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Figure 29 The Laki eruption's emissions of sulfur dioxide. Graphic created by Jack WALSH. Used with permission. It is based on data from ZAMBRI et al. 2019a: 4, Figure 1 —— **119**

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Figure 31 The sulfuric smell and its impact on health and vegetation, late June 1783. Map created by Jack WALSH. Used with permission. The map is based on the following data: 20 June 1783 (circa): Groningen, the Netherlands: BRUGMANS wrote of a fog that had appeared in Holland and Utrecht before 20 June with no apparent sulfuric odor, and in Gelderland and Overijssel, where "a sulfuric smell was admixed to the fog." BRUGMANS 1783: preface. 23 June 1783: Arras, France, Monsieur BUISSART for the Société Royale de Médecine: "Frost," based on hearsay; Société Royale de Médecine, Arras, Pas-de-Calais, June 1783. 23 June 1783: Franeker, the Netherlands: "Across the haze, the sun was perceived deep red, with brilliance at the edge; even at midday, we were able to gaze at the sun with our naked eyes without injury. Objects scattered further were scarcely and only unintelligibly perceived. These were the usual effects of this haze, but on the 24th day it brought with it as a companion a sulfurous odor very readily perceived by the senses, crawling through everything, even closed houses. Men with delicate lungs experienced that same sensation, as if they were turned towards a place in the neighborhood of burning sulfur. They were unable to contain a cough, as soon as they were exposed to air. I myself experienced this, and many others, first in the city, then in the country. The heat was great enough. The sulfurous haze of this day brought very great loss to the vegetable realm, [. . .]. In the afternoon of the 24th many experienced very troublesome headaches and respiratory difficulties, similar to that which they experienced while the atmosphere around us was filled with the vapor of burned sulfur. Asthmatics experience a return of asthma. [. . .] In general it is possible to establish that it was not the origin of fructification that was injured, but only the leaves, which immediately began after midday on the 24th, but variously in various plants. Certain ones were covered with spots, which increased gradually and soon caused drooping of leaves. Some leaves were not entirely spoilt; they continued to quicken, but the places, in which they had been affected, were soon made into little holes. Others faster than a minute turned from green to brown, black, gray, or white. Others kept their color, but began to droop, so, that they were reduced to powder at the touch of one's fingers. A very great abundance of leaves fell. [. . .] Moreover the injury, and fallings of leaves, lasted for some time." VAN SWINDEN 2001: 73–74. 23 June 1783: Hardwick, England: "All these vegetables appeared exactly as if a fire had been lighted near them, that had shriveled and discoloured their leaves." CULLUM 1784. 23 June 1783: Königlich Privilegirte Zeitung, 19 July 1783: Report from Thuringia from 4 July 1783. In Thuringia, from 23 June onwards, many trees were covered by a "corrosive moist." which caused the leaves to look brown or even black; they then shrunk and withered. Other plants withered as well. 23 June 1783: Selbourne, England: "The blades of wheat in several fields are turned yellow & look as if scorched by frost." This was also the first day the dry fog appeared; Gilbert WHITE, "The Naturalist's Journal," 1783, Add MS 31848, British Library, London, UK: 128. 23–24 June 1783 (overnight): eastern parts of England, *Sherborne Mercury*, 14 July 1783 (quoted after GRATTAN, PYATT 1994): "Throughout most of the eastern counties there was a most severe frost in the night between 23rd and 24th of June. It turned most of the barley and oats yellow, to their very great damage; the walnut trees lost their leaves, and the larch and firs in plantation suffered severely." 23–24 June 1783

(overnight): Schleswig-Holstein: “The second half of June had warm days but cool nights. There was rime and frost during the night from 23 to 24 June; the buckwheat was touched by the great frost.” Kuss 1826: 170. 23–24 June 1783 (overnight): Dannenberg/Elbe: “During the night from the 23rd to the 24th, we had a sharp night frost, which damaged fruit and other crops, the foliage of all kinds, as well as grass, and crops, turned black from this night frost, some fell off, others turned yellow [. . .], after this night’s frost, a new, strong and stinking dry fog, or so-called vapor, came and lasted every day until 18 July.” Elias Diderich Thörl, no title, Archiv Dannenberg: 95–96. A transcript of this record was given to me by Wolfgang Jürries. 24 June 1783, Brussels: first description of sulfuric smell; de Poederle 1784: 336. 24 June 1783, Groningen: on 24 June, the fog was so intense that one could taste it with each breath. The smell began to dissipate over the following days, although the dry fog remained: on the morning of 28 June, the sulfuric smell had vanished entirely; Sebald Justinus Brugmans, as above. 24 June 1783, Groß Hesepe, Emsland: a few days before Saint John’s Eve (24 June), a smell that a local chronicler compared to “heated hay” had already manifested itself. On 24 June, the smell of sulfur became apparent. Locals compared it to the smell of burnt gunpowder and decay. The comparison to burnt gunpowder strongly suggests what they smelt was really sulfur dioxide, which is known to have a sharp smell similar to that of burnt matches. Locals “felt a sulfuric or saltpeter-like taste in their mouth on 24 June and the days after, some even complained about an itchy throat or breathing difficulties. The water in some rain tanks also started to have a saltpeter-like taste.” Santel 1997: 108–121. 24 June 1783, Königlich Privilegirte Zeitung, 22 July 1783: 714: Report from Hildburghausen from 24 June 1783. “All the forests in the area are white instead of green; the whole sky looks like chalk; the fog is true natural sulfur, which spoils everything that it touches; the sun and moon always set in a blood-red color. For eight days now, inside the mountain there has been a horrendous and frightening bashing, as if cannons were being fired; then, finally, the whole mountain opened up under the plumes of thick sulfuric smoke; and in the entire area you can hear a constant terrible roaring and rushing (*Sausen und Brausen*) from the opening.” 24 June 1783, Nacton, England: a particular sale at a market “began notwithstanding the close heat in the day, it was commonly reported that there was a sharp freezing rhyme this morning, which on the succeeding day caused the leaves to drop from the Trees.” J. Fenton, The Weather, etc. from June 27, 1779 to December 30, 1786 (at Nacton, Suffolk), Bib. No. 178296, National Meteorological Library and Archive, Met Office, Exeter, UK. 24 June 1783, Selbourne: “Sun, sultry, misty & hot [. . .]. This is the weather that men think injurious to hops.” Gilbert White, as above. 24 June 1783, Weston Longville, England: “a smart frost this evening,” James Woodforde, Weather Diary for Weston Longville, Norfolk, vol. 10: 1782–1784, MET/2/1/2/3/467, National Meteorological Library and Archive, Met Office, Exeter, UK. 24 June 1783, Weston Longville: “A smart Frost again this Night,” James Woodforde as above. 24–25 June 1783 (overnight), Groß Hesepe: another chronicle for Groß Hesepe dramatically describes this “poisoning thaw,” which withered everything it touched and covered all the land, water, and the ocean; Santel, Santel 1992: 71–94. 24–25 June 1783 (overnight), Plön, Schleswig-Holstein: a strong dew damaged the grain crop. The grain turned yellow [. . .] but later recovered again; based on the notes of Heinrich Christian Struck, a mason from Plön, in: Kinder 1904 (1976): 304–307. 25 June 1783, Franeker: “In the morning of the 25th day the fields showed a very sad appearance. The green color of the trees and plants had disappeared and the earth was covered

in dropping leaves. He would easily have believed that it was October or November. But happily, it befell that not all plants were equally affected; certain uninjured ones remained standing." VAN SWINDEN 2001: 75. 27 June 1783 (before this date), Heilbronn, Königlich Privilegirte Zeitung, 12 July 1783: Report from Lautern from 29 June 1783. Sometime before 27 June, "the air smelled like sulfur and the sun also seemed very red and fiery in the evening." 30 June 1783, Leicestershire, England: it was an evening with "thick smoaky [sic] air & smell of fens" with winds from the North to the East. The "smell of fens" is probably in reference to hydrogen sulfide, a colorless gas that is characterized by the foul odor of rotten eggs; Thomas BARKER, Private Weather Diary for Lyndon Hall, Leicestershire, MET/2/1/2/3/227, National Meteorological Library and Archive, Met Office, Exeter, UK. Late June 1783, Koblenzer Intelligenzblatt, 18 July 1783: people in the Lower Rhine region had to cover their faces with sheets because "the heaviest smell of sulfur" was almost unbearable when leaving their houses. Late June 1783, the Netherlands: "The dry fog was very strong in the Netherlands, for half a week it did not become day[light], when the people wanted to go outside, they had to put on sheets because of the strong sulfuric smell." Bayerische Akademie der Wissenschaften 1783: 45 —— **126**

Figure 32 Synoptic weather maps, 23 to 28 June 1783. Graphic created by Jack WALSH. The maps are based on data from John KINGTON's The Weather of the 1780s Over Europe. Reproduced with permission of Cambridge University Press through PLSclear —— **127**

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Figure 34 Peak temperatures of the August 1783 heat wave. Graphic created by Jack WALSH. Used with permission. It is based on the following data: the temperatures given in the Ephemerides are usually in Réaumur; for the purpose of easier comparability, they have all been converted into Celsius here: Rome, Societas Meteorologica Palatina 1783: 523; Copenhagen, Societas Meteorologica Palatina 1783: 603; Andechs, Societas Meteorologica Palatina 1783: 90; Geneva, Societas Meteorologica Palatina 1783: 424; Marseille, Societas Meteorologica Palatina 1783: 506; Padua, Societas Meteorologica Palatina 1783: 220; London, Unknown, Private Weather Diary for London (and additional locations), Gentleman's Magazine, MET/2/1/2/3/255, National Meteorological Library and Archive, Met Office, Exeter, UK; Franeker, VAN SWINDEN 2001: 80; Munich, Bayerische Akademie der Wissenschaften 1783: 48; this value is corroborated by the Societas Meteorologica Palatina 1783: 270; Düsseldorf, Societas Meteorologica Palatina 1783: 157; Mannheim, Societas Meteorologica Palatina 1783: 13; Göttingen, Societas Meteorologica Palatina 1783: 668; Dijon, Societas Meteorologica Palatina 1783: 450, Societas Meteorologica Palatina 1783: 111; Würzburg, Societas Meteorologica Palatina 1783: 383, Hamburg, KUSS 1826: 172 —— **133**

Figure 35 Temperature anomaly for June, July, and August 1783 based upon 31-year mean, 1770–1800. Graphic created by Jack WALSH. Used with permission. It is adapted from Alan ROBOCK's graphic, kiss.caltech.edu/workshops/geoengineering/presentations1/robock_sc.pdf (9 March 2020). The reconstruction is based upon data from LUTERBACHER et al. 2004 —— **135**

Figure 36 Earthquakes in Europe in 1783. Map created by Jack WALSH. Used with permission. It is based on the following data: 2 February 1783, Vallespir, France, 4.99 moment magnitude (Mw), https://emidius.eu/SHEEC/maps/query_eq/external_call.php?eq_id=6122. 5 February 1783, 03:00, Scuol, Switzerland, 3.79 Mw, https://emidius.eu/SHEEC/maps/query_eq/external_call.php?eq_id=8476. 5 February 1783, 12:00, Calabria, 7.0 Mw, https://emidius.eu/SHEEC/maps/query_eq/external_call.php?eq_id=1384.

6 February, 00:20, Calabria/Messina, 6.20 Mw, https://emidius.eu/SHEEC/maps/query_eq/external_call.php?eq_id=1387. 7 February 1783, 13:10, Calabria, 6.61 Mw, https://emidius.eu/SHEEC/maps/query_eq/external_call.php?eq_id=1390. 18 February 1783, Central Slovenia, 4.30 Mw, https://emidius.eu/SHEEC/maps_nomdp/query_eq/external_call.php?eq_id=96051. 1 March 1783, 01:40, Calabria, 5.94 Mw, https://emidius.eu/SHEEC/maps/query_eq/external_call.php?eq_id=1393. 9 March 1783, Stemnytsa, Greece, 5.94 Mw, https://emidius.eu/SHEEC/maps/query_eq/external_call.php?eq_id=8093. 23 March 1783, 05:00, Athani, Greece, 6.64 Mw, https://emidius.eu/SHEEC/maps/query_eq/external_call.php?eq_id=8094. 25 March 1783, 03:00, Basse-Durance, France, 4.44 Mw, https://emidius.eu/SHEEC/maps/query_eq/external_call.php?eq_id=6125. 28 March 1783, 18:55, Calabria, 6.98 Mw, https://emidius.eu/SHEEC/maps/query_eq/external_call.php?eq_id=1396. 29 March 1783, 18:30, Lorca, Spain, 4.52 Mw, https://emidius.eu/SHEEC/maps_nomdp/query_eq/external_call.php?eq_id=200820. 14 April 1783, 23:00, Porto, Portugal, 5.00 Mw, https://emidius.eu/SHEEC/maps_nomdp/query_eq/external_call.php?eq_id=18224. 22 April 1783, 02:45, Komárno, Hungary, 5.35 Mw, https://emidius.eu/SHEEC/maps/query_eq/external_call.php?eq_id=8347. 22 April 1783, 11:00, Komárno, Hungary, 3.80 Mw, https://emidius.eu/SHEEC/maps_nomdp/query_eq/external_call.php?eq_id=100367. 26 April 1783, 02:10, Milazzo, Sicily, 4.72 Mw, https://emidius.eu/SHEEC/maps/query_eq/external_call.php?eq_id=1398. 31 May 1783, 12:00, Komárno, Hungary, 4.46 Mw, https://emidius.eu/SHEEC/maps_nomdp/query_eq/external_call.php?eq_id=100369. 1 June 1783, Istanbul, Turkey, 5.43 Mw, https://emidius.eu/SHEEC/maps_nomdp/query_eq/external_call.php?eq_id=26831. 1 June 1783, Síða region, Iceland, earthquake swarm, mid-May to June 8, 1783, more than 4.0 Mw, Þórarinsson 1984: 35; Thordarson et al. 2003b: 19. 8 to 11 June 1783, Síða region, Iceland, strong earthquakes continued, damaging farmsteads, Steingrímsson 2002: 181. 15 June 1783, Síða region, Iceland, earthquakes continued, Steingrímsson 1998: 30. 21 June 1783, 18:00, Belledonne, near Lyon, France, 3.95 Mw, https://www.emidius.eu/SHEEC/maps/query_eq/external_call.php?eq_id=6127; Quenet 2005: 541. 22 June 1783, Schweidnitz, Silesia, Severe thunderstorm, probably not an earthquake, Berlinische Nachrichten, 1 July 1783: 605: Report, 25 June 1783. Königlich Privilegirte Zeitung, 1 July 1783, Hamburgischer Unpartheyischer Correspondent, 4 July 1783. 29 June 1783, 04:30, Florence, Italy, “another weak earthquake,” Hamburgischer Unpartheyischer Correspondent, 19 July 1783: Report from Florence, 30 June 1783; Königlich Privilegirte Zeitung, 24 July 1783: 723: Report from Florence, 30 June 1783. July 1783, Austria, Königlich Privilegirte Zeitung, 31 July 1783: 742: Report from Austria, 19 July 1783. 6 July 1783, 09:56, Vallée de l’Ouche, near Dijon, France, 5.14 Mw; VI (Mercalli), https://www.emidius.eu/SHEEC/maps/query_eq/external_call.php?eq_id=6131; Quenet 2005: 541; Berlinische Nachrichten, 26 July 1783: 693: Report from Paris 14 July 1783. 20 July 1783 [?], Gorgona, Italy, lightning struck powder magazine on Gorgona; people in Livorno thought it was an earthquake, Hamburgischer Unpartheyischer Correspondent, 5 August 1783: Report from Italy, 20 July 1783. 20 July 1783, Tripoli, Lebanon, Journal historique et littéraire, 1 November 1783: 363; Ambraseys 2009: 613. 28 July 1783, Val di Ledro, Italy, 4.80 Mw, https://emidius.eu/SHEEC/maps/query_eq/external_call.php?eq_id=1400. 8 August 1783, 03:00, between Aachen, Germany, and Maastricht, the Netherlands, Quenet 2005: 541; Demarée, Ogilvie 2001: 226; Königlich Privilegirte Zeitung, 21 August 1783: 802: Report from Cologne, 10 August 1783. 10 August 1783, Devon, England, mild tremors, Exeter Flying Post, 14 August 1783 (quoted after Grattan, Brayshay 1995: 6). 11 August 1783, 04:00,

Lucerne, Switzerland, 3.9 Mw, https://www.emidius.eu/SHEEC/maps_nomdp/query_eq/external_call.php?eq_id=200976. 15 November 1783, 09:15, S. Severo, Italy, 5.17 Mw, https://emidius.eu/SHEEC/maps_nomdp/query_eq/external_call.php?eq_id=6258. 20 November 1783, 12:58, S. Gregorio, Calabria, 5.17 M, https://emidius.eu/SHEEC/maps_nomdp/query_eq/external_call.php?eq_id=6259. 9 November 1783, 04:00, Cambrai, France, 4.59 Mw, VI Mercalli, Quenet 2005: 541; https://emidius.eu/SHEEC/maps/query_eq/external_call.php?eq_id=6135. 10 December 1783, 05:00, Komárno, Hungary, 3.48 Mw, https://emidius.eu/SHEEC/maps_nomdp/query_eq/external_call.php?eq_id=100371 (all 9 March 2020) —— **145**

Figure 37 Earthquake history in Europe. This map shows the distribution of earthquakes between the years 1000 and 2006, as compiled by the SHARE European Earthquake Catalog (SHEEC). Woessner et al. 2015: 3358, Figure 2. This map is licensed under a CC BY 4.0 license —— **147**

Figure 38 Earthquake risk in today's Germany, Austria, and Switzerland. Grünthal, Gottfried; Mayer-Rosa, Dieter; Lenhardt, Wolfgang A.: Abschätzung der Erdbebengefährdung für die D-A-CH-Staaten – Deutschland, Österreich, Schweiz. In: Bautechnik 75, no. 10 (1998), 753–767, here 764, Figure 6. I thank Professor Grünthal for providing me with an extracted version of this map featuring a map legend —— **148**

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Palatina 1783: 271. Lyndon Hall, Leicestershire, England, late September 1783, "The latter part of the month [September] very fine, warm and pleasant, often thick air." Thomas Barker, Private Weather Diary for Lyndon Hall, Leicestershire, MET/2/1/2/3/227, National Meteorological Library and Archive, Met Office, Exeter, UK. Nain, Labrador, 30 September 1783, "smoky sky," Meteorological Observations at Nain & Okak at Labrador, Hudson's Bay Company, MA/143, Archives of the Royal Society, London, UK, here: 10 September 1783. Prestonpans, Scotland, 1 October 1783, "hazy," George and James Warroch in Prestonpans, 1783–1807, CS96/4401, National Records of Scotland, Edinburgh, UK. Mannheim, 5 October 1783, "vapors tenuis [fine haze]," Societas Meteorologica Palatina 1783: 16. Sagan, 11 October 1783, "Fog, like smoke," Societas Meteorologica Palatina 1783: 346. Okkak, Labrador, 23 October 1783, "heazey and sun shine," Meteorological Observations at Okkak and at Hoffenthal, Hudson's Bay Company, Labrador, Newfoundland, 1782–1786, MA/144, Archives of the Royal Society, London, UK. Hoffenthal, Labrador, 16 November 1783, "[. . .] although we have had much snow this year yet it most all melted, and blown away and the land most over all haze." Meteorological Observations at Okkak and at Hoffenthal, Hudson's Bay Company, Labrador, Newfoundland, 1782–1786, MA/144, Archives of the Royal Society, London, UK — **156**

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Figure 66 A stamp commemorating the Laki eruption, released in 1970, featuring a painting by Sveinn ÓLAFSSON. This stamp was part of the *náttúruvernd* (nature conservation) series. Photograph by Katrin KLEEMANN. Used with permission from Myndstef — **299**

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