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Telling Stories of a Changed Climate: The Laki Fissure Eruption and the Interdisciplinarity of Climate History

Stories can be very powerful tools to illustrate complex connections that determine the world around us. History and science are not as different as they are often portrayed as being. Both tell stories. Historians work with historical documents. In the context of climate history, these are often referred to as archives of society and can take the form of diaries, newspapers, flood markers, or paintings, to name a few. Climate scientists work with so-called archives of nature, which can be corals, stalagmites, or tree rings, for instance. There is an abundance of written historical sources for the early modern and modern periods, and a smaller number for antiquity and medieval times, which together result in history being primarily the history of human cultures, with little recourse to "deep time." Historians tend to study decades or centuries, whereas geologists and other natural scientists often study periods spanning millions or even billions of years—for example, climate scientists can reconstruct the climate going back hundreds of thousands of years with the help of ice cores. But just as with historical sources, some records give a clearer, more detailed image than others. Once historians and scientists have reviewed their records, they write up the most probable story that combines the available sources and explains why something occurred the way that it did. In the words of Australian historian Tom Griffiths, hypothesis is just another word for story. Scientists test a hypothesis with experiments to see whether it abides by the laws of the real world. Often it does not, and they then have to come up with a different story—and ideally, one of them will turn out to be provable.[1]

The history of a volcanic eruption, located on the fringe of the then known world, will illustrate the need for stories and science in the past and the present. In this essay, I'll show what this need can tell us about knowledge production, the limits of science, and the limits of narratives, and about how knowledge travels.

1 Tom Griffiths, *Slicing the Silence: Voyaging to Antarctica* (Cambridge, MA: Harvard University Press, 2007), 324.

The Laki Fissure Eruption

On 8 June 1783 it began. Just a few kilometers southwest of Vatnajökull, Iceland's largest glacier, the earth opened up and disgorged the largest amount of lava produced by any eruption in the last millennium. The lava did not come from a stereotypical cone-shaped volcano, but from a 27-kilometer-long fissure consisting of around 140 vents and craters. Today it is called the Laki fissure. The eruption was fed by the Grímsvötn volcanic system, one of Iceland's 30 active volcanic systems.[2]

Figure 1: The Laki fissure today, as seen from Mount Laki. Photo by Katrin Kleemann.

The Laki fissure is located in the remote Icelandic highlands. The nearest settlement at the time was Kirkjubæjarklaustur, a small village near the coast in the southeast of Iceland, located around 35 kilometers away from the Laki fissure. The two glacial rivers, the Skaftá and the Hversfisfljót, which feed Kirkjubæjarklaustur, both dried up and were replaced with lava flows. These events were described by the village's reverend, Jón Steingrímsson, who kept a journal. In Iceland, the eruption is remembered as skaftáreldar, the Skaftá Fires. A few farms, churches, and livestock were lost to the lava, although fortunately there were no human fatalities.

2 Thorvaldur Thordarson and Armann Höskuldsson, *Iceland* (Edinburgh: Dunedin, 2014), 10.

Lava, however, was only one product of the eruption. Another product had more deadly effects on the Icelandic population: volcanic gases. The aftermath of the Laki fissure eruption is also known as *móðuharðindin*, the famine of the mist. It is considered the worst catastrophe in Icelandic history and still occupies a place in the country's cultural memory. In addition to the ashfall that occurs after a volcanic eruption, the fissure also produced exceptionally large amounts of fluorine, a highly toxic halogen. In small doses, such as in toothpaste, fluorine is beneficial to human health; in large quantities, it can cause dental or skeletal fluorosis, which results in bone fractures and deformations. Fluorine from the eruption contaminated lakes and fields, and thus wrought havoc on livestock. By the summer of 1785, about one-fifth of Iceland's population of 50,000 had perished—people died of diseases such as fluorosis or dysentery, died of hunger, or simply froze to death in the subsequent cold winter.

1783: *Annus Mirabilis* in Europe

The Laki fissure eruption released 122 megatonnes of sulfur dioxide, which produced a dry fog that was visible above large parts of Europe between June and August of 1783.[3] The fog, which was also described as a haze or mist, was characterized by its dryness and its sulfuric smell. Large quantities of aerosols in the atmosphere resulted in "blood red" sunsets and sunrises.

Figure 2: The location of the Laki fissure and Iceland in contrast to the rest of Europe. Image by the European Space Agency, contains modified Copernicus Sentinel data (2017), processed by Sinergise/ESA. The satellite image was modified by the author. Used with permission.

People outside of Iceland were oblivious as to the cause of the dry fog, the red sunsets, and the other unusual phenomena of that summer, which prompted them to dub 1783 an *annus mirabilis,* a year of awe. The most perplexing of all was the dry fog—what could have caused it? Speculation was rife as to the origin of these extraordinary phenomena. In the midst of the Enlightenment, there was no shortage of ideas.

3 Thorvaldur Thordarson and Stephen Self, "Atmospheric and Environmental Effects of the 1783–1784 Laki Eruption: A Review and Reassessment," *Journal of Geophysical Research* 108 (2003): 1–29.

Among the cornucopia of ideas were propositions ranging from the terrestrial, such as the belief—oh so close to the truth!—that they were the result of an eruption of Hekla, one of Iceland's best-known volcanoes, to the extraterrestrial, with some pointing the finger at a meteor, whose tail, it was suggested, swept across Earth's path, shrouding it. A few suggested that earthquakes in Italy had caused a crack in the Earth, which let sulfurous gases out into the atmosphere; reports of earthquakes in western Europe and news about the new "burning island" off the coast of Iceland led some contemporaries to believe they lived in the time of a "subsurface revolution." A fleeting theory was that volcanic activity within the German Territories was the cause.[4] This turned out to be false and was retracted a few weeks later. Electricity was also considered a possible culprit, either too much or too little of it: the large number of thunderstorms that occurred during the summer triggered a breakthrough for installations of the lightning rod in the German Territories, which some believed to be the cause of the dry fog, as the air was now lacking its natural electricity.[5]

The impacts of the Laki fissure eruption reached far beyond Europe. The dry fog was observed as far away as the Altai Mountains in Central Asia. A recent study by Joe Manning et al. establishes that Laki and other eruptions contributed to the suppression of the Nile summer flooding, which caused hunger and revolt.[6] Alaska also saw an extremely cold summer that year.[7] Both these examples raise questions as to how far and wide the eruption's sphere of influence actually was.

Eighteenth-Century Science Communication

It would take until early September for any news about the volcanic eruption to reach Denmark and subsequently the rest of Europe. The summer was almost over and the most obvious visible and olfactory consequences of the eruption were by then literally

4 John Grattan, David D. Gilbertson, and Andreas Dill, "'A Fire Spitting Volcano in Our Dear Germany': Documentary Evidence for a Low-Intensity Volcanic Eruption of the Gleichberg in 1783?" *The Archaeology of Geological Catastrophe* [Geological Society London, Special Publications] 171 (2000): 307–15.

5 Oliver Hochadel, "'In Nebula Nebulorum': The Dry Fog of the Summer of 1783 and the Introduction of Lightning Rods in the German Empire," *Transactions of the American Philosophical Society* 99, no. 5 (2009): 45–70.

6 Joseph G. Manning, Francis Ludlow, Alexander R. Stine, et al., "Volcanic Suppression of Nile Summer Flooding Triggers Revolt and Constrains Interstate Conflict in Ancient Egypt," *Nature Communication* 8 (2017): 900, https://doi.org/10.1038/s41467-017-00957-y.

7 Gordon C. Jacoby et al., "Laki Eruption of 1783, Tree Rings, and Disaster for Northwest Alaska Inuit," *Quaternary Science Reviews* 18 (1999): 1365–71.

yesterday's news. The news of a volcanic eruption in Iceland did not contribute to the understanding of the dry fog or the other unusual phenomena.

The connection between the dry fog and the eruption of the Laki fissure did not seem to be fully understood until the much larger eruption of the Indonesian volcano Krakatau in 1883 produced similar red sunrises and sunsets around the globe.[8] In the one hundred years since the Laki fissure eruption, telegraphy had been invented and it connected the world. It did not take months for the news of the Krakatau eruption to reach Europe, merely days. The story of the Laki fissure eruption is therefore at least partly one of communication—or the lack thereof. In 1783, people could not correspond faster than ships could travel.

In the aftermath of the Laki fissure eruption, the sciences were not yet far enough advanced to reliably identify the cause of this unusual weather. Yet the population still needed a narrative to make sense of what was happening to them. The story of the dry, sulfuric-smelling fog popped up in the newspapers of the time again and again, with different explanations that tried to make sense of it. Most theories that were argued were believable. But, in the end, all turned out to be wrong.

Today, we look back 236 years to how people in 1783 dealt with their own reality when they faced something that was hard to explain. They were ignorant through no fault of their own. They used the tools that were at their disposal—the knowledge, theories, and experiments they had at hand—to understand and document the situation they were in. It is quite extraordinary how people document situations even if they do not fully understand what is happening. And some of their explanations came—in fact—pretty close to the truth: the eruption of either a German volcano or of the Icelandic volcano Hekla, would have explained all the phenomena they were witnessing. They were just off with regard to the location.

Back in the eighteenth century, people were adept at using stories to help them understand the effects of the Laki fissure eruption, even though they did not have the science to understand exactly what had happened and where. What this shows us is that science does not exist in a vacuum, but it has always been something that has to be contextualized and interpreted using stories, especially stories from the past.

8 George Symons et al., *The Eruption of Krakatoa, and Subsequent Phenomena* (London: Harrison and Sons, 1888).

In our particular moment of anthropogenic climate change, we hear many stories of extreme weather events with devastating consequences, such as wildfires, hurricanes, or coral bleaching, to name but a few. All of these are made more likely and prolonged by climate change. At the same time, we have plenty of scientific data to support the argument that present-day climate change is caused by human fossil-fuel emissions. The challenge is combining the stories with the science, and communicating this in a way that everybody can grasp. This would lead to a better understanding of the magnitude of anthropogenic climate change, which in turn may persuade people to change their own behavior and demand meaningful action from their politicians. What we really need, therefore, are interdisciplinary modes of action that find ways of recontextualizing and telling stories about science that are able to truly explain what is happening and to outline modes of human response and adaptation.

Interdisciplinary Climate History

Today, we are already 1°C above preindustrial levels; although it is debatable when "industrial" began, this is used as the baseline of natural climatic variability before the effects of industrialization became measurable. A change of 1°C does not sound like much, but if you look at the climate history of the last millennium, you will quickly realize that even 1°C can make a huge difference. As recently as the early modern period, prior to the onset of anthropogenic climate change, our ancestors were faced with the Little Ice Age. This period affected the entire early modern period on a global scale, and saw glaciers advance in both hemispheres. Lasting from about 1250 to 1850, this was a time of predominantly colder-than-average weather with the overall average global temperature about 1°C below the 1900–1960 norm. The frequency of extreme weather events was also high compared to the present.[9]

Looking at the early modern period shows not just the foundation of the present world, but also how much has changed. The systematic knowledge upon which people now draw was constructed over generations and centuries, leading to an ever more detailed understanding of our physical reality. Today, historians and climate scientists work together across disciplines in a relatively young field called climate history, which studies the climates of the past and how societies responded to the shifting climate and

9 Dagomar Degroot, *The Frigid Golden Age: Climate Change, the Little Ice Age, and the Dutch Republic, 1560–1720* (Cambridge: Cambridge University Press, 2018), 2.

weather. The consequences of anthropogenic climate change are already visible today: an increasing number of extreme weather events can be attributed to climate change. Extreme weather events or a changing climate are nothing new per se. The climate on our planet shows a high degree of natural variability; for some periods it is more stable than for others. Some climatic changes occur on very long timescales over hundreds of thousands of years, some on shorter decadal or multidecadal timescales. They can occur abruptly (induced by volcanic eruptions, for instance), but what we are seeing today is unprecedented. Human actions and fossil-fuel emissions are causing the climate to change at a previously unseen pace.

Several interdisciplinary initiatives exist already that aim to further cooperation between the climate sciences and the humanities. One example of cooperation between the (paleo-)sciences and the humanities is Past Global Changes (PAGES), which is a core project of the global sustainability science program Future Earth. PAGES has several working groups that work on flood events, sea-ice dynamics, and coral archives, just to name a few, as well as past volcanic eruptions. The latter working group is called Volcanic Impacts on Climate and Society (VICS), which brings climate scientists, climate modelers, climate historians, archeologists, tephrochronologists, dendrochronologists, and others together in order to "foster interdisciplinary activities towards a better understanding of the impacts of volcanic forcing on climate and societies."[10] There are other initiatives in the field of historical climatology, such as the Climate History Network founded by Dagomar Degroot and Sam White, which is a forum for climate and environmental historians as well as climate scientists. The collaboration between climate scientists and climate historians has produced reconstructions—histories—of past climates that offer a new perspective on how to understand the climate change we are facing in the present and future, and how we as humans can respond to it.

This sort of truly interdisciplinary research is the future. Some interdisciplinary collaborations in the field of climate change research already exist, but they are few and far between. The problem lies within tertiary education: most universities regard the humanities and the natural sciences as entirely different entities that rarely cross paths, which is reflected in how research and teaching are institutionalized and thereby rein-

10 The introduction text to the Volcanic Impacts on Climate and Society (VICS) on the Past Global Changes website, http://pastglobalchanges.org/ini/wg/vics/intro.

scribe disciplinary divisions. Going forward, if university students were to attend classes in both humanities and natural-sciences subjects, they would develop a basic sense of both. These insights would give the scholars of tomorrow a better foundation for presenting their work across disciplines and communicating effectively in interdisciplinary collaborations, which will only become more important and pressing in our warming world. Likewise, interdisciplinary collaborations need to be conceptualized from the beginning by both scientists and historians (or other humanities scholars), in order to walk truly novel ground. Applying new methods or combining methods from different fields will lead to fresh perspectives on old and new questions, which can lead to new insights into past and present climate change and might give us new strategies to deal with future climate change.

In the reconstruction of volcanic eruptions, the technological and methodological advances have been great in the past years and many volcanic eruptions can be dated more precisely using multi-proxy approaches, which means combining ice-core, tree-ring, tephra, and other records, as well as historical documents.[11] The results obtained may not be the absolute truth yet, and we might never know the absolute truth; as Jeroen Oomen points out in his article, "truth is in fact unattainable" (Oomen, this issue, p. 29). But we can produce more extensive and applicable knowledge with new tools, technology, and methods, which were simply unavailable to previous generations. The critical thing is that we don't lose sight of the need to contextualize and interpret this science. Science as an ideal is (inherently) interdisciplinary because it ought to entail that research has not only been validated by the methods and peers from one discipline, but works with the findings of at least two different disciplines.

Conclusions

Unlike those living in 1783, in our particular moment we do not need more science but more histories: when historians and climate scientists come together, they can write probable stories of how the climate has changed in the past and how societies responded to these changes. In this way, we can learn how to adapt to our own changing climate. Climate history will benefit from closer collaboration with climate scientists

11 Michael Sigl, Mai Winstrup, Joseph R. McConnell, Kees C. Welten, Gill Plunkett, Francis Ludlow, Ulf Büntgen, et al., "Timing and Climate Forcing of Volcanic Eruptions for the Past 2,500 Years," *Nature* 523 (2015): 543–49, https://doi.org/10.1038/nature14565.

and indeed, climate scientists will benefit from close collaboration with historians who can interpret historical documents, the context in which they have been produced, as well as the sources' reliability. It is crucial for these groups to come together and talk to one another, as so many opportunities have previously been lost, simply because of miscommunication—historians and scientists visit different conferences, use different terminology, and publish in different formats.

I agree with Jeroen Oomen: we should not decenter the scientist at any cost. The "Western scientific project has provided a very real (albeit particular) understanding of our world, and . . . no other knowledge system has seen such systematic accumulation of technological successes" (this issue, p. 29). At the moment we simply do not have a promising alternative to this concept of knowledge production. Science has never existed in a vacuum; (climate) science stimulates and is being stimulated by other disciplines as well as local knowledge. What is necessary to aid this stimulation is communication—communication as a way of narrating and interpreting science. The story of the Laki fissure eruption also shows us how important communication is. In terms of climate history, it very much plays in our favor that unusual weather seems to be more memorable than "normal" weather. Every story has a beginning, a middle, and an end. For the story of successful climate science communication to have a middle and an end, it needs to have a beginning. The beginning is history and science accepting and adopting an interdisciplinary approach, working with and complementing each other. Without this cooperation, we risk this story becoming simply a scattering of words.

Suggested Further Reading

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