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Iceland: The Heat of Change

Empirical Study on Icelanders Perceptions and Observations of Global Warming

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Abstract

Iceland as a northern country glazed with snow and ice, beholding a diverse ecosystem. Temperature has a large impact and climate change has made its presence immediately felt. The increase in water temperature has brought new species to the land and seas of Iceland causing others to reduce in populations or having to move away to find more food or both. The research project reviews the effects of climate in Iceland, the damage the increase in temperature is causing to its fragile ecosystem, and Icelanders account of this change. Data was collected through interviews of native Icelanders, field observations, and second hand sources. An analysis of the data showed that younger generations are more informed about what climate change means to the future of Iceland. Data also highlighted that older generations have seen firsthand the populations of puffins decreasing, the fish moving north, the glaciers shrinking rapidly, the increase in rains, winds, and less intense winters. The people of Iceland see adapting to new weather and rising rivers as not a very intense matter, but find the possible changes in the Gulf Stream and acidification of waters as horrifying. Many Icelanders are taking advantage of the warmth by growing new crops that could not grow in the harsh weathers before. The future is still unknown for Iceland.

Introduction

Iceland is a Nordic country covered in vast wilderness. With rolling hills, glaciers, fiords, farms, and an abundance of seal life surrounding it, Iceland is at the top of the list for many people to visit. As it is so far north and is accustomed to being a cold climate, global warming has and will continue to have a larger impact on the island. Icelanders believe overall that the impacts of global warming are real and being seen all across the island. The perspective towards global warming is different from in the United States, Icelanders believe that global warming is occurring, but they will adapt with the changes. The first hand observations of changes due to global warming are immense. They range from changes in the weather, nature, and animal populations. Environmental impacts can have major effects on society. The impact of loss of sea life has been seen before in Iceland's history. Siglufjörður is known as Iceland's historic herring town in the 1900's. Every year more and more people would flock to Siglufjörður to make money from the fishing village. Then one year they over fished the herring. Over the next few years the village population exponentially decreased as there were so few herring and so few jobs. After several decades some of the population returned, but Siglufjörður never returned to the booming town it once was. Climate change is real. The literature was reviewed and the following themes were found: Icelander's beliefs in regards to global warming, global warming effects on the weather, physical landscapes, and animals. These themes will be explored in more detail below

Literature Review

Beliefs

The belief in climate change sits in the hearts of many Icelanders. Among Icelanders only three percent believe that global warming is not man made (Iceland Magazine, 2017). Young and old alike are able to see the immediate effects on the Nordic region as the ice cap around the North Pole melt at record rates and the oceans grow warmer (Hares, S., 2018). Within the 70 percent of Icelanders avidly concerned about the environment and nature, the majority felt that politicians should do more to protect nature (Ungt fólk hefur áhyggjur af loftslagsbreytingum, 2017). In December 2017, Iceland elected their first prime minister from the Left- Green Party who pledged to take Iceland further than the Paris accords in reducing greenhouse gas emissions and to aid in conservation to combat climate change (Stone, 2017). According to Brynjólfsson (2018), after the elections 54 percent of Icelanders believe that Iceland is still doing too little to adapt to climate change and that politicians don't prioritize limiting greenhouse gas emissions.

Weather

The temperature in Iceland has been increasing for years. As seen in the chart below the temperature curves with the seasons, but overall is increasing. Between the 1940's to mid-2000 the average temperature in Stykkishólmur has increased at least 1.5 degrees Celsius (Jónsson, 2008).

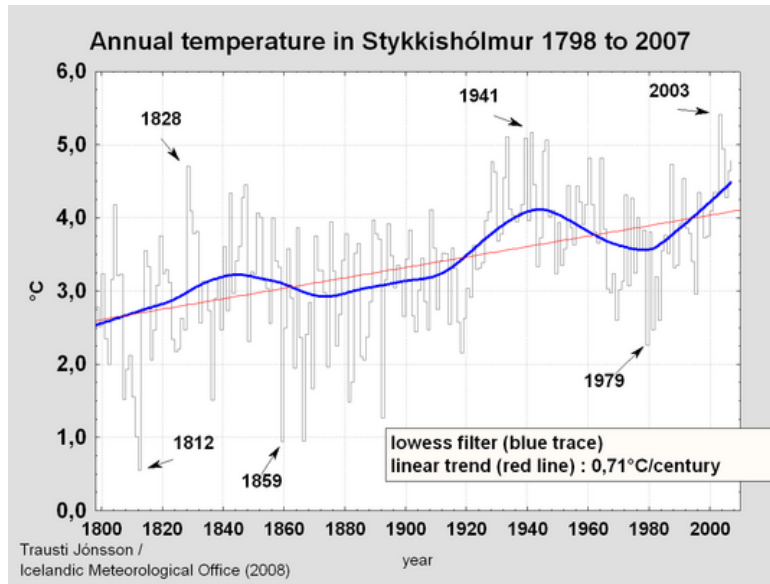


Figure 1. Annual temperature in Stykkishólmur 1798 to 2007 (Jónsson, 2008)

The amount of snowfall in some locations such as Siglufjörður has reduced in which now the rare event of rain is occurring more frequently. Furthermore, Reykjavik has precipitation 213 days per year, but has had less snow than years before (Center for Climate Change Adaptation, 2018). Along with increase in rains there has been an increase in the amount of lightning and thunderstorms occurring on the island (Balder Gylfason, personal communication, March 12, 2018). These thunderstorms have not done much damage to the environment or humans, but it is a major indicator of Iceland's atmosphere is heating up. These storms are caused by cumulonimbus clouds forming when the ground is hot and causing the air to rise. Then the water vapor cools forming a cloud where ice forms at the top and collides with other pieces of ice to cause an electrical charge (Smith, 2017). Researchers have known for a while that climate change was producing more lightning strikes. According to Goldenberg (2014) scientists have found that lightning strikes will increase by about 12 percent for every one degree of Celsius of warming. The wind on the island has been increasing in regions beyond the coast. This blows

away nutrients in the soil causing loss of vegetation and nutrients in the soil (Smith, 2017). Dust storms have been occurring more often and are very effective in eroding and transporting soil materials (Ingólfsson, 2007).

Beyond dust storms, the warming effects the physical environment by wind. Melting water from the polar icecaps and glaciers can disrupt the Gulf Stream and cause the temperature of the waters around Iceland to increase. The figure below represents the Gulf Stream patterns around Iceland.

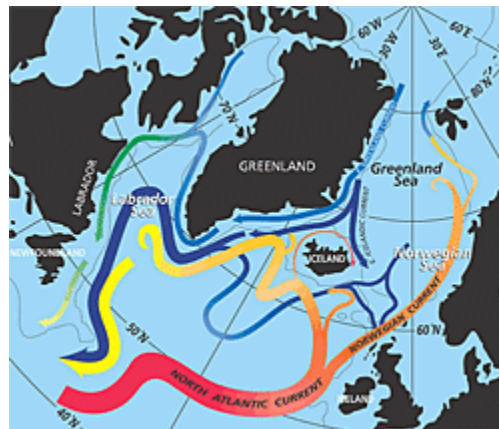


Figure 2. The Gulf Stream air current patterns around Iceland; LeGrande, Allegra, and Gavin Schmidt (2006)

As less and less of the cold water joins the circulation due to global warming and as temperatures change, the Gulf Stream is predicted to change with it (LeGrande et al., 2006). Science correspondent, Josh Gabbatiss (2018) elaborated more stating that the Gulf Stream current, which has not been running at peak strength for centuries, is now at its weakest point in the past 1,600 years. Several computer simulations predicted changes in ocean circulation, brought about by rising carbon dioxide levels, providing direct proof this is happening (Gabbatiss, 2018). In a presentation by Stefan Rahmstorf of the Potsdam Institute (2016) explained that the purpose of the Gulf Stream is to redistribute heat around the earth. Rahmstorf and his team of researchers

have found that the Gulf Stream's sea surface temperature fingerprint on the oceans circulation has shown a slowed down of 15 percent (2016). Rahmstorf (2016) expressed that the warming of the earth has caused a major mass loss from Greenland. This is changing the salinity and the height of the oceans. Additionally, since Iceland is in the center of the Gulf Stream, the circulation of hot and cold air allows Iceland to have a temperate climate. The temperate climate gives Iceland milder weather in the summers and not as cold winters (Smith, 2017). Any changes within the Gulf Stream, such as increased temperatures caused by global warming, impact Iceland.

Physical Landscape

According to scientists from the University of Arizona and the University of Iceland, the Earth's crust is rising at a much faster rate within the last 30 years (Goldenberg, 2015). In locations with some of Iceland's largest ice caps have reported an increase in elevation by 1.4 inches per year (Goldenberg, 2015). Iceland is rising at a faster pace as global warming melts the island's ice caps (Choi, 2015). Choi explains that as the glaciers melt and become lighter the earth rebounds as the weight of the ice decreases (2015).

Additionally, the gap produced from Iceland rising crust has created a pressure pocket under the island. This pressure pocket is building up and many of the islanders believe that this is contributing to the earthquakes and make of the volcanoes behaving as if they are close to being once again active (personal communication, Baldur, March 12, 2018). Most of Iceland is sitting on the edges of their seats, waiting to see when the next volcano eruption will be and where it will happen. Volcanic eruptions can cause global warming to speed up immensely and can even lead to more eruptions. In the immediate tense. Global warming in turn has an impact on volcanic eruptions.

Beyond the land sits Iceland's vast oceans. Within these oceans temperature has a major role to play. According to Astthorsson (2016), the increase temperature has proven to show an increase the acidity in water. On top of the acidity, mass loss from Greenland icecaps is changing the salinity of the oceans. As more fresh water from the melted ice mixes with the salt water, this causes the ocean to not only increase in height, but increases the acidity. This can lead to fish and other sea creatures to no longer be able to survive in the oceans (Rahmstorf, 2016).

Animals

A specific animal that Icelanders have taken to their nations pride are puffins, which are birds that migrate and live off of the southern cliffs of Iceland in the spring. They enjoy fishing in cold waters, but unfortunately the water temperature is increasing. This means that puffins are migrating to the north-west. Puffin population were estimated at eight million in Iceland during 2003, but that number has dropped to around five million, a 37 percent decrease in 2014 (Robert, 2014). According to Zoe Robert, puffins have been arriving later and later into the year and breeding rates have been decreasing in the Westman Islands.

Alongside birds, climate change has impacted sea life greatly already. Herring have had a large impact on Icelanders history. According to Carlsen, recently in the West Iceland's fjords tons of herring were found floating dead on the surface (2013). In 2013, 22,000 tons of herring in Kolgrafafjordur and 30,000 tons in 2012 were found dead. Scientists at Iceland's Marine Research Institute found that oxygen levels in the water were significantly low due to calm weather with less wind. Less wind in the area leads to less atmospheric oxygen entering the water (Carlsen, 2013). 2016's annual survey showed that global warming has caused a northern shift of distribution of many northern fish stocks. The survey added that the number of cod surrounding Iceland's-East Greenland waters are decreasing and fisheries are now catching more

fish in colder waters (Astthorsson, 2016). As Iceland's economy is heavily reliant on their fish market, this can be detrimental. Warming oceans around the North Pole are harming biodiversity and fish stocks, and causing acidification in the world's northern regions, forcing countries like Iceland to adapt to a new reality (Hares, 2018).

Methodology

The purpose of this research is to identify Icelander's perception of environmental impact on wildlife caused by global warming. This project studied individual's perception of environmental changes. To conduct this research different methods of data collection were used, including conducting interviews, online research through the Embry-Riddle Hunt Library along with ProQuest, and Google Scholar, and analyzing Icelandic media. Newspaper articles and television broadcasts were translated and gathered to gain more research. Documents regarding global warming, migration patterns of native species, media portrayal of global warming, and animal trends were accumulated. The purpose is to identify if the topic of global warming is at the forefront of public discussions, if the public divided similar to our current society, or both.

Personal observations were made during the trip to Iceland in which effects due to global warming, animal behavior, and ecological abnormalities were observed. Observations were made at the Gunnhver geothermal sight, Icelandic Seal Center in Hvammstangi, Strokkur Geysir geothermal area, and during a glacier walk on the Sólheimajökull Glacier. Data was collected through several methods; photographs, videos, and a field journal. Interviews were also conducted with the tour guide, tour's bus driver (a native Icelander), seal researcher and conservationist, the curator at the Herring Era Museum, and some of the hiking guides at the Sólheimajökull Glacier. Other interviews were conducted with natives from cities and rural areas. When language barriers arose, a tour guide assisted in translation. Interviews were either

recorded or transcribed during the communication. For interview questions please see Appendix I.

Results and Analysis

Iceland has few inhabitants but is vast with unique nature. After interviewing Icelanders to learn about their perspectives on global warming, the general perspective was that global warming is happening, but Icelanders will adapt to the changes in the earth as they happen. The researcher interviewed 10 people to discover Icelanders perspectives and observations of global warming.

Icelander's Beliefs on Global Warming

Global warming is also not a common stressor on their minds like it is in the United States and is not a topic spoken about casually among Icelanders. According to Baldur Gylfason and Asgeir Gunnbjörn Skúlason, global warming referred to most often in politics, school, and occasionally in the news (personal communication, March 12 and 15, 2018). According to Baldur, the political party in office currently in Iceland is the Green Party, therefore during elections global warming and conservation were a topic of interest. He also shared that there is always a small debate as to whom and or what the cause of global warming is, but there is a consensus that the world is warming up. Within education students are taught about global warming, what are some of the causes, about conservation, and that it is causing the world to heat up (Balder, personal communication, March 12, 2018).

Within the news, global warming is often a topic of discussion (Balder, personal communication, March 2018). In Iceland global warming is mentioned mainly in broadcasts in regards to politics, any UN policy changes, BBC programs, or regarding local research (Asgeir,

personal communication, March 15, 2018). There is a common reaction toward global warming stating “We will deal with it as it comes.” (Baldur, personal communication, March 12, 2018)

Among the Icelanders interviewed, a majority believe global warming is occurring. All interviewees were asked if they believed there was a difference in age groups that talked about global warming. Each age group referenced their own, but provided their examples as to why they believed that their generation talked about global warming more. Younger generations below the age of 30 believe in global warming based on what they were taught from school and the internet. They believe that since they grew up into a world where global warming was common knowledge, it is a common trend. Older generations’ belief is based on what they have seen over time. Several people within this category referenced major changes witnessed over time, for example, the reduction in size of the glaciers or the increase in greenery and reduction in the amount of snowfall. Here is an accumulation of such observations;

Anita Elefsen calls Siglufjörður home where she shared “winters have been less harsh and in some locations the amount of snowfall has reduced.” Anita expressed that in Siglufjörður people have noticed that the once rarity of rain is occurring more frequently (personal communication, March 12, 2018).

Baldur and Asgeir both agreed that every time they go back to the Solheimajokull Glacier they see that the glaciers have changed, getting smaller and smaller (personal communication, March 15, 2018).

Nicco Segreto, a hiking guide on the Solheimajokull Glacier stated that “there has been less snow fall here. This also has been contributing to the glaciers shrinking. The environment has also become warmer allowing more plants to grow and not die from the permafrost (personal communication, March 15, 2018).”

Global Warming Changes in Weather

The increase in temperature due to global warming has begun to leave an impact on Iceland. Ragnheiður Georgsdóttir shared that over time she has noticed warmer seasons, and less

snow fall across the island. She stated that over the past few years, Iceland's winters have been less harsh which has allowed the soil to be able to support more crops like mushrooms (Ragnheiður Georgsdóttir, personal communication, March 15, 2018). This has opened more doors for Icelanders to earn more income. Icelanders can maintain their trade and sell their produce to farmers markets and grocery stores.

Icelanders reported that the tips of the once black and snow covered mountains turning green as the land becomes more habitable for plants (Baldur, personal communication, March 15, 2018). There has been increase in thunderstorms on the island are perceived as a new occurrence to native Icelanders. Balder shared that in Iceland thunderstorms are a significant and rare occasion that become alerts on the news (personal communication, March 15, 2018). These thunderstorms have not done much damage to the environment or humans, but it is a major indicator of Iceland's atmosphere is heating up.

The possible change in the Gulf Stream around Iceland are a major fear of Icelanders. According to Baldur, this is a major fear that Icelanders push into the back of their minds (personal communication, March 12, 2018). If the Gulf Stream changes the entire ecology of Iceland would be drastically impacted. Many species living in the water would either die or must migrate to survive, and many of the bird populations and other land species would also decrease in population (Nicco Segreto, personal communication, March 15, 2018). This means that not only would the environment Icelanders pride themselves on would disappear, but also their food security and economy would suffer.

Global Warming Impacts on Iceland's Physical Landscape

Iceland is known as the land of ice and fire for its vast snow peaks and volcanoes. Each Icelander shared that a lot of Iceland's nature is being affected by global warming. One effect that has brought ease to Icelanders is the increase in vegetation. Since the environment has increased in temperature the land is now more suitable for crops to grow. The ability to farm more crops has opened up new doors for Icelanders that can help the people prosper. Many are already taking advantage of it and sell their fresh fruits and vegetables all across the island which would not have survived in the cold (Ragnheiður Georgsdóttir, personal communication, March 15, 2018). Moreover many Icelanders have stumbled across wild vegetation such as wild strawberries, blueberries, and crowberries (Baldur, Personal communication, March 15, 2018). This increase in vegetation has also lead to more insects and birds being drawn to the island (Ágústa Helgadóttir, personal communication, March 15, 2018). Opportunity is abundant as long as the winds don't blow away the soil.

Iceland was once covered in glaciers. Many of the crevices and fjords were left behind from large glaciers. Asgeir, a native Icelander, shared that over the past 40 years he has seen the glaciers receding and reducing leaving him no doubt that global warming is occurring (personal communication, March 15, 2018). At the Sólheimajökull Glacier, tour guides Nicco Segreto and Thor Girdleson shared that since 2010 the glacier has receded about 2 kilometers (personal communication, March 15, 2018). Below in Figure 2 shows the reduction of the glacier.



Figure 2. Sólheimajökull Glacier. Sign was placed in 2010 on the border of the glacier and states the amount of meters the glacier has reduced each year. Photo taken by Julianna Marorella March 15 2018.

It is common knowledge that with the glaciers melting, sea levels will rise in the oceans. With the Sólheimajökull Glacier there is now a glacier lake just before the glacier several meters deep where the glacier once stood. Beyond increasing sea levels, the loss of glacier pack has decreased the large amount of mass allowing the Iceland to be rising from the sea (Baldur, personal communication, March 15, 2018). It is an amazing phenomenon that has Icelanders saying, “The rising oceans will have no effect on us” (Suanna Kristen Oladotir, personal communication, March 14, 2018). The island is rising and the height increases alongside the temperature increases.



Figure 3. Sólheimajökull Glacier with a lake of melted ice. Photo taken by Daniel Roberts March 15 2018.

The worry about waters rising is not all that plausible among Icelanders, but the fear of volcanic eruptions makes up for that. The harshest impacts of global warming are not seen until a volcano erupts. Icelanders are well versed on the effects on global warming on volcanoes. In a discussion with Baldur he shared that over time of dormancy ice has formed over the tops of volcanoes and mountains. This ice “works like a plug on a champagne bottle.” Once the ice melts away the pressure within a volcano will release in the form of an eruption (personal communication, March 13, 2018). Volcano eruptions are random, but show signs before an eruption. The three major volcanoes on the island are showing signs that that are due for an eruption (Baldur, personal communication, March 13, 2018). One eruption may or may not trigger multiple eruptions afterwards, but one is all that is needed to speed up the effects of global warming. Icelanders will be okay and will be able to be evacuated, but livestock, seal life, plant life, and the air quality will be immediately affected. An eruption will release more pollutants in the air, kill crops and farm animals, and will cause more soil erosion making the air more difficult to breathe. According to Sunna Kristin Oladóttír, this happened after the 2010 eruption. After the volcano exploded many of the sheep and cows died from the poisons released

from the volcano (Kristin Oladóttír, personal communication, March 15, 2018). Once all of the ash has settled, the absorption of heat on the black ash will heat up the thinner layers and cause the land to heat up (Nicco Segreto, personal communication, March 15, 2018).

Global Warming Impacts on Animals

Icelanders pride themselves on their unique ecosystems and creatures that come to live on and around the island. Icelanders have confirmed that puffins are now found migrating to the Westman Islands instead of their usual locations (Nicco Segreto, personal communication, March 15, 2018). Concurrently, the increase in temperature has brought mackerel into the Icelandic waters. The mackerel are eating one of puffins' main food sources, the sand eel and are causing a lack in food source. (Balder, personal communication March 13, 2018).

Similar to puffins, a change in seals has also been noticed. Seals live majority of their lives in the northern waters of Iceland and follow the migration patterns in fish to survive. Many species of fish have begun to migrate more north following the colder water (Sigurður Líndal Þórisson, personal communication, March 13, 2018). This migration has caused a food shortage for the seals that decided to stay in their historic hunting grounds. On top of this, researchers at the Icelandic Seal Center in Hvammstangi, including Sigurður, have concluded that many seals may no longer be able to maintain their body temperature within the warmer waters. Researchers at the Seal Center believe that this could also contribute to their decrease in populations and increase in migration (personal communication, March 13, 2018). Furthermore Anita Elefsen, reported that other species such as shrimp and herring have been seen to be migrating towards colder waters slowly more and more (personal communication, March 17, 2018).

In Iceland global warming will affect the birds and sea populations most negatively. As the water temperatures increase, the water surrounding Iceland will no longer be habitable for the fish located in the region now (Anita Elefsen, personal communication, March 12, 2018). Many new sea creatures will also migrate into the area following the temperatures. This will cause the original species to either die from lack of a food source, or have to migrate more north away from the island. Anita elaborated more sharing that sea life has a major impact on Iceland's economy. All of the Herring were once over fished in her father's generation. This had caused the once booming village of Siglufjörður became almost a ghost town (Anita, personal communication, March 12, 2018). Slowly new species migrated back to the area, but there definitely still is an impact on the populations of fish in the harbor. Birds, fish, and seals would end up following the similar trends of either having to migrate north to follow cold climate and food sources, decrease in population and find new food sources, or become extinct.

Conclusion

Iceland is changing due to global warming. Icelanders believe when climate change hit, they will change with it, and that is exactly what they are doing. The changes in the weather and nature have decreased the amount of doubt that global warming is occurring in Iceland. While others begin to mourn the loss of wildlife that has been around for centuries, many Icelanders are using this change as a chance to evolve the way of life on the island. By opening up green houses, more farms, and taking advantages of their natural resources, Icelanders are beginning their own evolution adapting to the new weather patterns. Conservation efforts are in place to reduce over fishing, land deterioration, and pollution in order to maintain as much of the native ecosystems that they can. Unfortunately they are still seeing more species reducing, migrating, and getting closer to extinction. This research is important in order to bring the rest of the world

closer to the reality of what global warming brings and to reduce any doubt in its occurrence. Data shows that the temperature is only going to increase unless the world is able to unite towards a common goal towards reducing emissions and to reverse global warming.

The limitations within this research sit mainly within the small sample size and the small duration spent on the island. It would be optimal to attain survey results from 50 people below the age of 30 and 50 people above who are from different regions of Iceland in order to gain broader research. In the future, the comparison between these two generations' observations, experiences, and what they believed has shaped their perspective would be a fascinating notion to dive deeper into. Furthermore, it would be beneficial to be in Iceland to record data during different seasons within the year for several years. Being able to observe the Left Green Party in office of the duration of their term alongside the implementation of any new conservation efforts could be explored as well.

Appendix I: Research Questions

- What is your perspective on global warming? Believe it is real or not?
- Is global warming a frequent topic talked about? When is it talked about?
- Is mentioning of global warming present in media?
- Have you seen the impacts of global warming first hand?
- Have you observed any noticeable temperature or weather pattern changes?
- Have you noticed any differences in animal behavior/physical features/migration patterns?
- Do you believe there is a difference in age groups when talking about global warming?
- Is global warming a topic of conversation among private groups or is it talked about in schools and other public settings?
- Do you think your community/country is putting in enough effort towards reversing global warming?

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