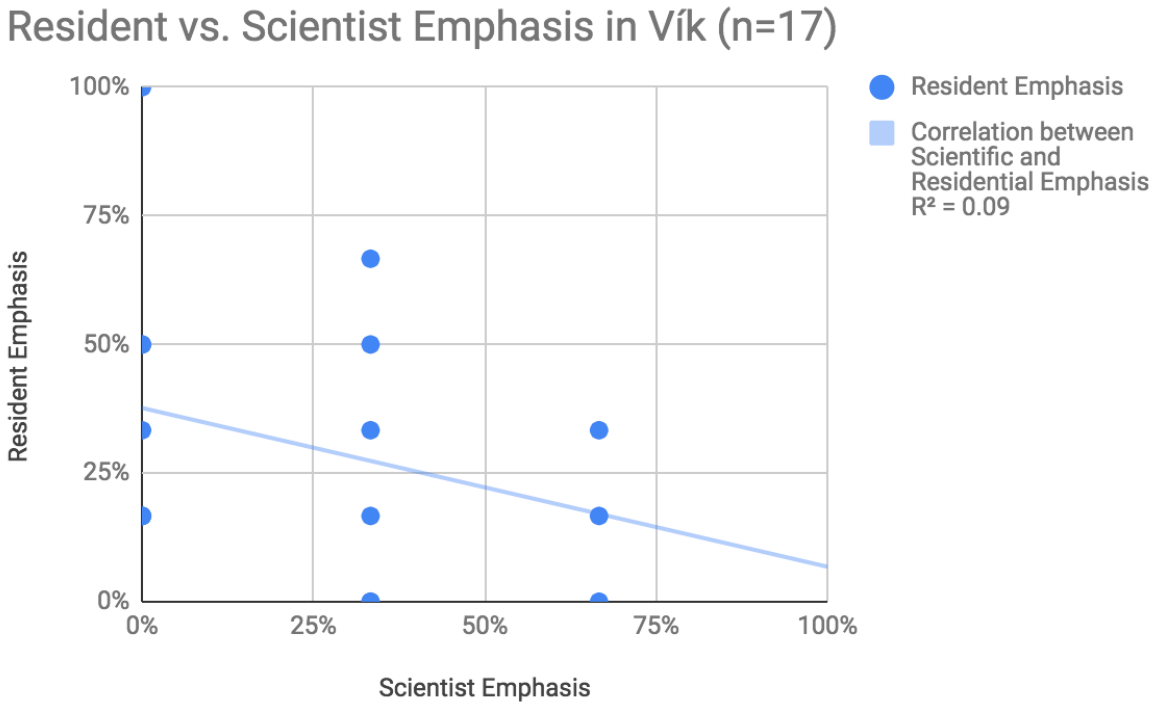


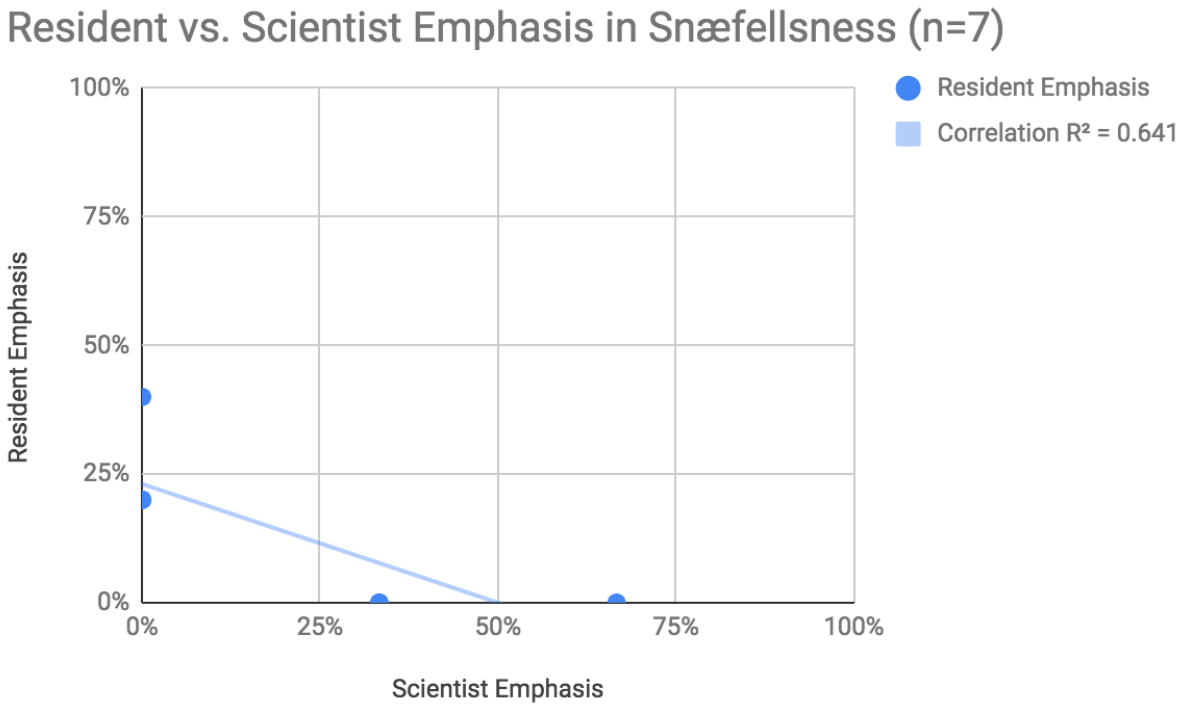
D. Höfn í Hornafirði

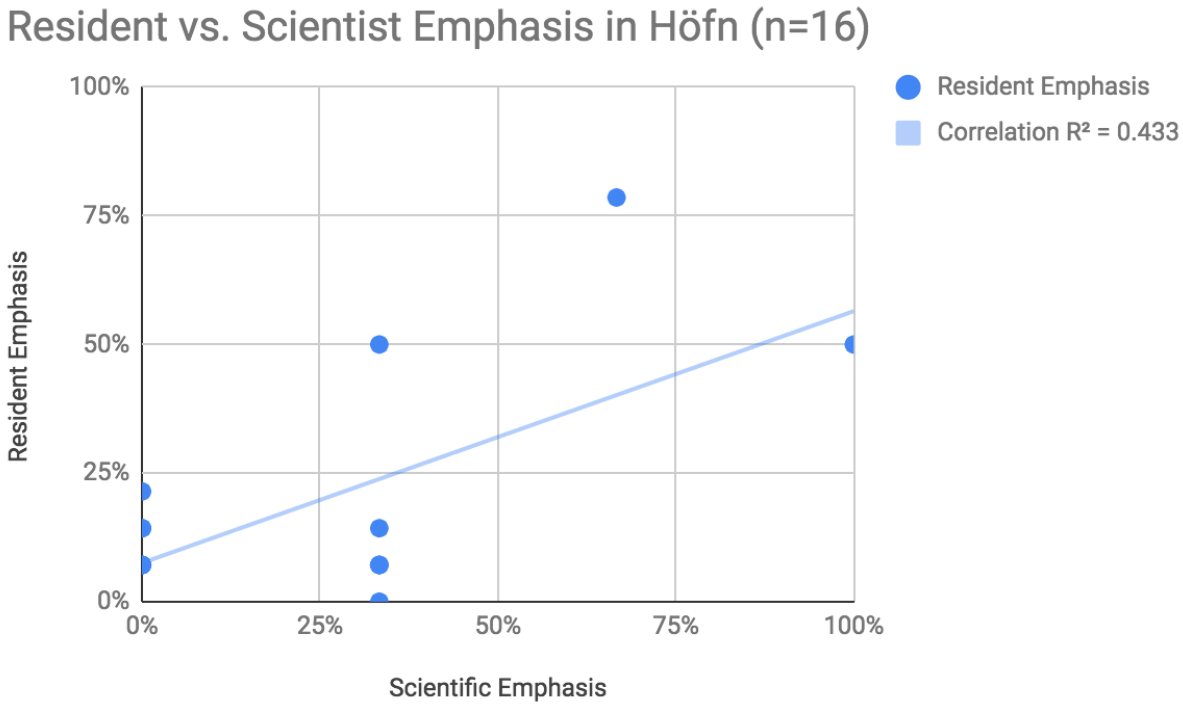


Appendix G: Correlations between Emphases






Resident vs. Scientist Emphasis in Snæfellsness (n=7)
Resident Emphasis
Correlation R² = 0.641
100%
75%
50%
25%
0%
Resident Emphasis
0%
25%
50%
75%
100%
Scientist Emphasis


Resident vs. Scientist Emphasis in Höfn (n=16)
Resident Emphasis
Correlation R² = 0.433
100%
75%
50%
25%
0%
Resident Emphasis
0%
25%
50%
75%
100%
Scientific Emphasis