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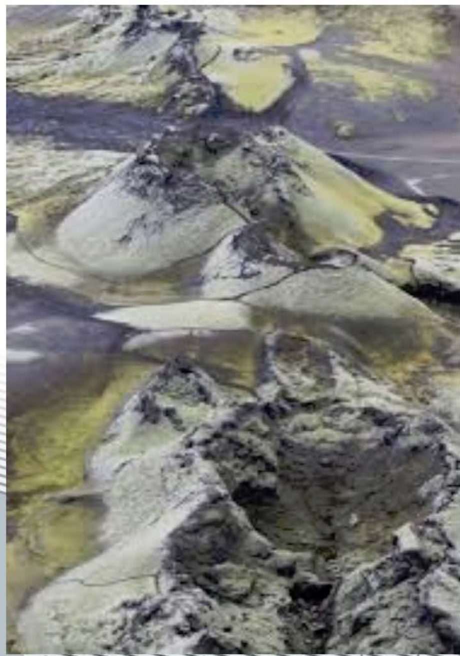

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Par
Geoffrey HELLMAN

The Laki volcanic eruption of 1783-1784

A reappraisal and reinterpretation of the consequences of the event in Europe. Villain or fall guy ?

Thèse présentée et soutenue à Rennes, le 22 mars 2021

Unité de recherche : CReAAH UMR 6566

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SOUS LE SCEAU DE L'UNIVERSITÉ EUROPEENNE DE BRETAGNE

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Ecole Doctorale - Sciences Humaines et Sociales

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DEDICATION

This thesis is dedicated to the hundreds of volunteers worldwide,

who, in their own time, transcribe parish registers

in order to make them accessible to everyone.

Thank you so much.

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ABBREVIATIONS

BPEMR	A Soviet TV channel
COPD	Chronic obstructive pulmonary disease
EHP	Environmental Health Project
GLC	Greater London Council
IDLH	Immediately dangerous to life or health
IFR	Instrument flight rules
INED	Institut national d'études démographiques
I.O.M.	Isle of Man
LIFE	Leading International Fungal Education
mi	Miles
Mt	Million tonnes
Mt.	Mount
NIH	National Institutes of Health
NIOSH	National Institute for Occupational Safety and Health
NNE	North north east
NNW	North north west
OECD	Organisation for Economic Co-operation and Development
oz	Ounce
PBq	Petabecquerel (a unit of measurement of radioactivity)
RBMK	Reaktor bolshoy moshchnosty kanalny (high-power channel reactor)
SSE	South south east
UNSCEAR	United Nations Scientific Committee on the Effects of Atomic Radiation
USGS	United States Geological Survey
VEI	Volcanic Explosivity Index
WHO	World Health Organisation
WNA	World Nuclear Association

SUMMARY

INTRODUCTION

This thesis opens by placing Laki within the context of Iceland's geology and the different types of volcano found there. It has been well documented that what is known to the world as the Laki eruption - but to the people of Iceland as Lakagígar (the Laki fissure eruption), or Skaftáreldar (Skaftá fires), after the nearby river Skaftá - was to prove one of the largest volcanic fissure eruptions in Iceland's recorded history. The eruption started on the 8th June 1783, following a series of minor earth tremors the previous month and strong earthquakes in early June. The eruption was to last for a further eight months until 7th February the following year. During this period, it released an estimated 122 Mt of sulphur dioxide, together with millions of tonnes of water vapour, fluorine and chlorine, and enough lava to cover an area of approximately 580 km^2 [1].

The outcome of this was catastrophic for the Icelandic population. Fields used for grazing became so contaminated by fluorine, that over 60% of the livestock, which was the backbone of the Icelandic economy, perished through contracting chronic fluorosis, by eating the poisoned grass. This in its turn caused a devastating famine which resulted in the death of approximately 10,000 people, i.e. 20% of the population. In Iceland, this was known as the Móðuharðindin, or "Famine of the Mist"[2].

The clouds of gas and dust produced by the eruption were known as the "Dry Fog", and within a month had spread over much of the northern hemisphere, possibly as far as China and Japan. See Map 1:4. It has been proposed that the dry fog caused a great loss of life in parts of Northern Europe, particularly Britain and France. In Britain alone, figures of between 8,000 to 30,000 additional deaths have been mooted. However, in other areas, the fog was reported to have had beneficial effects, for example, increased harvests were reported from Germany, Austria, Hungary, and Poland.

[1] DAMODARAN, Vinita et al., 'The 1780s: Global Climate Anomalies, Floods, Droughts, and Famines', in *The Palgrave Handbook of Climate History* (London: Palgrave Macmillan, 2018), 520.
[2] DAMODARAN, Vinita et al., 520.

The purpose of this thesis is to test this proposition by a detailed analysis of well over one thousand burial records obtained from parish registers, mainly in Britain, but also from Continental Europe; by an in-depth assessment of the published literature, both popular and scientific; and by utilising a wide range of contemporary records, it examines both the nature and responses of the population to the momentous events of the year which led to its being called “Annus Mirabilis”. Extreme weather conditions, volcanic eruptions and earthquakes in other parts of Europe, including the devastating series of quakes which struck Calabria and Messina between February and March killing many thousands of people, and unusual sightings of meteors are just a few of the extraordinary phenomena discussed.

The thesis examines rural and urban living standards and living conditions, and their relationship to both endemic and epidemic diseases which were prevalent during the latter half of the eighteenth century. It examines in detail the pathology and transmission of these diseases. In this connection, the London Bills of Mortality are of particular interest as they list over 80 causes of death. This thesis further reviews the state of medical knowledge and the medical profession during this period within the context of medical and social history. The appalling number of infant deaths together with the incidence of infanticide is discussed, together with comparisons of survival rates in lying-in hospitals in England and Europe. In addition, the dangers posed by inhaling dust and ash from volcanic eruptions are reviewed, especially in relation to Britain and Europe.

In Chapter 4, we discuss the merits and shortcomings of parish registers as these are the main basis of our argument. In Britain alone, statistics from several thousand registers, representing over 1,400 parishes have been counted for the period 1770 to 1799, and a month by month analysis made for the years 1783 and 1784. This number vastly exceeds that used by previous researchers, who based their estimation of the of the number of additional deaths caused by the eruption, on the 404 parishes obtained by Wrigley and Schofield for their magnum opus, *The Population History of England*. In addition, statistics for the years 1800 to 1820 were extracted to ascertain whether there was a discernible increase in the incidence of mortality during the year

1816, “the year of no summer”. A critical evaluation will be made of the role that the El Niño Southern Oscillation played vis à vis the extraordinary weather conditions of the years 1783 to 1785 and the impact that this may have had on the health of the population.

In Chapter 5, the effects of the Laki eruption will be compared to five other famous volcanic eruptions, including Tambora in 1815 and *Eyjafjallajökull in 2010,* and additionally, to two other disasters, the 1952 London smog, and the 1986 Chernobyl nuclear accident. The VEI (volcanic explosivity index) which is used to measure the magnitude of volcanic activity during an eruption or phase of an eruption will be explained.

In the final chapter we will review the evidence that has been presented and assess whether Laki was, in fact, the villain or the fall guy when taken in a British and European context.

All quotes have been made using the original punctuation and spelling, apart from the long “s”, which occurs in the older examples.

CHAPTER 1 – The Laki eruption of 1783-1784 and the Annus Mirabilis

This chapter will place Laki within the context of the geology of Iceland and the different types of volcano found there. In addition, we shall investigate the effect that the 1783-1784 eruption had on the Icelandic population and on the rest of Europe generally. The mechanism whereby the noxious gasses produced by the eruption, mainly, SO_2, F, and Cl, together with fine volcanic ash, were transported over Europe, will also be discussed.

The year 1783 not only saw an unusual amount of seismic activity in Europe, but the number of large scale natural disasters and other unusual atmospheric events which occurred, gave great cause for public concern and it was often referred to as "Annus Mirabilis" (the Year of Awe).[3] These events will be scrutinised in detail using a wide range of documentation both contemporary and recent.

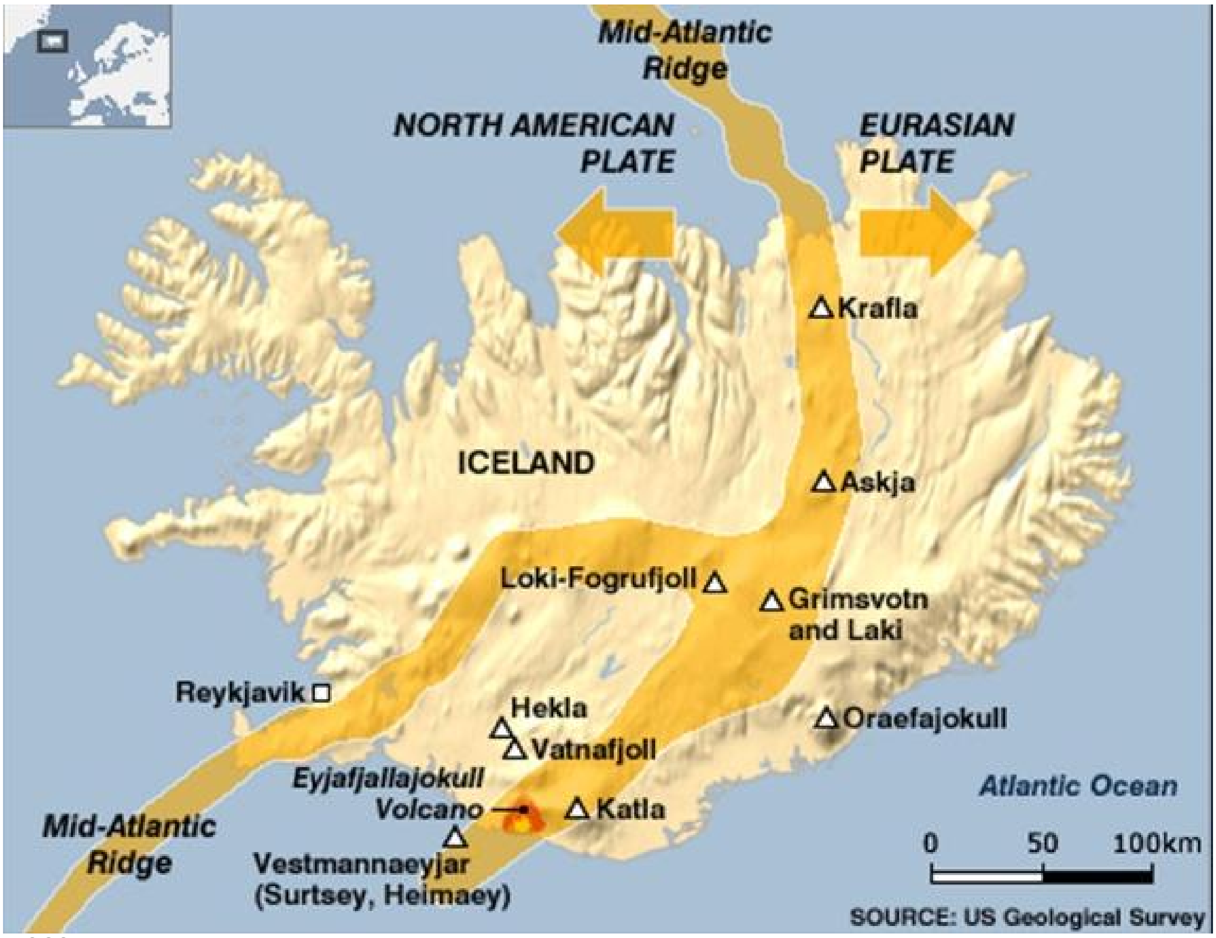
1:1 Geology of Iceland

Iceland is a volcanic island located in the North Atlantic Ocean between Greenland and Norway between 63°23'N to 66°30'N and between 13°30'W to 24.30'W. The island is part of a much larger landmass situated at the junction of two large submarine physiographic structures, the Mid-Atlantic Ridge and the Greenland-Iceland-Faeroes Ridge as can be seen in Map 1.

It is thought to have been formed about 24 million years ago from magma welling up through the Mid-Atlantic Ridge and is the only place on earth where the ridge rises above sea level. As can be seen from the above map, Iceland is sitting on the junction of the North American Plate and the Eurasian Plate, i.e. the Mid-Atlantic Ridge, and is slowly being pulled apart by them at approximately 2 cm per year, that's about 1 cm

[1] STEINTHORSSON, S, 'Annus Mirabilis: 1783 I Erlendum Heimildum (Annus Mirabilis: The Year 1783 according to Contemporary Accounts outside of Iceland)', *Skirnir* 166 (1992): 133–59; THORDARSON, Thorvaldur and SELF, Stephen, 'Atmospheric and Environmental Effects of the 1783-1784 Laki Eruption: A Review and Reassessment', *J. Geophys. Res.* 108, no. D1, 4011 (8 January 2003): 1–29, doi:10.1029/2001JD002042; CHENET, Anne-Lise, FLUTEAU, Frédéric, and COURTILLOT, Vincent, 'Modelling Massive Sulphate Aerosol Pollution, Following the Large 1783 Laki Basaltic Eruption', *Earth and Planetary Science Letters* 236, no. 3–4 (2005): 721–31; PAYNE, Richard J., 'Meteors and Perceptions of Environmental Change in the Annus Mirabilis AD1783-4', *North West Geography* 11, no. 1 (2011), http://www.mangeogsoc.org.uk/pdfs/payne_11_1.pdf.

Map 1:1 Iceland showing the North American and Eurasian plates and main volcanoes



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in each direction. However, it is also sitting over the Iceland mantle plume or hotspot which has been continuously forcing magma up from the earth's interior for some 65 million years and fuels the island's volcanoes.[4]

This view has been challenged by Foulger and Anderson who suggest "*processes related to plate tectonics that are sourced in the shallow upper mantle*"[5].

[4] THORDARSON, Thor, 'Outline of Geology of Iceland Chapman Conference 2012', *Thordarson Chapman 2012*, accessed 6 May 2016, 2&4 http://www.agu.org/meetings/chapman/2012/bcall/pdf/Chapman_Outline_of_Geology_of_Iceland.pdf; THORNHILL, Ted, 'Incredible Aerial Pictures Show US and European Tectonic Plates in Iceland Pulling Apart Leaving Dramatic 200ft Water-Filled Crevices That Divers Can Explore', *Mail Online*, 23 August 2015, http://www.dailymail.co.uk/travel/article-3207774/Incredible-aerial-pictures-European-tectonic-plates-Iceland-pulling-apart-leaving-dramatic-200ft-water-filled-crevices-divers-explore.html; REYKJANES RIDGE EXPEDITION, 'Geology of Iceland', 2007, http://www.soest.hawaii.edu/HIGP/Faculty/hey/rr2007/icelandgeo.html;
MACDOUGALL, Doug, 'Iceland: Scars on the Landscape', *Doug Macdougal Musings*, 26 September 2015, http://www.dougmacdougall.com/musings/iceland-scars-on-the-landscape/.
[5] FOULGER, G. R., 'Plumes, or Plate Tectonic Processes?', *Astronomy & Geophysics* 43, no. 6 (12 2002): 6.19-6.24, https://doi.org/10.1046/j.1468-4004.2002.43619.x; FOULGER, G. R. and ANDERSON, Don L., 'A Cool Model for the Iceland

Although the birth of Iceland dates from around 24 million years ago, the oldest rock on land is a relatively young 18my and this has been continually added to by frequent volcanic eruptions. Approximately 11.05% of the land area of the island (about 11,400 km² out of the total area of 103,125 km²) is covered by glaciers. The majority of the present landscape was fully developed by the beginning of the Holocene period, about 9,700 years ago with the exception of the river courses and canyons which were formed after the melting of the Younger Dryas glacier, and the active volcanic zones which are being modified by present day volcanic activity.[6]

There are 30 active volcanic zones and 20 central volcanoes that have been active in the recent geological past.[7]The volcanic zones consist of a central volcano, a fissure swarm or a combination of both, The fissure swarms which are elongated strips between 5-20 km wide can extend for between 50 to 200 km, whilst the eruptions produced can be either short-lived (days to weeks) or long-lived (months to years).[8]

Volcanic eruptions can be divided into three types: explosive, with little or no lava, but a large volume of tephra (all fragments of rock including ash, ejected into the air by an eruption); effusive, mainly consisting of lava flows; and mixed, which, as its name suggests, has properties of both the previous types.[9]

Hotspot', *Journal of Volcanology and Geothermal Research* 141 (1 March 2005): 1, https://doi.org/:10.1016/j.jvolgeores.2004.10.007; FOULGER, Gillian R., 'Are "hot Spots" Hot Spots?', *Journal of Geodynamics* 58 (July 2012): 1–28, https://doi.org/10.1016/j.jog.2011.12.003.

[6] THORDARSON, Thor, 'Outline of Geology of Iceland Chapman Conference 2012'; WIKIPEDIA, 'List of Glaciers of Iceland', Wikipedia, 31 December 2015, https://en.wikipedia.org/wiki/List_of_glaciers_of_Iceland.

[7] THORDARSON, Thor, 'Outline of Geology of Iceland Chapman Conference 2012', 7.(accessed 6.5.2016)

[6] THORDARSON, T. and LARSEN, G, 'Volcanism in Iceland in Historical Time: Volcano Types, Eruption Styles and Eruptive History', *Journal of Geodynamics* 43 (2007): 121–23, https://doi.org/10.1016/j.jog.2006.09.005; THORDARSON, Thor, 'Outline of Geology of Iceland Chapman Conference 2012', ibid.

[9] THORARINSSON, Sigurdur, 'On the Damage Caused by Volcanic Eruptions with Special Reference to Tephra and Gasses', in *Volcanic Activity and Uuman Ecology*, ed. SHEETS, Payson, D. and GRAYSON, Donald K. (New York: Academic Press, 1980), 125–26, http://cidbimena.desastres.hn/pdf/eng/doc13631/doc13631-1.pdf; BAXTER, Peter J. et al., 'Medical Aspects of Volcanic Disasters: An Outline of the Hazards and Emergency Response Measures', *Disasters* 6, no. 4 (December 1982): 218, https://doi.org/10.1111/j.1467-7717.1982.tb00549.x.

Table 1:1 Geological timetable from the birth of Iceland until the present. From Thordarson, Chapman Conference, 2012

Era	Period	Epoch	Age	Stage	Sub-Stage	Formations	Events
Cainozoic	Quaternary	Holocene	0 2.5ky	Late Bog Period (sub-Atlantic)		Upper Pleistocene Formation	
			5.0ky	Late Birch Period (sub Boreal)			
			7.2ky	Early Bog Period (Atlantic)			
			9.3ky	Early Birch Period (Boreal)			
			10ky	Pre-Boreal			
		Upper Pleistocene	11Ky	Weichselian	Younger Dryas		Ice Age glacier disappears
			12ky		Allerød		Fossvogur sediments accumulate
			20ky		Older Dryas		
			70ky				Last glacial stage
			130ky	Eemian			Elliðavogur sediments accumulate Last interglacial
			170ky	Saale			Second last glacial stage
			700ky				Svínafell sediments accumulate
		Lower Pleistocene	2.5my			Plio-Pleistocene Formation	Rauðsgjá tillite Breiðavík tillite and sediments Furuvík tillite formed Full scale glaciation
	Tertiary	Pliocene	3.3my				Tjörnes sediments stop accumulating Pacific Ocean fauna arrives in Iceland Bearing strait opens
			7my			The Tertiary Basalt Formation	Tjörnes sediments begin to form First sign of cooling climate
		Upper Miocene	12my.				Warm temperate climate
		Middle Miocene	18my				Oldest rock on land.
		Early Miocene	25my				Birth of Iceland

1:2 Setting the scene

> Around midmorn on Whitsun, June 8th of 1783, in clear and calm weather, a black haze of sand appeared to the north of the mountains nearest the farms of the Siða area. The cloud was so extensive that in a short time it had spread over the entire Siða area and part of Fljótshverfi as well, and so thick that it caused darkness indoors and coated the earth so that tracks could be seen. The powder which fell to earth looked like burnt ash from hard coal. A light drizzle, which fell from that black cloud that day over the Skaftártunga region, turned this powder into black, inky liquid.[10]

Thus began, in the words of Jón Steingrimsson, the second largest basaltic lava flow eruption in recorded history, the first being that of Eldgjá in 939-940. During 8 months of activity, Laki spewed out 14.7 ± 1 km^3 = 4.0 x 10^{13} kg of lava over an area of some 580km^2; 0.4 km^3 = 1.1 x 10^{12} kg of tephra; 122 Mt. i.e. 122,000,000 tonnes of sulphur dioxide; 235 Mt. water vapour; 15 Mt. of fluorine and 7 Mt. of chlorine.[11] To put this into perspective, the total tephra released was double the amount of the 1980 Mt. St. Helens eruption, whilst the volume of lava ejected was great enough to have been able to bury the square mile (2.5898 km^2) of the City of London to a depth of ~5.7 km.[12] Laki is not a single volcanic cone, but a 27 km long vent system comprising 10 volcanic fissures or cones and over 140 vents, extending in a north easterly direction from the Ulfarsdalur Valley in the west towards the Sidujökull glacier in the east. In its turn, Laki is part of the Grimsvôtn volcanic system which consists of the Grimsvötn central

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8 STEINGRIMSSON, Jón, *Fires of the Earth: The Laki Eruption1783-1784*, trans. KUNZ, Keneva (Reykjavik: Nordic Volcanological Institute and the University of Iceland Press, 1998), 25–26.

11 THORDARSON, T. et al., 'Sulfur, Chlorine, and Fluorine Degassing and Atmospheric Loading by the 1783–1784 AD Laki (Skaftár Fires) Eruption in Iceland.', *Bulletin of Volcanology* 58 (1996): 205–25, http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.476.5278&rep=rep1&type=pdf; THORDARSON, Thorvaldur and SELF, Stephen, 'Atmospheric and Environmental Effects of the 1783-1784 Laki Eruption: A Review and Reassessment', 1–6; SCHMIDT, Anja et al., 'Climatic Impact of the Long-Lasting 1783 Laki Eruption: Inapplicability of Mass-Independent Sulfur Isotopic Composition Measurements.', *Journal of Geophysical Research: Atmospheres* 117, no. D23 (13 December 2012): 1–14, https://doi.org/DOI: 10.1029/2012JD018414; THORDARSON, Thorvaldur, 'Volatile Release and Atmospheric Effects of Basaltic Fissure Eruptions' (PhD, Honolulu, University of Hawaii, 1995); DAMODARAN, Vinita et al., 'The 1780s: Global Climate Anomalies, Floods, Droughts, and Famines', 520.

12 SARNA-WOJCICKI, Andrei M et al., 'Areal Distribution, Thickness, Mass, Volume, and Grain Size of Air-Fall Ash from Six Major Eruptions of 1980.', in *The 1980 Eruptions of Mount St. Helens, Washington*, Geological Survey Professional Paper 1250 (Washington, D.C.: US Geological Survey, 1981), 844, https://books.google.fr/books?id=9sZUAAAAYAAJ&pg=PR15&lpg=PR15&dq=sama-wojcicki+shipley+waitt&source=bl&ots=5cN4zvCTCM&sig=ZGql3JFaQD5i3pZ_htH1DR4G-Uw&hl=en&sa=X&ved=0ahUKEwjP3N_J5bLRAhXH6xQKHZicCF8Q6AEIHTAA#v=onepage&q=sama-wojcicki%20shipley%20waitt&f=false; THORDARSON, Thor and SELF, Stephen, 'The Laki (Skaftár Fires) and Grímsvötn Eruptions in 1783–1785', *Bulletin of Volcanology* 55, no. 4 (May 1993): 233–63, https://doi.org/10.1007/BF00624353; THORDARSON, Thorvaldur and SELF, Stephen, 'Atmospheric and Environmental Effects of the 1783-1784 Laki Eruption: A Review and Reassessment'.

volcano and a volcanic fissure swarm approximately 100 km long and 15 km wide[13]. To be strictly accurate, the Laki eruption of 1783-1784, which commenced on the 8th of June, 1783 and ceased on the 7th February, 1784, represents the main volcanic event of a two-year-long volcano-tectonic episode within the Grimsvôtn system lasting from May 1783 to 26th May 1785. In Iceland, this is often called the Lakagígar or Skaftáreldar (Skaftár fires) eruption.[14] The timing of earthquakes, explosive activity, lava surges and the peak SO_2 emissions which occurred during these eruptions is shown in the following Table.

Ten of the eruption episodes shown in the above table are linked with the Laki eruption, whilst the remaining four episodes with the Grimsvôtn volcano. Most of the eruptions began with an earthquake swarm of increasing intensity, leading to the emergence of a new fissure segment. This was followed by an explosive eruption and a massive increase in the outpouring of lava. The remaining two earthquake swarms do not appear to be directly connected to either the Laki or Grimsvôtn eruptions.[15] By the end of October, nearly 90% of the total volume of tephra had been emitted. See Fig. 1:1

Large explosive volcanic eruptions, for example, Samalas, 1278, Tambora, 1815, and Pinatubo, 1991, inject large amounts of sulphur dioxide, other volatiles and volcanic dust directly into the stratosphere, and this may significantly affect climate worldwide, whereas fissure eruptions such as Laki, seem only to have sufficient power to send the majority of their ejecta into the middle and upper troposphere and a much smaller quantity into the lower stratosphere.[16]

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[13]THORDARSON, Thorvaldur et al., 'The 1783–1785 A.D. Laki-Grímsvötn Eruptions II: Appraisal Based on Contemporary Accounts', *Jokull* 53 (January 2003): 11–48.

[14] DEMAREE, Gaston R. and OGILVIE, Astrid E. J., 'Bons Baisers d'Island: Climatic, Environmental, and Human Dimensions Impacts of the Lakagigar Eruption (1783-1784) in Iceland', in *History and Climate: Memories of the Future* (New York, Boston, Dordrecht, London, Moscow: Kluwer Academic/Plenum, 2001), 219–46; THORDARSON, Thorvaldur and Self, Stephen, 'Atmospheric and Environmental Effects of the 1783-1784 Laki Eruption: A Review and Reassessment'.

[15] THORDARSON, Thorvaldur et al., 'The 1783–1785 A.D. Laki-Grímsvötn Eruptions II: Appraisal Based on Contemporary Accounts', *Jokull* 53 (January 2003): 11–48; THORDARSON, T. et al., 'Sulfur, Chlorine, and Fluorine Degassing and Atmospheric Loading by the 1783–1784 AD Laki (Skaftár Fires) Eruption in Iceland.'

[16] ROBOCK, Alan, 'Volcanic Eruptions and Climate', *Reviews of Geophysics* 38, no. 2 (May 2000): 191–219, http://www.aos.wisc.edu/~aos915/Robock_2000.pdf; STEVENSON, D. S. et al., 'Atmospheric Impact of the 1783–1784 Laki Eruption: Part I Chemistry Modelling', *Atmospheric Chemistry and Physics* 3 (19 May 2003): 487–507, http://cepsar.open.ac.uk/pers/v.gauci/pics/d39297.pdf; THORDARSON, Thorvaldur and SELF, Stephen, 'Atmospheric and Environmental Effects of the 1783-1784 Laki Eruption: A Review and Reassessment'; OMAN, Luke et al., 'Modeling the Distribution of the Volcanic Aerosol Cloud from the 1783–1784 Laki Eruption', *Journal of Geophysical Research: Atmospheres* 111, no. D12 (24 June 2006): 1–15, https://doi.org/10.1029/2005JD006899.

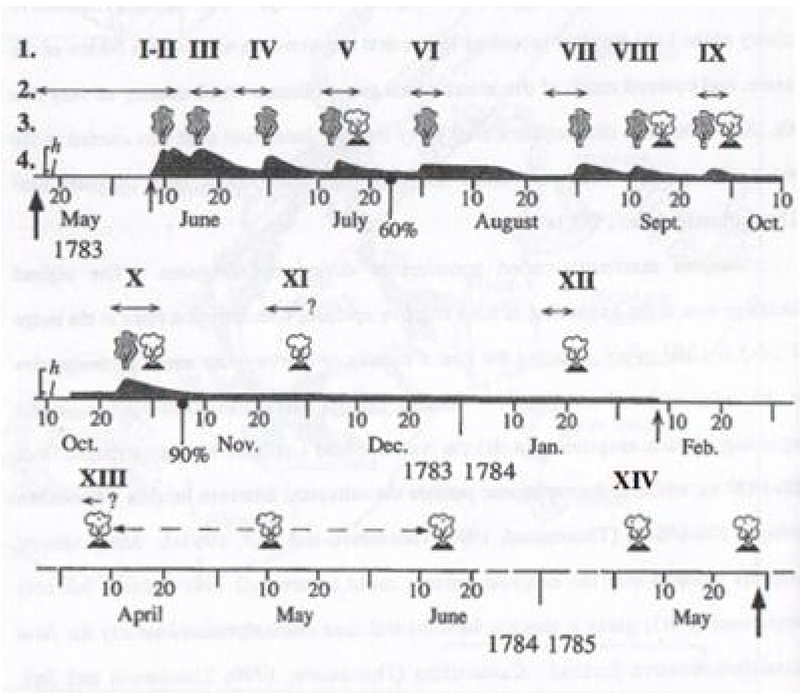
Table 1:2 Timing of earthquakes explosive activity, lava surges,and peak SO_2 emissions

Earthquakes	Tephra Fall	Lava Surges	Peak SO_2 Emissions	Eruption Episodes
19th May – 8th June	8th – 9th June	12th June	8th June	I
9th – 11th June	10th – 11th June	14th June	11th – 12th June	II
13th – 19th June	14th June	18th – 20th June	14th – 15th June	III
	21st June			?
23rd – 26th June				
30th June	25th – 28th June	29th June	26th –28th June	IV
14th July	9th – 10th July	14th July	9th – 10th July	V
17th – 20th July	18th – 19th July	18th July		V
29th July ?				
1st – 3rd Aug.	29th – 30th July	7th Aug.	29th – 30th July	VI
23rd – 31st Aug.	7th Sept.	2nd Sept.	31st Aug.?	VII
	14th Sept.	10th Sept.	7th Sept.	VIII
26th Sept.		26th Sept.	24th – 25th Sept.	IX
24th – ? Oct.	25th Oct.	25th – 29th Oct.	25th Oct.	X
2nd Nov.				?
24th Nov.	24th Nov.			XI
	Jan. 1784			XII
Feb. 1784				
	8th April 1784			XIII
14th – 25th Aug.				
	4th – 26th May 1785			XIV

After Thordarson et al. 2003

It has been estimated that Laki's explosive eruption columns ejected gases and volcanic dust from between 9km to 13km into the atmosphere, and of these, $^{2}/_{3}$ remained in the troposphere and were rapidly transported by the westerly jet stream towards the high-pressure zone positioned over Europe, whilst the remainder persisted in the stratosphere for 12 months or more. Moreover, according to Maclean, the total lunar eclipse of 10 September 1783 was not unusually dark, thus intimating that the column of fine ash and gas reached up to, at the most, the tropopause, some 8 to 11km above the earth, during the Icelandic summer.[17]

Figure 1:1 Sequence of events during the Laki-Grimsvôtn eruptions



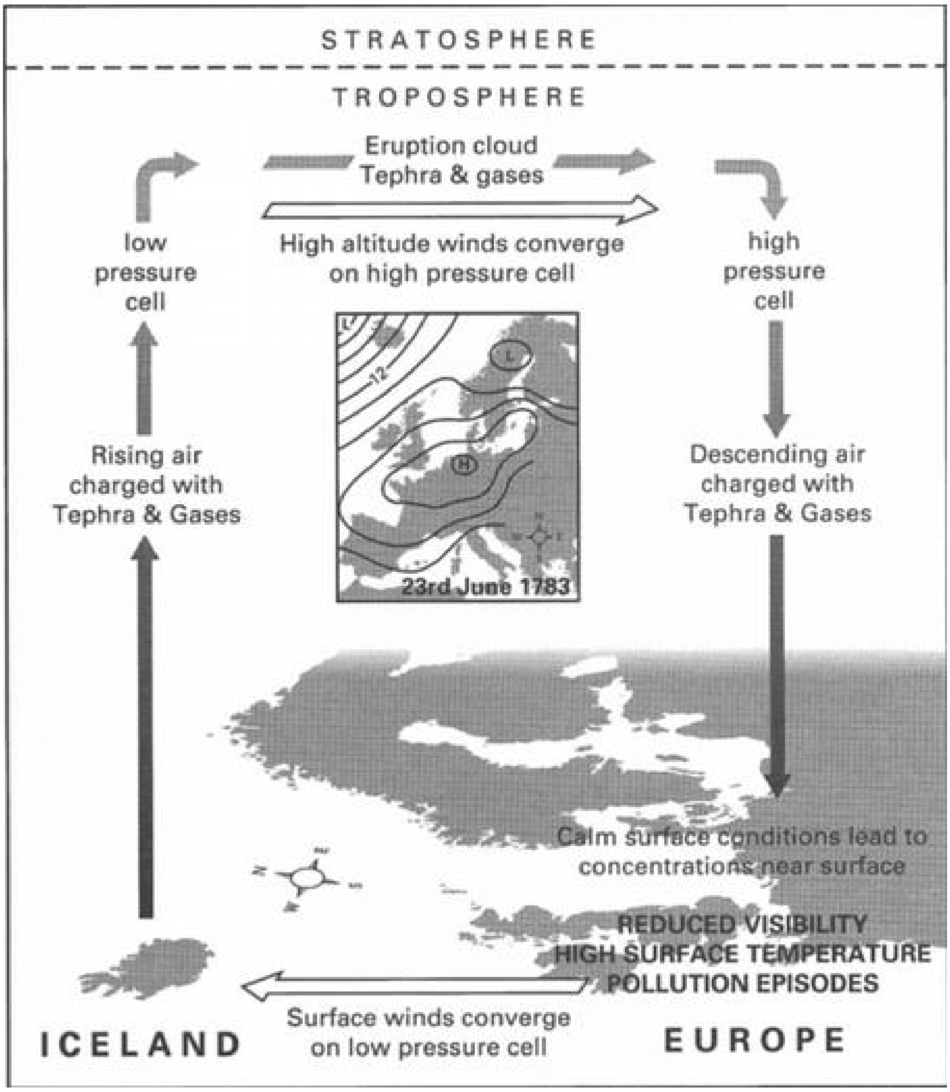
After Thordarson, 1995

Schematic illustration of sequence of events during the Laki-Grimsvôtn eruptions.1. The Roman numerals denote the eruption episodes. 2. Horizontal arrows show the extent of each earthquake swarm during the Laki eruption. 3. Eruption clouds denote explosive activity at Laki fissures, eruption clouds with a cone at base denote explosive activity at Grimsvôtn volcano. 4. Stippled area indicates fluctuations in lava production

[17] MACLEAN, Alasdair D. I., 'The Cause of Dark Lunar Eclipses', *Journal of the British Astronomical Association* 94, no. 6 (1984): 263–65, http://articles.adsabs.harvard.edu/cgi-bin/nph-iarticle_query?db_key=AST&bibcode=1984JBAA...94..263M&letter=0&classic=YES&defaultprint=YES&whole_paper=YES&page=265&epage=265&send=Send+PDF&filetype=.pdf; RAMPINO, Michael R., SELF, Stephen, and STOTHERS, Richard B, 'Volcanic Winters', *Annual Review of Earth and Planetary Sciences* 16 (1988): 73–99, https://pubs.giss.nasa.gov/docs/1988/1988_Rampino_ra00400a.pdf.

(not to scale) at the Laki fissures. Large vertical arrows mark the beginning and end of the Laki - Grimsvôtn volcano - tectonic event, small vertical arrows the beginning and end of the Laki fissure eruption. The 60 and 90 percent marks refer to the volume fraction erupted up to that time.

Figure 1:2 Transportation mechanism of volcanic eruption cloud from Iceland to Western Europe, 23 June to 20 July 1783



Grattan & Brayshay, 1995

The mechanism enabling this transportation can be clearly seen from Fig.1:2. A trough of low pressure existed over Iceland, whilst there was a zone of high pressure over Europe. Any volatiles and dust which were confined to the troposphere would have been drawn to high altitude and transported by the ambient air currents which thus facilitated the transference of the eruption cloud to the high pressure cell.[18] The gases would then have been concentrated near the surface by the descending air column, where they would, in some instances, have been strong enough to damage vegetation and possibly be the cause of abnormal weather conditions.[19]

The following passage, again from Steingrimsson, gives one a very vivid idea of how frightening the eruption must have appeared.

> On the 12th the weather was clear, with a wind from the south. Now the flood of lava spilled out of the canyon of the River Skaftá and poured forth with frightening speed, crashing, roaring and thundering. When the molten lava ran into wet-lands or streams of water the explosions were as loud as if many cannon were fired at one time. At first this fiery flood followed the main course of the river, and then spread over the banks and out over the older lava fields which stretch out on both sides.[20]

Although the eruption was only VEI 4 on the Volcanic Explosivity Index – see Chapter IV – the consequences of this event were catastrophic for Iceland[21]. The despoliation of pasture and farmland and by volcanic ash and polluted rainfall, resulted in the death of more than 60% of the grazing livestock, mainly through chronic fluorosis.

[18] KINGTON, J. A., *The Weather Patterns for the 1780s over Europe* (Cambridge, New York: Cambridge University Press, 1988), 3; THORDARSON, Thor and SELF, Stephen, 'The Laki (Skaftár Fires) and Grímsvötn Eruptions in 1783–1785'; GRATTAN, John and BRAYSHAY, Mark, 'An Amazing and Portentous Summer: Environmental and Social Responses in Britain to the 1783 Eruption of an Iceland Volcano', *The Geographical Journal* 161, no. 2 (July 1995): 125–34, https://doi.org/10.2307/3059970; GRATTAN, J. P. and PYATT, F. B., 'Volcanic Eruptions Dry Fogs and the European Palaeoenvironmental Record: Localised Phenomena or Hemispheric Impacts?', *Global and Planetary Change* 21, no. 1 (July 1999): 173–79, http://www.sciencedirect.com/science/article/pii/S0921818199000132; GRATTAN, John and BRAYSHAY, Mark, 'An Amazing and Portentous Summer: Environmental and Social Responses in Britain to the 1783 Eruption of an Iceland Volcano'.

[19] GRATTAN, John and BRAYSHAY, Mark, 'An Amazing and Portentous Summer: Environmental and Social Responses in Britain to the 1783 Eruption of an Iceland Volcano'.

[20] STEINGRIMSSON, Jón, *Fires of the Earth: The Laki Eruption1783-1784*.pp 25-26.

[21] WIKIPEDIA, 'Volcanic Explosivity Index', Wikipedia, 18 October 2016, https://en.wikipedia.org/wiki/Volcanic_Explosivity_Index.

According to Jackson, over 10,000 cattle, 27,000 horses and 190,000 sheep died between 1783 and 1784. It is estimated that these figures represent approximately 50% of the total stock of cattle, 75% of the horses and nearly 80% of the sheep. As mutton made up a large proportion of the people's diet, these losses were devastating, and widespread starvation ensued, killing over 20% of the population, i.e. approximately 10,000 people.[22] However, after 1786 the population rapidly began to recover, having an annual growth rate of some 1.6%, and by 1824 the population had surpassed pre-eruption levels.[23]

1:3 Annus Mirabilis

1:3:1 Earthquakes, in Italy and elsewhere

The series of earthquakes which struck Calabria and Messina between the 5th of February and the 28th of March 1783 was the most severe to strike Italy since the Sicily earthquake of 11th of January 1693, which killed some 60,000 people.

During a period of nearly two months of activity a series of five quakes in Sicily and the Calabrian region of southern Italy, killed an estimated 35,000 to 50,000 people and devastated many towns and villages. Over 1,500 of these deaths were due to a tsunami which was triggered by the major collapse of Monte Paci into the sea near the town of Scila on 6th of February. Many of its inhabitants being fearful for their safety thought it safer to spend the night on the beach away from any buildings that might collapse, where they were overwhelmed by the deluge.[24] Several other earthquakes and tremors of minor importance occurred during mid-summer and December.

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[22] JACKSON, E.L., 'The Laki Eruption of 1783: Impacts on Population and Settlement in Iceland', *Geography* 67, no. 1 (January 1982): 42–50; THORDARSON, Thor and SELF, Stephen, 'The Laki (Skaftár Fires) and Grímsvötn Eruptions in 1783–1785', *Bulletin of Volcanology* 55, no. 4 (May 1993): 233–63, doi:10.1007/BF00624353; THORDARSON, Thorvaldur, 'Volatile Release and Atmospheric Effects of Basaltic Fissure Eruptions' (PhD, University of Hawaii, 1995); THORDARSON, Thorvaldur and SELF, Stephen, 'Atmospheric and Environmental Effects of the 1783-1784 Laki Eruption: A Review and Reassessment'; BRITISH GEOLOGICAL SURVEY, 'Laki Eruption, Iceland | Updated 2013', 2013, http://www.bgs.ac.uk/research/volcanoes/Laki.html.

[23] JACKSON, E.L., 'The Laki Eruption of 1783: Impacts on Population and Settlement in Iceland'.

[24] HAMILTON, Sir William, 'Account of the Earthquakes in Calabria, and Various Parts of Sicily', *The London Magazine: Or Gentleman's Monthly Intelligencer* 52, no. Sep&Oct (1783): 220–28; 295–304, http://babel.hathitrust.org/cgi/pt?id=nyp.33433081682779;view=1up;seq=443; DEMAREE, Gaston R. and OGILVIE, Astrid E. J., 'Bons Baisers d'Island: Climatic, Environmental, and Human Dimensions Impacts of the Lakagigar Eruption (1783-1784) in Iceland'; WIKIPEDIA, '1693 Sicily Earthquake', Wikipedia, 20 November 2016, https://en.wikipedia.org/wiki/1693_Sicily_earthquake; WIKIPEDIA, '1783 Calabrian Earthquakes', Wikipedia, 23 November 2016, https://en.wikipedia.org/wiki/1783_Calabrian_earthquakes; ANON, 'Foreigh Affairs: Earthquakes in Calabria', *The London Magazine: Or Gentleman's Monthly Intelligencer* 52, no. May (1783): 256.

On 6th of July there was an earthquake in the regions of the Jura, Franche-Comté, Burgundy and Geneva, minor quakes in Maastricht and Aachen on 8th of August, and tremors in northern France on 23rd of December.[25]

Map 1:2 Southern Italy and Sicily showing the Calabrian Earthquakes

Wikipedia

1:3:2 Volcanic Eruptions in Europe

Although the Laki eruption is the most famous, the Grimsvôtn eruptions were not the only ones that took place in 1783. Towards the end of February, a submarine eruption occurred at Fuglasker, off the Reykjanes Peninsula in the south west of Iceland. This event continued until the summer of that year and formed the short-lived Island of Nýey (New Island), which vanished soon afterwards.[26] There was also quite a lot of volcanic activity in Italy. On the 17th February, it was reported that Etna had erupted, and this was followed within a few days by Stromboli and probably Vulcano, thus adding to the

[25] DEMAREE, Gaston R. and OGILVIE, Astrid E. J., 'Bons Baisers d'Island: Climatic, Environmental, and Human Dimensions Impacts of the Lakagigar Eruption (1783-1784) in Iceland'; PAYNE, Richard J., 'Meteors and Perceptions of Environmental Change in the Annus Mirabilis AD1783-4'; DEMAREE, Gaston R. and OGILVIE, Astrid E. J., 'L'éruption Du Lakagigar En Islande Ou "Annus Mirabilis 1783". Chronique d'une Année Extraordinaire En Belgique et Ailleurs', in *Etudes et Bibliographies d'histoire Environnementale*, Collections Autres Futurs 5 (Namur: Presses universitaires de Namur, 2016), 297.

[26] FRANKLIN, Benjamin, 'Meteorological Imaginations and Conjectures', in *Memoirs of the Literary and Philosophical Society of Manchester*, 2nd ed. (London: J. Cadwell, 1789), 377, https://www.dartmouth.edu/~volcano/Fr373p77.html; WOOD, Charles A., 'Climatic Effects of the 1783 Laki Eruption', in *The Year Without a Summer? World Climate in 1816*, ed. HARRINGTON, C.R. (Ottawa, Canada: Canadian Museum of Nature, 1992), 576; STOTHERS, Richard B, 'The Great Dry Fog of 1783', *Climate Change* 32, no. 1 (1996): 79–89, https://doi.org/10.1007/BF00141279; DEMAREE, Gaston R. and OGILVIE, Astrid E. J., 'Bons Baisers d'Island: Climatic, Environmental, and Human Dimensions Impacts of the Lakagigar Eruption (1783-1784) in Iceland'.

destruction caused by the Calabrian and Sicilian earthquakes.[27] Six months later, on the 18th August there was a small eruption, of little consequence, on Vesuvius, which began that volcano's 1783-1794 eruptive sub-cycle.[28]

Volcanic activity of some sort was also reported to have taken place in the early summer at the Gleichberg mountain in Thuringia, Germany, but hard evidence is singularly lacking, and it could all have been an elaborate hoax.[29]

1:3:3 The Hot Dry Fog and Blood-Red Sun

The summer of 1783 is best known for the abnormally hot, persistent, sulphurous, dry fog, which was generated by the Laki eruption and which pervaded Europe and much of the northern hemisphere for the second part of the year. Some of the more bizarre contemporary explanations blamed the haze on the Calabrian earthquakes, evaporations from the soil, atmospheric electricity, meteors, and the debris from the tail of a comet.[30] However, Professor Kratzenstein of Copenhagen University and the French naturalist, M. Mourgue de Montredon correctly identified its origin as being due to a volcanic eruption in Iceland.[31]

[27] GRATTAN, John, BRAYSHAY, Mark, and SADLER, Jon, 'Modelling the Distal Impacts of Past Volcanic Gas Emissions. Evidence of Europe-Wide Environmental Impacts from Gases Emitted during the Eruption of Italian and Icelandic Volcanoes in 1783', *Quaternaire* 9, no. 1 (1998): 25–35, https://doi.org/doi : 10.3406/quate.1998.2103.

[28] BEHENCKE, Boris, 'Vesuvio Volcano, Italy The Activity between 1632 and 1794', Italy's Volcanoes: The Cradle of Volcanology, 12 June 1996, http://www.geo.mtu.edu/volcanoes/boris/mirror/mirrored_html/VESUVIO_1632-1794.html.

[29] GRATTAN, J. P., GILBERTSON, D. D., and DILL, A, '"A Fire Spitting Volcano in Our Dear Germany": Documentary Evidence for a Low-Intensity Volcanic Eruption of the Gleichberg in 1783?', *Geological Society, London, Special Publications* 171, no. 1 (January 2000): 307–15, https://doi.org/10.1144/GSL.SP.2000.171.01.22.

[30] THORDARSON, Thorvaldur, 'Volatile Release and Atmospheric Effects of Basaltic Fissure Eruptions'; STOTHERS, Richard B, 'The Great Dry Fog of 1783'; THORDARSON, Thorvaldur and SELF, Stephen, 'Atmospheric and Environmental Effects of the 1783-1784 Laki Eruption: A Review and Reassessment'; de LAMANON, 'Observations on the Nature of the Fog of 1783', in *The Philosophical Magazine: Comprehending the Various Branches of Science, the Liberal Arts, Agriculture, Manufactures and Commerce by Alexander Tilloch*, vol. 5 (London: J. Davis, 1799), 80–89, http://babel.hathitrust.org/cgi/pt?id=hvd.hxh3j3;view=1up;seq=92.

[31] HOLM, S.M., 'Account of a Remarkable Fiery Eruption from the Earth in Iceland, in the Year 1783', in *The Philosophical Magazine: Comprehending the Various Branches of Science, the Liberal Arts, Agriculture, Manufactures and Commerce by Alexander Tilloch*, vol. 3 (London: J. Davis, 1799), 113–20, http://babel.hathitrust.org/cgi/pt?id=pst.000068485061;view=1up;seq=132; STOTHERS, Richard B, 'The Great Dry Fog of 1783', 79–89; DE MONTREDON, Mourgue, 'Recherches sur l'origine et sur la nature des vapeurs qui ont régné dans l'Atmosphère pendant l'été de 1783', in *Histoire et Mémoires de l'Académie Royale des Sciences, Paris, Imprimerie Royale* (Paris: l'Académie Royale des Sciences, 1784), 773, http://gallica.bnf.fr/ark:/12148/bpt6k35800/f888.item.zoom; THORDARSON, Thorvaldur and SELF, Stephen, 'Atmospheric and Environmental Effects of the 1783-1784 Laki Eruption: A Review and Reassessment'.

The first appearance of the fog outside Iceland was around the 10th of June in the Faeroe Islands, Bergen, and Trondheim, when there was a fall of volcanic ash and acid rain. There were also reports that ships sailing between Denmark and Iceland experienced an ashfall which coloured their decks and sails black.[32] According to Geikie, there was a fall of ash in Caithness, Scotland, which spoiled the crops, and caused it to be called "the year of the ashie", and Venice, in Italy, experienced a haze of dust so rich in iron that it was attracted to a magnet.[33]

The following map, Map 1:3, has been constructed from historic accounts that mention the deposition of fine ash or dust that formed a coating between a few millimetres to several millimetres in thickness. It has been calculated that this covered an area of at least 760,000 km^2 in a broad swathe running from Iceland down to Northern Italy in the east and Northern Poland in the west.[34]

In western and southern Europe, a fine haze was first noticed between the 16th and 19th of June and by the 26th, almost all Europe was shrouded by a thick, evil-smelling, dry fog which made the eyes smart, triggered headaches and caused great distress to those suffering from asthma or similar conditions.[35] See Maps 1:4 and 1:5 for the first appearance of the fog throughout Europe.

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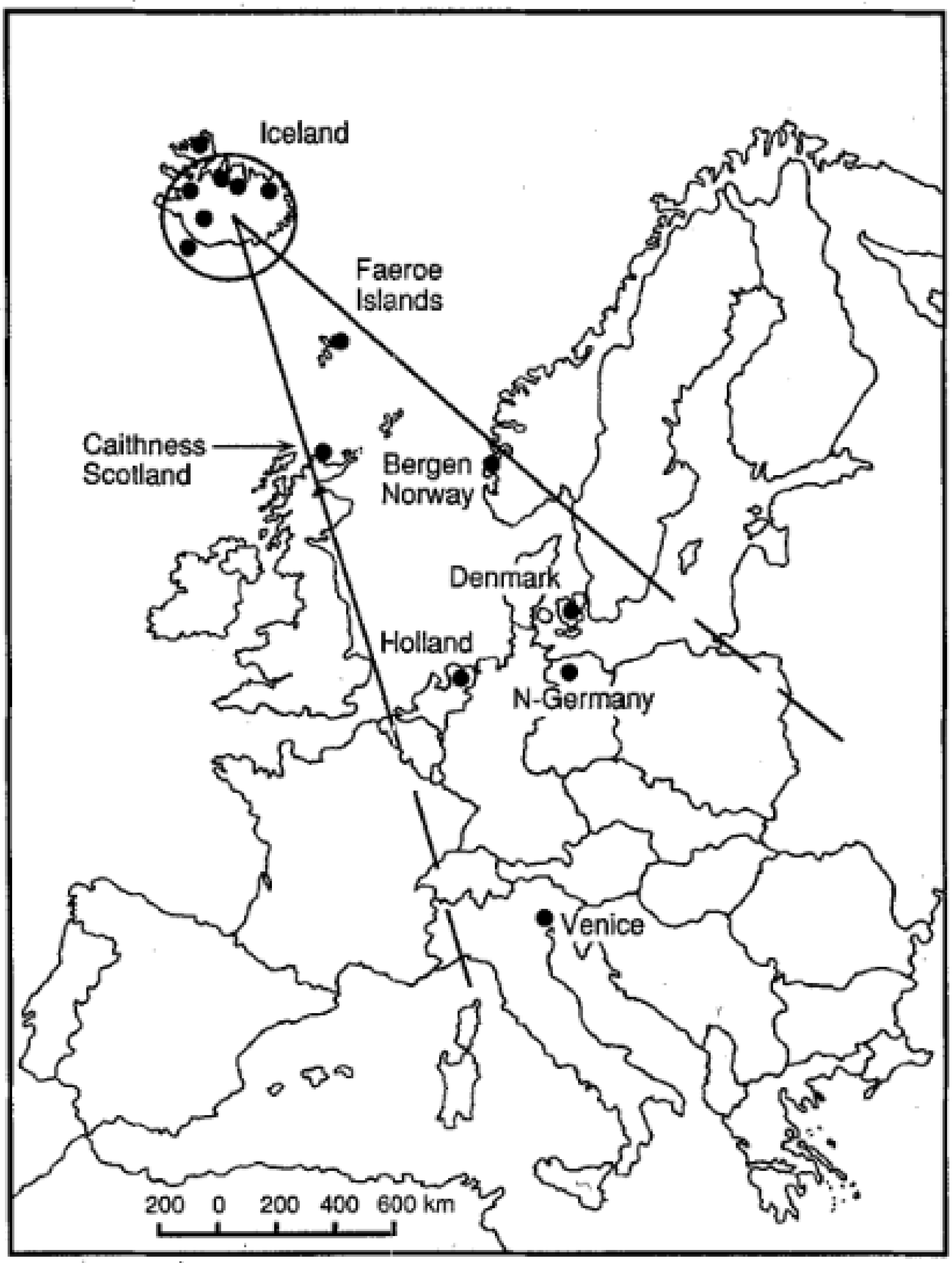
[32] THORDARSON, Thorvaldur, 'Volatile Release and Atmospheric Effects of Basaltic Fissure Eruptions'.

[33] GEIKIE, Archibald, *Text-Book of Geology*, 2nd ed. (London: Macmillan, 1885), 202, https://archive.org/details/textbookofgeolog00geikuoft; THORODDSEN, Th, *Die Geschichte Der Isl~indischen Vulkane* (Copenhagen, Denmark: Konglige Danske Videnskabens Selskab Skrif om Naturen og Mathematik, Afd. B. IX., 1925) quoted in THORDARSON & SELF, 1993, p. 249.

[34] THORDARSON, Thor and SELF, Stephen, 'The Laki (Skaftár Fires) and Grímsvötn Eruptions in 1783–1785', 250–51.

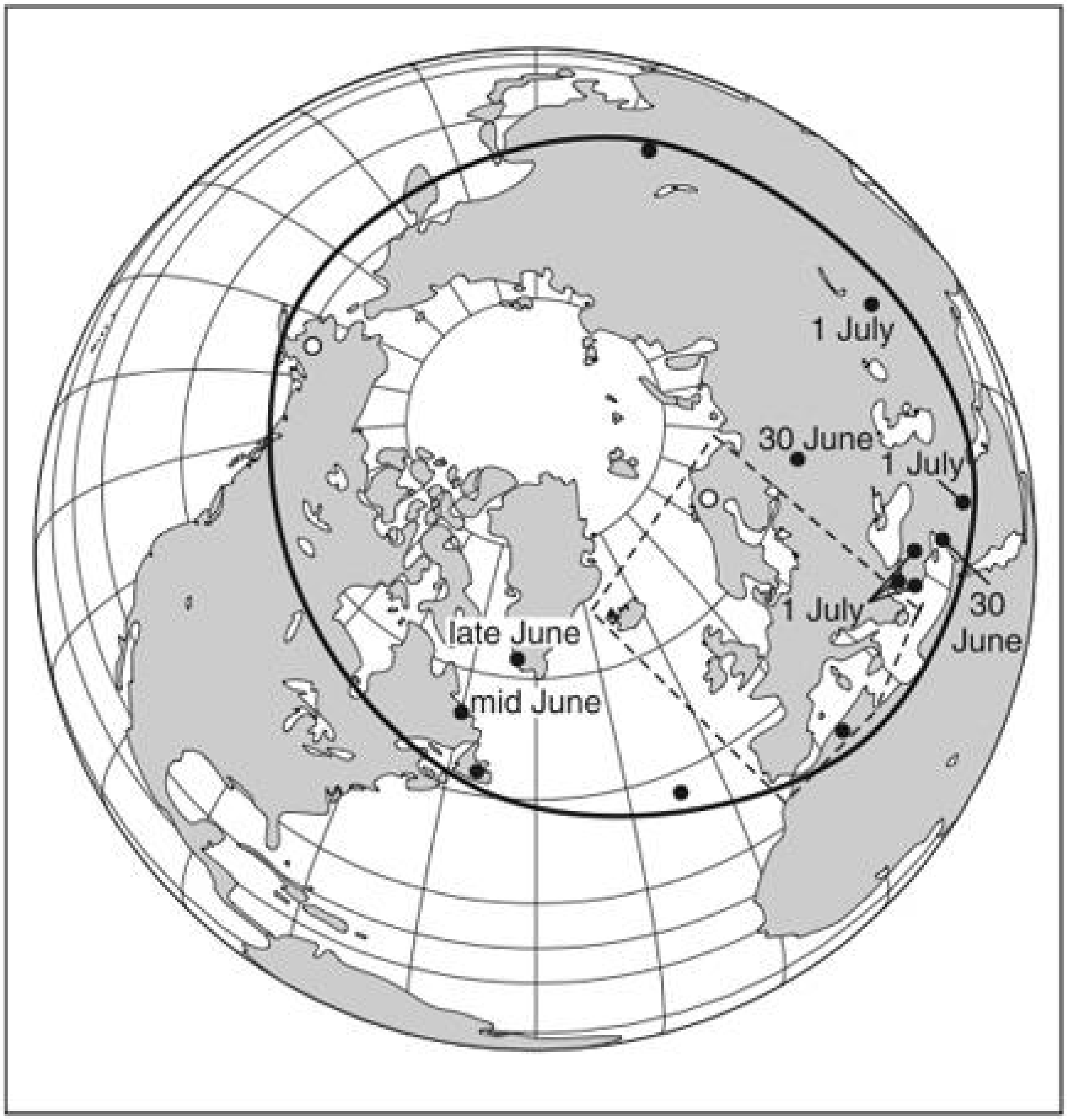
[35] de LAMANON, 'Observations on the Nature of the Fog of 1783'; GRATTAN, John, BRAYSHAY, Mark, and SADLER, Jon, 'Modelling the Distal Impacts of Past Volcanic Gas Emissions. Evidence of Europe-Wide Environmental Impacts from Gases Emitted during the Eruption of Italian and Icelandic Volcanoes in 1783'; DEMAREE, Gaston R. and OGILVIE, Astrid E. J., 'Bons Baisers d'Island: Climatic, Environmental, and Human Dimensions Impacts of the Lakagigar Eruption (1783-1784) in Iceland'; THORDARSON, Thorvaldur and SELF, Stephen, 'Atmospheric and Environmental Effects of the 1783-1784 Laki Eruption: A Review and Reassessment'; VAN SWINDEN, S.P., 'Observations on the Cloud (Dry Fog) Which Appeared in June 1783', ed. THORDARSON, Thorvaldur, trans. LINTLEMAN, Susan, *Jokull* 50 (January 2001): 73–80, https://www.researchgate.net/publication/280527027_Lintleman_and_Thordarson_2001._van_Swinden_contemporary_description.

Map 1:3 Known dispersal of fine ash estimated from locations of reports (dots) of ash or dust fall from the Laki eruption



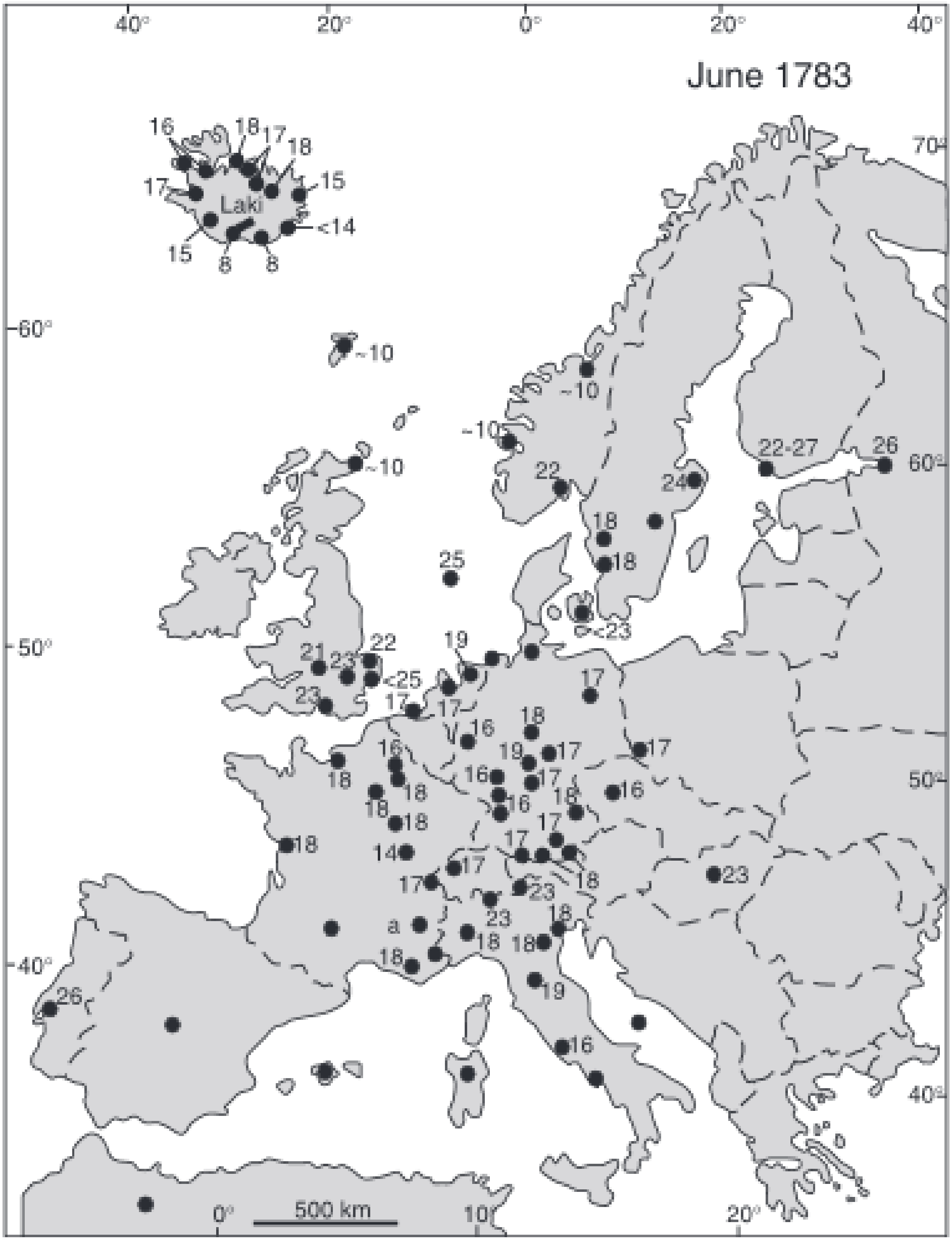
From Thordarson and Self (1992) Fig. 15

Map 1:4 Locations and timing of the first appearance of the Laki haze in June 1783 in the Northern Hemisphere



Thordarson & Self (2003)

Map 1:5 Locations and timing of the first appearance of the Laki haze in June 1783 in Europe



Thordarson & Self (2003)

In the following extract from *The Natural History of Selborne*[36], Gilbert White gives a vivid impression of his experience of the fog.

> THE ſummer of the year 1783 was an amazing and portentous one, and full of horrible phænomena; for, beſides the alarming meteors and tremendous thunder-ſtorms that affrighted and diſtreſſed the different counties of this kingdom, the peculiar *haze*, or ſmokey fog, that prevailed for many weeks in this iſland, and in every part of *Europe*, and even beyond it's limits, was a moſt extraordinary appearance, unlike any thing known within the memory of man. By my journal I find that I had noticed this ſtrange occurrence from *June* 23 to *July* 20 incluſive, during which period the wind varied to every quarter without making any alteration in the air. The ſun, at noon, looked as blank as a clouded moon, and ſhed a ruſt-coloured ferruginous light on the ground, and floors of rooms; but was particularly lurid and blood-coloured at riſing and ſetting. All the time the heat was ſo intenſe that butchers' meat could hardly be eaten on the day after it was killed; and the flies ſwarmed ſo in the lanes and hedges that they rendered the horſes half frantic, and riding irkſome. The country people began to look with a ſuperſtitious awe at the red, louring aſpect of the ſun; and indeed there was reaſon for the moſt enlightened perſon to be apprehenſive; for, all the while, *Calabria* and part of the iſle of *Sicily*, were torn and convulſed with earthquakes; and about that juncture a *volcano* ſprung out of the ſea on the coaſt of *Norway*.

Gilbert White, writing in his journal on 7th of July, said that, "*The heat overcomes the grass-mowers & makes them sick*".[37]

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[36] WHITE, Gilbert, *The Natural History and Antiquities of Selborne in the County of Southampton: With Engravings and an Appendix* (London: T. Bensley, 1789), 301–2, https://ia800504.us.archive.org/12/items/naturalhistorya04whitgoog/naturalhistorya04whitgoog.pdf.

[37] WHITE, Gilbert, *The Journals of Gilbert White1774-1783*, ed. GREENOAK, Francesca, vol. 2 (London: Century Hutchinson, 1988), 468.

According to de Lamanon:

> At Sallon the fog sometimes diffused a very disagreeable smell…which some believed to be sulphurous…It was hurtful to the eyes… persons whose lungs were weak, found disagreeable effects from it. The inhabitants of the Champsaur informed me that several people in the neighbourhood had violent pains in the head…[38]

van Swinden wrote that: "*In the afternoon of the 24th (June) many experienced very troublesome headaches and respiratory difficulties, similar to that which they experienced while the atmosphere around us was filled with the vapour of burned sulphur. Asthmatics experienced a return of asthma*."[39] Antonín Kodytek, a teacher in Kunvald, eastern Bohemia, made much of the heat when writing in his journal:

> ... in summer there was such a heat that if there were not for the unusual fog which shaded the sun, perhaps everything would have been burnt by the sun's heat. Because the rising morning sun could not be seen due to the fires and then from six to nine o'clock the sun looked like a red hot iron ball, then from nine to three or four o'clock it shone more intensely, but looked sad, which made the people wonder.[40]

By the 30th of June it had reached Moscow, and the following day, the Altai Mountains of central Asia, some 7,000 km. from Iceland.[41]

There are many reports from Europe and further afield describing the fog and the violent storms resulting from it. Benjamin Franklin, the American ambassador to France, writing from Paris in 1784, said:

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[38] de LAMANON, 'Observations on the Nature of the Fog of 1783'.
[39] VAN SWINDEN, S.P., 'Observations on the Cloud (Dry Fog) Which Appeared in June 1783'.
[40] PISEK, Jan and BRAZDIL, Rudolf, 'Responses of Large Volcanic Eruptions in the Instrumental and Documentary Climatic Data over Central Europe', *International Journal of Climatology* 26, no. 4 (25 January 2006): 439–59, https://doi.org/10.1002/joc.1249.
[41] THORDARSON, Thorvaldur and SELF, Stephen, 'Atmospheric and Environmental Effects of the 1783-1784 Laki Eruption: A Review and Reassessment'.

> …during several of the summer months of the year 1783, when the effect of the sun's rays to heat the earth in these northern regions should have been greater, there existed a constant fog over all Europe, and great part of North America. This fog was of a permanent nature; it was dry, and the rays of the sun seemed to have little effect towards dissipating it, as they easily do a moist fog, arising from water. They were indeed rendered so faint in passing through it, that when collected in the focus of a burning glass they would scarce kindle brown paper.[42]

He then goes on to ponder the cause of the fog, being one of the first to suggest that it was volcanic in origin:

> Whether it was adventitious to this earth, and merely a smoke, proceeding from the consumption by fire of some of those great burning balls or globes which we happen to meet with in our rapid course round the fun, and which are sometimes seen to kindle and be destroyed in passing our atmosphere, and whose smoke might be attracted and retained by our earth; or whether it was the vast quantity of smoke, long continuing; to issue during the summer from Hecla in Iceland, and that other volcano which arose out of the sea near that island, which smoke might be spread by various winds, over the northern part of the world, is yet uncertain.[43]

However, Josepho Toaldo, writing of the fog which arrived in northern Italy on the 18th of June and lasted for a large part of August, thought that it was caused by the earthquakes in Calabria:

> Abbiamo considerate questa nebbia, ch'era secca ed alta, come un polverio eccitato dale concussion della terra, o come un fumo delle interne

[42] FRANKLIN, Benjamin, 'Meteorological Imaginations and Conjectures', 375–77.
[43] FRANKLIN, Benjamin, 375–77.

> fermentazioni, dai venti portato sopra luoghi distanti, come sopradi noi dalla Calabria.[44]

A report dated 29th of September 1783, which appeared in the Gentleman's Magazine, shows that the thick fog had not only reached, but was still prevalent along the Mediterranean coast of Africa:

> By the late mails from Africa it appears that the fogs in summer were thicker and more suffocating all along their coasts than with us in England, and that in the Archipelago, and along the Mediterranean sea, they were so thick as to render the communication dangerous.[45]

Gilbert White was not the only commentator to note the blood-red appearance of the sun, the following table, adapted from Thordarson 1995, showing just a few of its appearances throughout Europe.

The reason of course, for the sun's blood-red colour was that it was being viewed through the extremely dense fog of volcanic pollution.

As if the fog were not enough, it was frequently interrupted by violent storms, accompanied by intense thunder and lightning, which in many cases caused loss of life to both people and livestock, as well as considerable damage to crops and property.

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44 TOALDO, J, 'Dei principali accidenti dell'anno 1783', *Giornale Astrometeorologico per l'anno 1784*, 1784, 59–79 in GRATTAN et al 1998; TOALDO, M., 'Meteorological Observations Made at Padua in the Month of June 1783, with a Dissertation on the Extraordinary Fog Which Prevailed about That Time.', *The Philosophical Magazine: Comprehending the Various Branches of Science, the Liberal Arts, Agriculture, Manufactures and Commerce by Alexander Tilloch* VI (1799): 417–22, http://babel.hathitrust.org/cgi/pt?id=hvd.hxh3j2;view=1up;seq=7;size=175.

45 URBAN, Sylvanus (John Nichols), ed., *The Gentleman's Magazine; and Historical Chronicle*, vol. 54 (London: D. Henry, 1784), 803, https://babel.hathitrust.org/cgi/pt?id=hvd.hxig2i;view=1up;seq=639;size=150.

Table 1:3 Some contemporary descriptions of the optical effects of the Laki haze regarding the blood-red sun

Zealand and Copenhagen, Denmark	Even in Zealand and at Copenhagen the sun, from the beginning of June till the 8th of August seemed remarkably red; and throughout the whole month of July the atmosphere, was so filled with dust and vapour, that the sun could not be seen in the evening after eight or nine o'clock. Even at noon the sun was red, and this was observed in the night-time to be the case with the moon and stars. (Holm, 1799).[46]
South Halland Province, Sweden	The so called "sun-smoke" has now for many weeks been permanently resting over the horizon, so thick that in mornings and evenings the sun appears completely red. (Gotebôrgs Allehanda, 22nd July, 1783 and Stockholms Posten, No 171 p.3; 29th July, 1783, in Thordarson, 1995)[47].
Franeker, Holland	Across the cloud (haze) the sun was perceived deep red with a brilliance at the edge, even at midday itself we were able to gaze at the sun with our naked eyes without injury. (van Swinden, 1783, in Thordarson, 1995).[48]
Berlin, Germany	In June: From the 17th to 29th the shine of the sun was practically dull because of the atmospheric haze, but on the other hand, the sun often appeared red in colour at sunrise or sundown, as if it had been soaked in blood. The atmosphere, evidently, was stuffed with very thick exhalations that prevented transmission of the rays (sunshine), and particularly on the 22nd, 23rd, 24th, 26th, and 28th, whereby it could not be observed at all. July to October: Rising and setting sun was blood-red and the atmospheric haze was said to be located up towards the sky. (Beguelin, 1783, in Thordarson, 1995)[49]
Zagan, Poland	In July: Some days the sun was hardly visible; mornings and evenings its colour was exceptionally red, less so at midday when it was more yellowish green. This coloration was unquestionably not caused by clouds because the sky at the horizon was occupied by the thick haze. (Presus, 1783 in Thordarson, 1995)[50]

[46] HOLM, S.M., 'Account of a Remarkable Fiery Eruption from the Earth in Iceland, in the Year 1783'.
[47] THORDARSON, Thorvaldur, 'Volatile Release and Atmospheric Effects of Basaltic Fissure Eruptions'.
[48] THORDARSON, Thorvaldur.
[49] THORDARSON, Thorvaldur.
[50] THORDARSON, Thorvaldur.

La Rochelle, France	On 18th June the rising sun was red, without any shine and was seen this way until 6 a.m. and after that the haze seemed to fade away, such that the sky appeared clear at 2 p.m. but the sun bright red. (Seignette, 1783 in Thordarson, 1995).[51]
Barcelona, Spain	At the end of June, a white and thick fogs tarted to be observed in this capital (Barcelona) which did not allow (anyone) to see the nearest mountains and through which the sun seemed to be of a bloody colour, particularly at sunset. (Salvà in Demarée and Ogilvie, 2001)[52]
Hermannstadt, Romania	14th July 1783. After a long rainy weather, an extraordinary heat followed which lasted approximately 8 days. During that period the sun set every evening in a bloody red colour behind dense foggy exhalations. (Pressburger Zeitung, Bratislava, 30 July 1783, in Demarée and Ogilvie, 2001)[53]
Písečné, Moravia, Czech lands	In 1783 from John's holiday [24 June] to the harvest every day and night there were such dense fogs everywhere that no one could see anything but a small piece of the world. Also the sun and the moon were changing. The sun rose every day blood red and the moon was like a black sack. (Jioí Vrbas, Paměti starých písmáků moravských,1916, in Pisek and Brazdil, 2006).[54]

1:3:4 Violent Storms and Great Balls of Fire

According to the Abbot van der Meulen, who was writing from Roesbrugge, West Flanders: "The year with the nicest weather was 1783; it was permanently or nearly (always) sunny from 8 o'clock in the morning till evening, during 103 days".[55] Northern Europe, because of its latitude, could usually expect cooler weather than the south, and 1783 saw a period of intense heat in some areas, making the summer western Europe one of the warmest for the past 300 years. But as we shall see, between the months of June and September, there were many reports of unusually

[51] THORDARSON, Thorvaldur.
[52] DEMAREE, Gaston R. and OGILVIE, Astrid E. J., 'Bons Baisers d'Island: Climatic, Environmental, and Human Dimensions Impacts of the Lakagigar Eruption (1783-1784) in Iceland'.
[53] DEMAREE, Gaston R. and OGILVIE, Astrid E. J.
[54] PISEK, Jan and BRAZDIL, Rudolf, 'Responses of Large Volcanic Eruptions in the Instrumental and Documentary Climatic Data over Central Europe'.
[55] BLONDEAU, R-A, 'Vander Meulen van Roesbrugge', *De IJzerbode* 1981/9 (1981): p.58. quoted in DEMAREE and OGILVIE, p. 228

violent storms of torrential rainfall accompanied by thunder, lightning, hurricane force winds, hail, and the occasional fireball. The cause of this was the high level of evaporation from the ground's surface brought about by the hot fogs, which charged the atmosphere with an abundance of water vapour. The air was also loaded with considerable quantities of fine volcanic dust, and this provided a source of highly efficient condensation nuclei. Some reports of these storms are given below.

The following is an extract of a letter from Avignon, dated 5th August 1783:

> Several letters from the neighbouring parts make mention of the storms which have multiplyed (sic) of late, and done great damage in the country places. The 22d of last month, at St. Esprit, there was a storm which destroyed the harvest for the space of a league. The hail-stones were of the size of a hen's egg; and their irregular form cut the vines and trees to pieces. A naturalist remarked, during the storm, a very extraordinary phenomenon – A girl who was spinning silk, feeling herself struck on the head with a hailstone, put her hand to the part, and found her cap on fire, which she immediately tore off, and flung away. As at that moment there was neither thunder nor lightning it was presumed that the fire had flashed from the collision of two hailstones which had hit each other on the girl's head. *(Chelmsford Chronicle*, *29 August 1783)*

> Much about the same time, there was also a terrible storm at the Bouschet (sic) in this country, where the hail fell with such violence, that part of that territory was totally ravaged. A peasant who was overtaken with the storm in the open country was knocked down by a hailstone of an enormous size, and died in three hours. (*Chelmsford Chronicle,* 29 August 1783) [56]

[56] ANON, 'Extract of a Letter from Avignon, Aug 5th', *Chelmsford Chronicle*, 29 August 1783, https://search.findmypast.co.uk/bna/ViewArticle?id=BL%2F0000225%2F17830829%2F001%2F0004&browse=true.

Two further reports from the Chelmsford Chronicle testify to the ferocity of the storms:

> A letter from Carmarthen, in South Wales, says, that on Sunday the 31st ult. they had a tremendous storm of thunder and lightning; many of the houses were unroofed, and the rain came down so heavy, that the damage done is very great in the parts adjacent; many head of cattle were found dead in the fields, and two labourers and their wives who lived in little huts were found dead.

> Friday last there was a most tremendous storm of thunder and lightning in the neighbourhood of Grantham; at Foston, a ball of fire entered the house of Mr. Neale, made its way through the tiles, struck down some of the family, and very much shattered the walls; it then took its way through the window, which was broken to pieces; and entered the adjoining house and burnt a woman in a most shocking manner. . (*Chelmsford Chronicle,* 19 September 1783)[57]

A report from Cracow, Poland, dated 27th of July stated that:

> On the sixth instant the storm of thunder and lightning was the most awful ever known in this country. Some people counted 200 claps of thunder with almost incessant flashes of lightning, by which 12 houses were set on fire, and several churches, with the Starost's palace, much damaged. Next day some people were found dead in the streets.[58]

Lightning was not the origin of all the balls of fire mentioned in newspapers. On the evening of the 18th of August 1783, an extraordinarily bright meteor was seen over

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[57] ANON, 'A Letter from Carmarthen', *Chelmsford Chronicle*, 19 September 1783, https://search.findmypast.co.uk/bna/ViewArticle?id=BL%2F0000225%2F17830919%2F001%2F0004&browse=true.
[58] URBAN, Sylvanus (John Nichols), *The Gentleman's Magazine; and Historical Chronicle*, 54:794.

Britain and northwest Europe. William Cooper, Archdeacon of York, reported to the Royal Society in London:

> As we proceeded, I observed to my attendants, that there was something singularly striking in the appearance of the night, not merely from its stillness and darkness, but from the sulphureous vapers which seemed to surround us on every side. In the midst of this gloom, and on an instant, a brilliant tremulous light appeared to the N.W. by N. At the first it seemed stationary; but in a small space of time it burst from its position, and took its course to the S.E. by E. It passed directly over our heads with a buzzing noise, seemingly at the height of sixty yards. Its tail, as far as the eye could form any judgement, was about eight or ten yards in length. At last, this wonderful meteor divided into several glowing parts or balls of fire, the chief part still remaining in its full splendor. Soon after this I heard two great explosions, each equal to the report of a canon carrying a nine-pound ball. During its awful progress, the whole of the atmosphere, as far as I could discern, was perfectly illuminated with the most beautifully vivid light I ever remember to have seen.[59]

Piggott writing about his observations of the meteor on Hewit Common near York said:

> I perceived some luminous matter in motion, and collecting together from several directions, which immediately taking fire presented itself under the form of a ball, and so vivid a brightness, that the whole horizon was illuminated, so that the smallest object might have been seen on the ground.[60]

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[59] COOPER, William, 'Observations on a Remarkable Meteor Seen on the 18th of August, 1783, Communicated in a Letter to Sir Joseph Banks, Bart. P.R.S. By William Cooper, D.D. F.R.S. Archdeacon of York', *Philosophical Transactions of the Royal Society* 74 (1 January 1784): 116–17, http://rstl.royalsocietypublishing.org//content/74/116.full.pdf.

[60] PIGGOTT, Nathaniel, 'An Account of an Observation of the Meteor of August 18, 1783, Made on Hewit Common Near York. In a Letter from Nathaniel Pigott, Esq. F. R. S. to the Reverend Nevil Maskelyne, D. D. F. R. S. and Astronomer Royal', *Philosophical Transactions of the Royal Society* 74 (1 January 1784): 457–59, http://rstl.royalsocietypublishing.org/content/74/457.

Cavallo, who was at Windsor at the time described the meteor thus, see also Figures 1:3 and 1:4:

> … but as soon as the meteor emerged from behind a cloud, its light was prodigious. Every object appeared very distinct; the whole face of the country in that beautiful prospect before the terrace being instantly illuminated. At this moment the body of the meteor appeared of an oblong form…and soon after it parted into several small bodies, each having a tail, and all moving in the same direction…[61]

The meteor was first seen over the Shetland Isles travelling in a S.S.E. direction over Scotland, northern and eastern England and then over northern Europe, where it was seen in Dunkirk, Ostend, Calais, Brussels, Paris, Nuits in Bergundy and Leiden, with a possible sighting in Rome.[62] It was also recorded at Newtonards, near Belfast, Armagh, and Edgeworthstown, near Mullingar in Ireland, and various other places on a S.S.E. trajectory through England.[63]

Six days after the Great Meteor, there was an account from Dublin of an unseasonable Aurora Borealis linked with meteors, and two weeks later there are reports of Aurora sightings in southern England.[64]

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[61] CAVALLO, Tiberius, 'Description of a Meteor, Observed Aug. 18, 1783. By Mr. Tiberius Cavallo, F.R.S.', *Philosophical Transactions of the Royal Society* 74 (1 January 1784): 108–11, http://rstl.royalsocietypublishing.org/content/74/108.

[62] PQ., 'An Account of the Late Meteors Which Have Been Seen in England; Together with an Historical Relation of the Circumstances Which Have Been Recorded Concerning Meteors of the Same Kind during the Last and Present Centuries: Collected from the Philosophical Transactions of the Royal Society of London, the Memoirs of the Royal Academy of Sciences at Paris, and Other Periodical Publications, Both Foreign and Domestic. To Which Are Added the Opinions of Some of the Most Celebrated Philosophers Concerning the Nature and Properties of These Meteors.', *The London Magazine: Or Gentleman's Monthly Intelligencer* 52, no. Dec. (1783): 492–97, http://babel.hathitrust.org/cgi/pt?id=nyp.33433081682779;view=1up;seq=443; BLAGDEN, Charles, 'An Account of Some Late Fiery Meteors; With Observations. In a Letter from Charles Blagden, M. D. Physician to the Army, Sec. R. S. to Sir Joseph Banks, Bart. P. R. S.', *Philosophical Transactions of the Royal Society* 74 (1 January 1784): 201–32, http://rstl.royalsocietypublishing.org/; PAYNE, Richard J., 'Meteors and Perceptions of Environmental Change in the Annus Mirabilis AD1783-4'.

[63] BLAGDEN, Charles, 'An Account of Some Late Fiery Meteors; With Observations. In a Letter from Charles Blagden, M. D. Physician to the Army, Sec. R. S. to Sir Joseph Banks, Bart. P. R. S.'; EDGEWORTH, Richard Lovell, 'An Account of the Meteor of the 18th of August, 1783. In a Letter from Richard Lovell Edgeworth, Esq. F. R. S. to Sir Joseph Banks, Bart. P. R. S.', *Philosophical Transactions of the Royal Society* 74 (1 January 1784): 118, http://rstl.royalsocietypublishing.org//content/74/118.full.pdf; PAYNE, Richard J., 'Meteors and Perceptions of Environmental Change in the Annus Mirabilis AD1783-4'.

[64] PAYNE, Richard J., 'Meteors and Perceptions of Environmental Change in the Annus Mirabilis AD1783-4'.

Descriptions of a further eleven meteors which were seen between September and November 1783, were reported in the press and further details of these can be found in Payne, 2011.

Map 1:6 – Sighting locations of the Great Meteor of the 18th August 1783 based on contemporary scientific and newspaper accounts

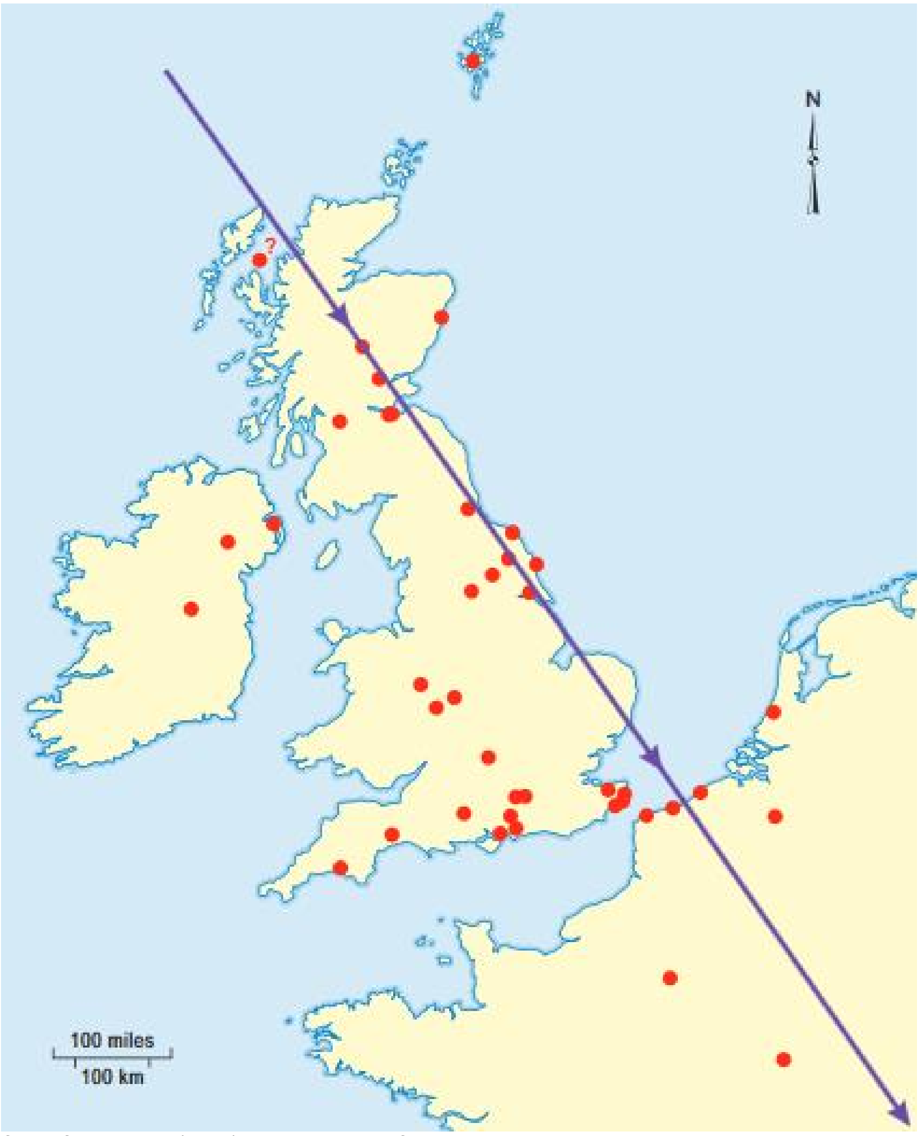
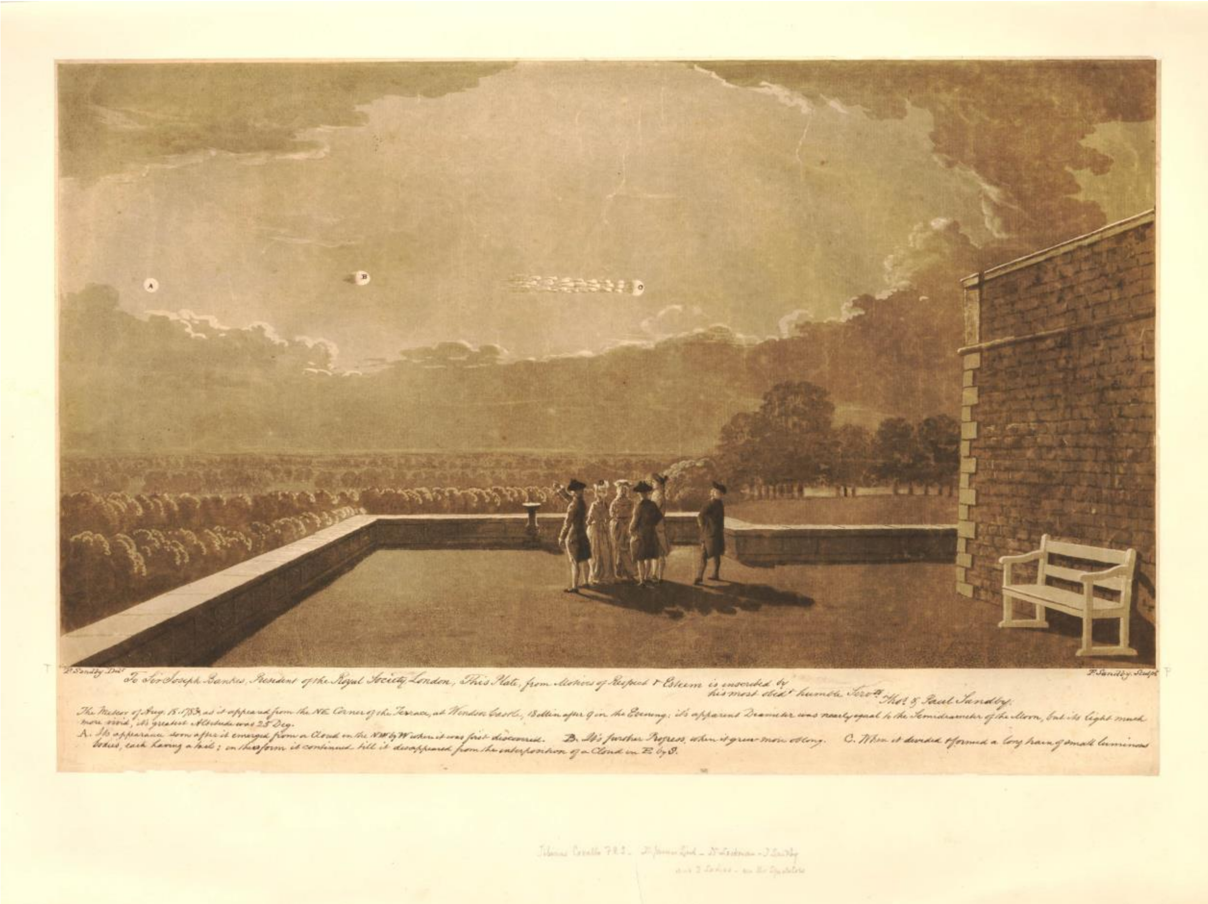


figure from Payne (2011) with permission from the author

Figure 1:3 The meteor of Aug 18th, 1783, as it appeared from the NE Terrace, at Windsor Castle. Print by Paul Sandby, October 1783



British Museum. Creative Commons

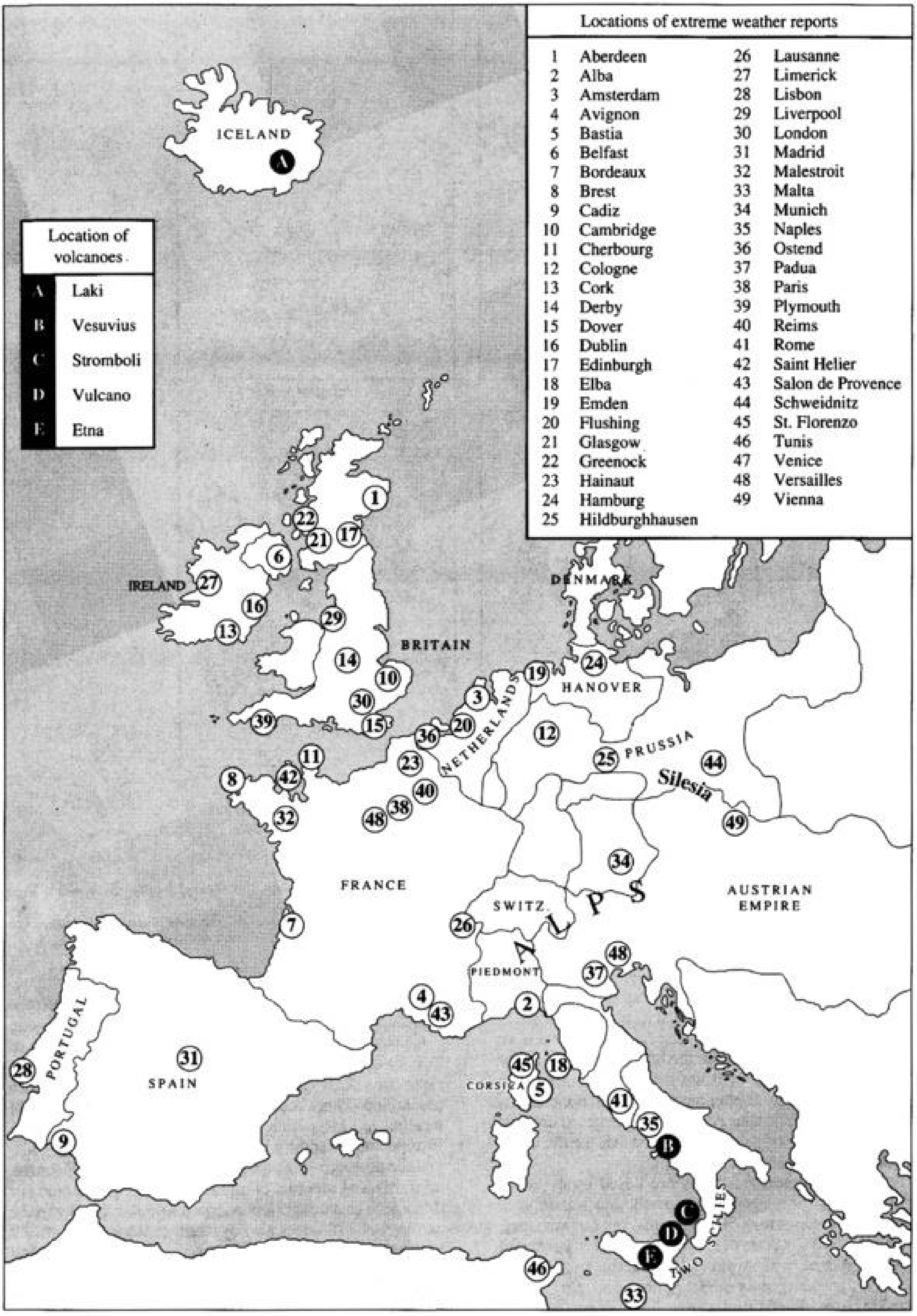
Two women and four men stand on a terrace at Windsor Castle, which overlooks the Great Park, all watching a meteor as it flies across the sky at night; the progression of the meteor is marked by three different locations, marked "A", "B", and "C*". "A It's appearance soon after it emerged from a Cloud, in the N.W. by W. where it was first discovered. / B It's further Progress, when it grew more oblong. / C When it divided & formed a long train of small luminous bodies, each having a tail: in this form it continued till it disappeared from the interposition of a Cloud in E by S."*

Figure 1:4 Meteor over Winthorpe near Newark upon Trent 18th August 1783. Mezzotint after Henry Robinson

British Museum. Creative Commons

"An accurate representation of the meteor which was seen on Augt. 18th. 1783. - At first it appeared as one ball of fire, but, in a few seconds, broke into many small ones. Its course was from N.W. to S.E. - This extraordinary phœnomenon was of that species of meteor which the great phisiologist Dr. Woodward and others call the Draco volans or Flying Dragon."

Map 1:7 Locations of some intense weather conditions in Europe, between June 1783 and March 1784

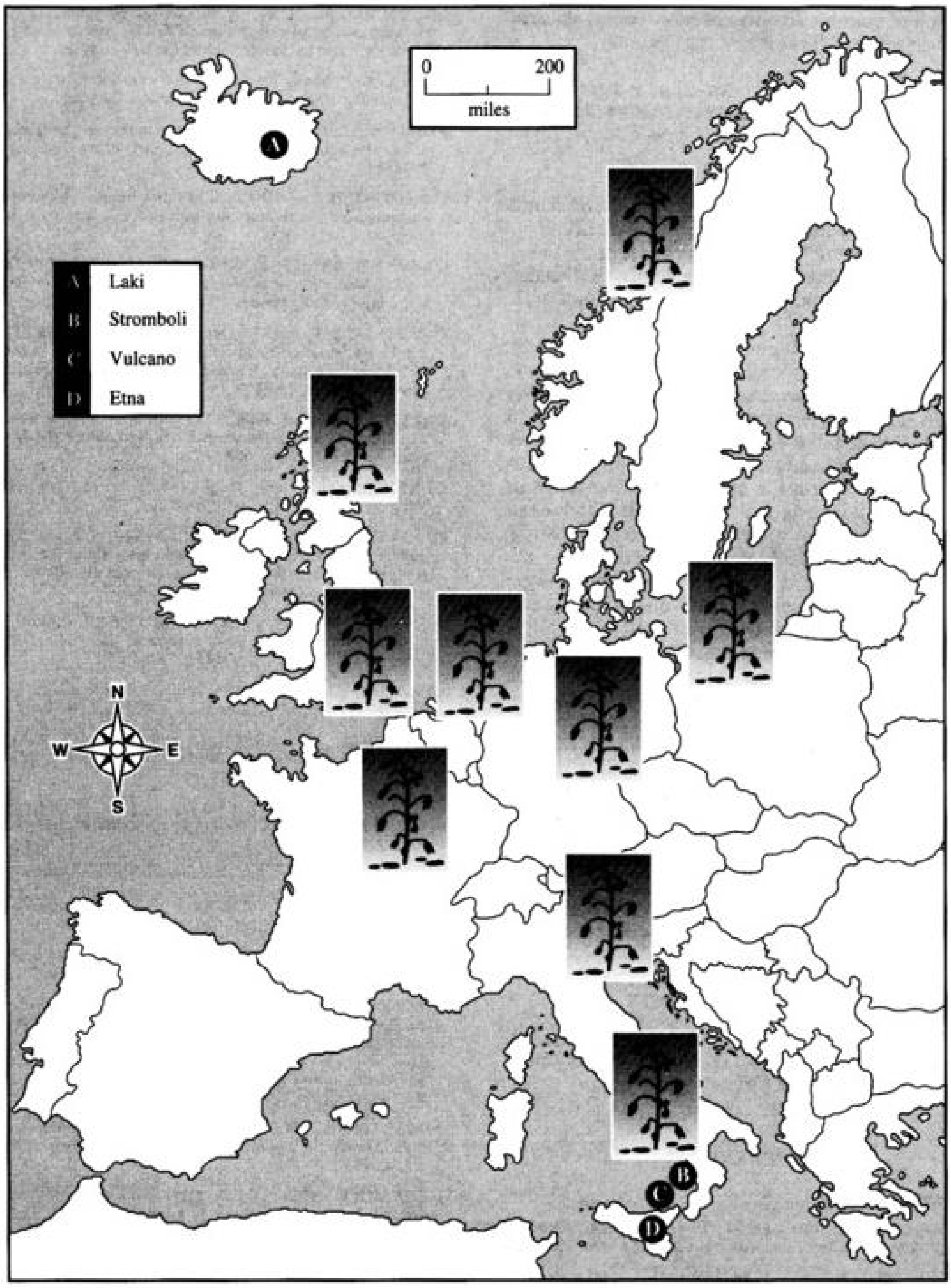


Grattan et al 1998

1:3:5 Dead Insects, Fish, and Falling Leaves

Apart from Iceland, there were many places in Europe, notably those bordering the North Sea and the Baltic regions, whose vegetation suffered from the effects of the dry fog or acid rain. Areas where severe and sudden defoliation was documented can be seen in the map below.

Map 1:8 Areas of severe defoliation



Grattan et al 1998

The following newspaper and journal extracts indicate that the fog caused severe damage to some of the vegetation in the British Isles and Europe. For example: Sir John Cullum writing from Hardwick House, Suffolk, on 10th of November 1783, said that on the morning of 23rd of June there was an unseasonable frost which:

> …produced some remarkable effects. The aristae of the barley, which was coming into ear, became brown and withered at their extremities, as did the leaves of the oats; the rye had the appearance of being mildewed; so that the farmers were alarmed for those crops. The wheat was not so much affected…. Some weather, that was cold for the time of year, had preceded this frost. On the 21st the thermometer had, at no time of the day risen to 60° (15.5°C); on the 22nd, at ten at night it had sunk to 50° (10°C).[65]

He goes on to relate that the tips of the leaves of the larch, Weymouth pine and hardy Scotch fir were withered and made a poor showing for the rest of the summer. His sheltered ash trees were severely damaged, the crop of a walnut tree was ruined, whilst a standard peach tree, cherry, filbert and hazel-nut trees shed their leaves as though it were autumn. Other plants including a barberry-bush, blackthorn and sweet violet had shrivelled and discoloured leaves and looked as though a fire had been lighted near them. However, an exotic mulberry-tree, fig-tree and vine were affected very little. Similar reports appear in other papers from Eastern England. The Cambridge Chronicle speaks of intense cold on the night of 23rd of June and on the following day all the grazing had dried up and was like hay to walk upon, whilst beans had turned a whitish colour and their leaves appeared as if dead. *(Cambridge Chronicle and Journal, Saturday >July 5th, 1783).* In a letter dated 25th of June and published in the Ipswich Journal it speaks of different varieties of grain, viz. wheat, barley and oats appearing very withered, but the grain inside, being protected by their husks, was not. (*Ipswich Journal,* Saturday July 12th, 1783)

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[65] CULLUM, Rev. Sir John, 'An Account of a Remarkable Frost on the 23rd of June 1783. In a Letter from the Rev. Sir John Cullum, Bart. F.R. S and S. A, to Sir Joseph Banks Bart, P.R.S', *Philosophical Transactions of the Royal Society* 74 (1 January 1784): 416–18, https://doi.org/doi: 10.1098/rstl.1784.0030.

It seems unlikely that a frost would cause some trees to shed a large quantity of leaves, leave an exotic mulberry tree undamaged whilst attacking hardy coniferous trees, albeit only damaging the tips of their leaves. These symptoms, when taken together with pasture drying up overnight and Cullum's scorched bushes, point not to frost damage, but to an acid or halogen attack, leaves being particularly susceptible as they easily absorb sulphur dioxide, fluorine, and hydrochloric acid.[66]

van Swinden reporting from the Netherlands said:

> In the morning of the 25th day (June) the fields showed a very sad appearance. The green colour of the trees and plants had disappeared and the earth was covered with drooping leaves. One would easily have believed that it was October or November… not all plants were equally affected; certain uninjured ones remained standing.[67]

van Swinden's compatriot, Sebald Justinus Brugmans, published a book in 1783 where he lists over 200 species of plants which were affected to a greater or lesser extent by the haze. See Appendix No.1 [68]

> An extract of a letter from Emden, dated 12th July states that: "The thick dry fog that has so long prevailed, seems to have spread over the whole surface of Europe… in some places it withers the leaves, and almost all the trees on the borders of the Ems have been stripped of theirs in one night." *(Gazette de France, No. 60, pp. 269-270, 29th July*,1783*; Ipswich Journal, 9 August,1783)*

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[66] GRATTAN, J. P. and PYATT, F. B., 'Acid Damage to Vegetation Following the Laki Fissure Eruption in 1783 - an Historical Review', *The Science of the Total Environment* 151 (1994): 241–47.
[67] VAN SWINDEN, S.P., 'Observations on the Cloud (Dry Fog) Which Appeared in June 1783'.
[68] BRUGMANS, Sebald Justinus, *Natuurkundige Verhandeling over Een Zwavelagtigen Nevel Den 24 Juni 1783 in de Provintie van Stad En Lande En Naburige Landen Waargenomen* (Groningen: Petrus Doekema, 1783), 7, 15–25.

Nevertheless, there was some good news. There were accounts from eastern and southern Europe where beneficial effects were attributed to the dry fog. For instance, there was a vigorous growth of vegetation in parts of Italy and record grape harvests were reported from Germany, Austria and Hungary, fruit of all kinds from the Banat, whilst in Poland, the corn was harvested at the beginning of July, an unprecedented event there.[69]

However, it was not only vegetation that felt the fog's harmful effects, but myriads of insects that appear to have been killed by the absorption of acid particles through the leaves. According to van Swinden:

> …this haze made a great slaughter of insects, especially of fleas, which settle on leaves of trees. When the leaves themselves were damaged, the insects of the trees, which were not injured by the haze, were killed exclusively as they remained intact to the leaves.[70]

The following account appeared in *The Caledonian Mercury, Saturday July 5th, 1783*.

> Wednesday night we had here a great storm of thunder and lightning, accompanied by a very heavy fall of rain… We hear, that next morning, after the storm of thunder and lightning here, there were found in the dam above the saw-mills on the water of Leith, a number of dead fish of different

[69] DEMAREE, G. R. and OGILVIE, A. E. J., 'Bon Baisers d'Islande: Climatic, Environmental and Human Dimensions, Impacts of the Lakagigar Eruption (1783-1784) in Iceland.', in *History and Climate: Memories of the Future?* (New York: Kluwer, 2001), 312, https://books.google.fr/books?id=-cgnFsLkIAYC&pg=PA219&dq=demaree,+ogilvie+bon+baisers+d%27islande&hl=en&sa=X&ei=IBh2VdT3MMvkUczsgIAF&ved=0CCkQ6AEwAA#v=onepage&q=demaree%2C%20ogilvie%20bon%20baisers%20d%27islande&f=false; LAPI, Giovanni, *Sulla caligine del corrente anno 1783. E sulla vigorosa vegetazione e fertilita delle piante del suddetto anno congetture di Giovanni Lapi Mugellano* (Firenze: Antonio Benucci, 1783), https://books.google.fr/books?id=iGb3e0SR59UC&pg=PR3&lpg=PR3&dq=G+Lapi+sulla+caligine+del+corrente+anno+1783.e+sulla+vigorosa+vegetazione+e+fertilita+delle+piante+del+suddetto+anno&source=bl&ots=gPdaS23sSh&sig=ljIaIsP2v7Z3GFubxXrjIRYHLEI&hl=en&sa=X&ved=0ahUKEwjV28KirojRAhVC1RoKHToZAg0Q6AEIIDAA#v=onepage&q=G%20Lapi%20sulla%20caligine%20del%20corrente%20anno%201783.e%20sulla%20vigorosa%20vegetazione%20e%20fertilita%20delle%20piante%20del%20suddetto%20anno&f=false.
[70] VAN SWINDEN, S.P., 'Observations on the Cloud (Dry Fog) Which Appeared in June 1783'.

> kinds floating on the surface of the water supposed to be killed by the lightning.[71]

There may be two reasons for the death of these fish. Firstly, the body of water they were in was struck by lightning and they were sufficiently near the strike for the electricity not to have spread out and been dissipated. Secondly, acids which may have been dry deposited and accumulated on the land for some time, may have been washed into the water by the storm, thus lowering its pH level and making it toxic.[72]

In Italy, however, they were having problems of a different sort. Gennari, writing from Padua, reported on a fatal illness which was thought to be contagious had attacked some cattle that had arrived from Dalmatia. He goes on to state that the disease also infected beasts from some of the country villages. Although the peasants believed their animals had contracted the sickness from the Dalmatian cattle, he speculates that the reason lay behind their having been fed on bad fodder and tree leaves during the winter owing to the lack of hay caused by a drought the previous summer. He argues:

> Then when the damp and always foggy spring came, the hungry cattle were sent to pasture on fresh grass on which they gorged themselves, being greedy and (the grass) ever so tender, their insides were affected by a malevolent disorder that then developed into the current illness. It was observed that the cattle which had been fed on good hay, have not, up till now, been affected by the bad influence.[73]

It is quite possible that this was a cattle disease such as coccidiosis, which is spread through damp grazing areas, or black leg which can prove fatal within twelve to forty

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[71] ANON, 'Storm in Leith', *Caledonian Mercury*, 5 July 1783, https://search.findmypast.co.uk/bna/ViewArticle?id=BL%2F0000045%2F17830705%2F008%2F0003&browse=true.
[72] GRATTAN, J. P. and PYATT, F. B., 'Acid Damage to Vegetation Following the Laki Fissure Eruption in 1783 - an Historical Review'.
[73] GENNARI, Giuseppe, *Notizie giornaliere di quanto avvenne specialmente in Padova dall'anno 1739 all'anno 1800.*, ed. OLIVATO, Loredana, Scrittori padovani, 7 (Padov: Rebellato, 1982) in CAMUFFO and ENZI, p. 153.

eight hours after infection, but it seems more likely that the cattle died through ingesting grass contaminated by acid volatiles, especially as those on good hay were not affected.[74]

1:3:6 Social Responses

The dry fog with its attendant storms and other strange and unusual phenomena caused a great deal of disquiet among the more unenlightened of the general population; so much so in fact, that the French astronomer, de la Lande, published a paper in the popular press in which he tried to stifle the rumour and speculation that had been spread by the ignorant. He accepted that "The multitude therefore may be easily supposed to strange conclusions, when they see the sun of a blood colour, shed a melancholy light, and cause a most sultry heat". He then goes on to say that there is no need for consternation as this:

> … is nothing more than a very natural effect from a hot sun after a long succession of heavy rain. The first impression of heat has necessarily and suddenly rarefied a superabundance of watery particles with which the earth was deeply impregnated, and given them, as they rose, a dimness and rarefaction not usual to common fogs.
>
> This effect, which seems to be very natural, is not so very new; it is at most not above nineteen years since there was a like example, which period too brings the moon in the same position on the same days, and appears to have some influence on the seasons. Among the meteorologic observations of the academy for the month of July 1764 I find the following: "The beginning of this month was wet, and the latter part dry … The mornings were foggy, and the atmosphere in a smoke during the day." This you perceive bears a great resemblance to the latter end of our June, so

[74] CAMUFFO, Dario and ENZI, Silvia, 'Impact of the Clouds of Volcanic Aerosols in Italy during the Last 7 Centuries', *Natural Hazards* 11 (1995): 135–61, https://www.academia.edu/4809507/Impact_of_the_clouds_of_volcanic_aerosols_in_Italy_during_the_last_7_centuries; VENKITESH, Deepa, 'Fatal Diseases in Cattle: Causes, Symptoms and Treatment', Knoji Consumer Knowledge, accessed 17 January 2017, https://farm-animals.knoji.com/fatal-diseases-in-cattle-causes-symptoms-and-treatment/.

that it is not an unheard of or forgotten thing. In 1764, they had afterwards storms and hail, and nothing worse need be feared in 1783.[75]

Gennari, writing from Padua, gives the impression that other scientists as well as de la Lande, were also trying to calm the fears of the less enlightened:

> The fog was high, dry and dense and this phenomenon was observed not only by us, but also everywhere in Italy, Germany and France, giving the opportunity for some astronomers and meteorologists, by their writings, to dissipate the fears conceived by the lower classes.[76]

Perhaps the Italian populace should not have been so worried, as the haze due to volcanic aerosols became quite common, there being at least nine confirmed instances of dry fog during the 18th century viz. 1710, 1735, 1775, 1780, 1783, 1785, 1786, 1791, & 1794.[77] In addition, it is highly likely that the population of large cities would have been used to this type of air pollution from the intensive burning of fuel.[78]

Judging from the following article which appeared in the 26th of August issue of the "*Cumberland Pacquet and Whitehaven Advertiser"*, the Great Meteor of 18th of August 1783 was the cause of some consternation to the "*ignorant multitude*", and like de la

[75] DE LA LANDE, 'Extract of a Letter from Paris, July 4.', *Aberdeen Press*, 21 July 1783, 21 July, p. 3 edition, http://search.findmypast.co.uk/bna/viewarticle?id=bl%2f0000570%2f17830721%2f003; DE LA LANDE, 'On the Extraordinary State of the Atmosphere. Paris, July 4, 1783', *Northampton Mercury,* 21 July 1783, 21 July, p. 4 edition, http://search.findmypast.co.uk/bna/viewarticle?id=bl%2f0000317%2f17830721%2f011; DE LA LANDE, 'Intelligence from Paris, on the Extraordinary State of the Atmosphere', *Bath Chronicle and Weekly Gazette*, 17 July 1783, 17 July, p. 4 edition, http://search.findmypast.co.uk/bna/viewarticle?id=bl%2f0000221%2f17830717%2f017; DE LA LANDE, 'The Unusual Heat of the Weather', *Derby Mercury*, 10 July 1783, 10 July, p. 2 edition, http://search.findmypast.co.uk/bna/viewarticle?id=bl%2f0000189%2f17830710%2f007; de la LANDE, 'Extraordinary State of the Atmosphere', *The Scots Magazine* 45, no. August 1783, p. 420 (August 1783): 715, http://search.findmypast.co.uk/bna/ViewArticle?id=BL%2F0000545%2F17830801%2F002%2F0001&browse=true See Appendix No 3 for original article. BRAYSHAY, Mark and GRATTAN, John, 'Environmental and Social Responses in Europe to the 1783 Eruption of the Laki Fissure Volcano in Iceland: A Consideration of Contemporary Evidence', *Geological Society, London, Special Publications* 161 (1999): 173–87.
[76] GENNARI, Giuseppe, *Notizie giornaliere di quanto avvenne specialmente in Padova dall'anno 1739 all'anno 1800.*; CAMUFFO, Dario and ENZI, Silvia, 'Impact of the Clouds of Volcanic Aerosols in Italy during the Last 7 Centuries'.
[77] CAMUFFO, Dario and ENZI, Silvia, 'Impact of the Clouds of Volcanic Aerosols in Italy during the Last 7 Centuries'; CAMUFFO, C and ENZI, S, 'Chronology of "Dry Fogs" in Italy, 1374-1891', *Theoretical and Applied Climatology* 50 (1994): 31–33, https://doi.org/10.1007/BF00864900.
[78] EVELYN, John, *Fumifugium or the Inconvenience of the Aer and Smoak of London Dissipated. Together with Some Remedies Humbly Proposed by J.E. Esq; to His Sacred Majestie and Parliament Now Assembled* (London: Printed by W. Godbid for Gabriel Bedel, and Thomas Collins, 1661); STOTHERS, Richard B, 'The Great Dry Fog of 1783'.

Lande and his explanation of the dry fog, attempted to calm their fears by explaining later on in the article what he thought a meteor was:

> The Meteor which appeared over this Town on Monday last, has been the Subject of the Meditations of the ignorant Multitude ever since; and they draw frightful Conjectures from it.
>
> Thank God, the Vulgar are pretty well cured of their Fears concerning Eclipses; these often taking Place, and, though at irregular periods, are always foretold; but Meteors are not to be foretold… whereas, such a one as that which appeared last Monday, naturally excites a surprise mixed with Terror, even in those who are not unacquainted with the Causes of such Effects; but that Fear vanishes as the Meteor itself does. It is not so with ignorant and superstitious People: in those uncommon sights, they plainly perceive*, War, Famine, Rebellion, Earthquakes*, nay the *End of the World!*[79]

The effects that the dry fog may have had on the health of the population and the perceived rise in mortality rates will be discussed in Chapter 4.

1:3:7 Bitter Winters, Spring Floods

There is no doubt that the winter of 1783-1784 coming after the Laki eruption, was one of intense cold, hard frosts, blizzards, heavy rain and strong winds. It was, in fact, one of the most severe winters during the past 500 years.[80] However, we must not forget that the 18th century was still in "The Little Ice Age", and in hindsight, winters such as this should not appear at all surprising.[81] In fact, the 1783-1784 winter with its heavy

[79] L'AMI DES HOMMES, 'On Meteors in General; Their Causes and Effects', *Cumberland Pacquet, and Ware's Whitehaven Advertiser*, 26 August 1783, 3, https://search.findmypast.co.uk/bna/ViewArticle?id=BL%2F0000950%2F17830826%2F010%2F0003&browse=true.
[80] BRAZDIL, Rudolf et al., 'European Floods during the Winter 1783/1784: Scenarios of an Extreme Event during the Little Ice Age', *Theoretical and Applied Climatology* 100, no. 1 (29 July 2009): 163–89, https://doi.org/10.1007/s00704-009-0170-5; D'ARRIGO, Rosanne et al., 'The Anomalous Winter of 1783-1784: Was the Laki Eruption or an Analog of the 2009-2010 Winter to Blame?', *Geophysical Research Letters* 38 (13 March 2011): 1–4, https://doi.org/10.1029/2011GL046696.
[81] MANN, Michael E., 'Little Ice Age', in *Encyclopedia of Global Environmental Change*, ed. MACCRACKEN, Michael C. and PERRY, John S., vol. 1, 5 vols (Chichester: John Wiley & Sons, 2002), 774, http://www.meteo.psu.edu/holocene/public_html/shared/articles/littleiceage.pdf; MATTHEWS, John A. and BRIFFA, Keith R., 'The "Little Ice Age": Re-Evaluation of an Evolving Concept', *Geografiska Annaler Series A-Physical Geography* 87, no. A(1) (2005): 17–36, https://www.lakeheadu.ca/sites/default/files/uploads/53/outlines/2014-15/NECU5311/MatthewsBriffa_2005_GA_LIAconcept.pdf.

frosts, deep snows and frozen soils and rivers was a typical "Little Ice Age" winter, even if more severe.[82] The onset of sudden rises in temperature was followed by three phases of severe flooding throughout Europe, the latter being the harbinger of a late spring.[83] The dates of these phases are as follows: December 1783 – early January 1784, in England, France, the Low Countries and the Kingdom of Hungary. The second and far more severe phase, began near the end of February and lasted into the second week of March, affecting a much greater area throughout parts of France, the Low Countries and Central Europe. The final phase lasted from late March until the first week in April, and mainly affected the Kingdom of Hungary.[84]The date the thaw started may of course be entirely subjective, depending on the observer, the phenomena observed, his geographical location, the direction of warm winds and rain etc.

The second phase of flooding was one of the most disastrous natural events to occur in Central Europe during the past millennium, and its magnitude may be gauged from the fact that few of the epigraphic markings relating to this event have been exceeded by those of other floods. For example, the flood level of the River Mosel at Cochem far exceeded all previous levels of flooding, whilst the flood marking at Eibelstadt is the highest recorded. However, the mark for the River Elbe in *Děčín is well below the flood level of 1845.*[85] See Figures 1:5 – 1:7

That the severity of the winter was remarkable in its intensity was widely covered in the press, as can be seen from the following extracts:

> *Flushing Feb. 3.* The two Schelds, the Maese, Rhine, Moselle, and indeed all the rivers in these parts, are frozen up. The island of Zealand is

[82] BRAZDIL, Rudolf et al., 'European Floods during the Winter 1783/1784: Scenarios of an Extreme Event during the Little Ice Age'.
[83] WOOD, Charles A., 'Climatic Effects of the 1783 Laki Eruption'; THORDARSON, Thorvaldur, 'Volatile Release and Atmospheric Effects of Basaltic Fissure Eruptions'; STOTHERS, Richard B, 'The Great Dry Fog of 1783'; GRATTAN, John, BRAYSHAY, Mark, and SADLER, Jon, 'Modelling the Distal Impacts of Past Volcanic Gas Emissions. Evidence of Europe-Wide Environmental Impacts from Gases Emitted during the Eruption of Italian and Icelandic Volcanoes in 1783'; STOTHERS, Richard B, 'Volcanic Dry Fogs, Climate Cooling, and Plague Pandemics in Europe and the Middle East.', *Climatic Change* 42, no. 4 (August 1999): 713–23, https://doi.org/10.1023/A:1005480105370; THORDARSON, Thorvaldur and SELF, Stephen, 'Atmospheric and Environmental Effects of the 1783-1784 Laki Eruption: A Review and Reassessment'; BRAZDIL, Rudolf et al., 'European Floods during the Winter 1783/1784: Scenarios of an Extreme Event during the Little Ice Age'.
[84] BRAZDIL, Rudolf et al., 'European Floods during the Winter 1783/1784: Scenarios of an Extreme Event during the Little Ice Age'.
[85] BRAZDIL, Rudolf et al.

surrounded by hills of ice, a circumstance never known before in our memory…

Munich (Bavaria), Jan. 19. On the 6th, 7th, and 8th of the present month, Reamur's thermometer was at 16¾ below the point of congelation *(-21°C)*, three quarters of a degree lower than 1709.

At *Heidesburgh* in the Palatinate, the cold is said to be almost insupportable, and the dread of the inundations on the snow's melting so alarming, that the inhabitants near the rivers Rhone and Main have packed up their effects, to be in readiness to move on the first signal.

…at *Rotterdam* there is the largest fair on the ice ever known, and with playhouses, and other places of diversion.

Hungary, Jan. 20. After deep snow and severe cold, a sudden thaw took place, Dec. 27, 28, 29. Reamur's thermometer stood for those three days ten degrees below the freezing point *(-12.5°C)*. The Danube and the river of Maros have exceeded their bounds, and occasioned the greatest destruction in their course. The greatest damage was at Newzaz and Arrad; the latter city is entirely under water, and the inhabitants of the greater part of the houses were obliged to go to the tops of them for refuge. Dec. 30. the misfortune was heightened by a frost, which covered the streets and houses with ice; the frost increased till the 5th of this month, so that the thermometer stood on that day at 23 1-half below the freezing point *(-29.37°C).* On the 7th of this month it diminished 7 deg.[86]

[86] URBAN, Sylvanus (John Nichols), *The Gentleman's Magazine; and Historical Chronicle*, 54:139–40.

<u>Figure 1:5 Flood marks of the River Elbe, Castle Rock, *Děčín, Czech Republic*</u>

View of the castle rock in *Děčín showing high water marks for R. Elbe (photo J.* Kašpárek)

Figure 1:6 Flood marks of the River Main on the city fortification, Eibelstädt near Würzburg

J. Herget et al (Creative Commons)

Figure 1:7 Epigraphic marking showing water level of 28 February 1784 (above the window of the Cochem water gauge) due to severe flooding of the River Mosel

Photo SurfGuard https://www.flickr.com/photos/surfguard/14674535080/in/photolist-omJQ2w-oBcREQ-oCXZPg/ Creative Commons

Rome, Feb. 6. Such a vast quantity of snow has fallen during the last week, that the post could not get over the mountains, although 600 workmen were employed in clearing the road.[87]

Paris, Jan. 30. Since a month the cold has been very severe in this capital and in its surroundings. There is no single day without snowfall and the frost does not allow one to clear the streets. As there is one foot of snow in Paris, it suggests there are three feet in the countryside and on the roads; everywhere was blocked.[88]

The Northampton Mercury Jan. 12 printed the following reports:

The Frost was never known in the Memory of Man so severe as on Tuesday and Wednesday last. The Severn was frozen over for Miles together, and various are the Accounts of the People and Cattle that perished. Last Week, during the severe Weather, the Post-boy from Dumfries to Thornhill was found frozen to death upon his Horse.[89]

And on the 23rd of February the same paper published a letter concerning the weather conditions in North Wales which stated that:

The oldest Man living does not remember such a Fall of Snow in those Parts as they have had this Winter. In many Places it is 12 Feet (3.66 m.)

[87] URBAN, Sylvanus (John Nichols), 54:139–40, 221; WOOD, Charles A., 'Climatic Effects of the 1783 Laki Eruption'; GRATTAN, John, BRAYSHAY, Mark, and SADLER, Jon, 'Modelling the Distal Impacts of Past Volcanic Gas Emissions. Evidence of Europe-Wide Environmental Impacts from Gases Emitted during the Eruption of Italian and Icelandic Volcanoes in 1783'; THORDARSON, Thorvaldur and SELF, Stephen, 'Atmospheric and Environmental Effects of the 1783-1784 Laki Eruption: A Review and Reassessment'.
[88] DEMAREE, Gaston R., 'The Catastrophic Floods of February 1784 in and around. Belgium – a Little Ice Age Event of Frost, Snow, River Ice … and Floods.', *Hydrological Sciences–Journal–Des Sciences Hydrologiques,* 51, no. 5. Special issue: Historical Hydrology (October 2006): 878–98, www.meteo.be/meteo/download/en/520459/pdf/rmi_scpub-1141.pdf quoting from the Gazette de Leyde, Supplément, 6 février, 1784.
[89] ANON, 'The Frost Was Never Known in the Memory of Man...', *Northampton Mercury*, 12 January 1784, https://search.findmypast.co.uk/bna/ViewArticle?id=BL%2F0000317%2F17840112%2F003%2F0002&browse=true.

> deep, so that they have been obliged to house all their Cattle, and the Roads are rendered almost impassable.[90]

The Gentleman's Magazine reported that on the 30th of January "A man walked across the River Thames, on the ice, at low water, from Rotherhithe to Wapping new stairs."[91] In York, the River Ouse "was frozen so firmly, that during eight successive weeks, it was frequented by the most timid with the utmost confidence."[92]

The majority of canals in Flanders were frozen over shortly after the 20th of December and remained so until the end of February and beginning of March when the thaw set in. According to Blomme, at Dendermonde in east Flanders the frost lasted from the 8th of December until the 21st of February, and the River Scheldt was frozen over from 18th of December and opened again on the 25th of February. There were freezing temperatures for the whole of March thus making for a late spring.[93] However, once the thaw started it was very rapid. The huge quantities of ice and snow that had built up over the winter melted rapidly, filling the rivers with so much water that they were unable to cope with removing it, thus bursting their banks, and flooding the neighbouring towns and villages. The following report gives a graphic description of the flooding that took place around the town of Louvain, in the Scheldt catchment area:

> Due to abundant snow that had fallen in and around the Walloon Brabant, when the thaw set in on the 21st (February), the water and snow could not soak away, making our rivers swollen beyond description, and flooding nearly the whole town. It started around midnight of the 23rd to the 24th of this month, while everybody was fast asleep; shouting and yelling to one

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90 ANON, 'A Letter from North Wales Says...', *Northampton Mercury*, 23 February 1784, https://search.findmypast.co.uk/bna/ViewArticle?id=BL%2F0000317%2F17840223%2F011%2F0002&browse=true.
91 URBAN, Sylvanus (John Nichols), *The Gentleman's Magazine; and Historical Chronicle*, 54:143.
92 HARGROVE, William, *History and Description of the Ancient City of York : Comprising All the Most Interesting Information, Already Published in Drake's Eboracum; Enriched with Much Entirely New Matter, from Other Authentic Sources, and Illustrated with a Neat Plan of the City, and Many Elegant Engravings*, vol. 1 (York: W. M. Alexander, 1818), 261, https://drive.google.com/file/d/0B9TdD8sEmgyvX3JXcW5pVzFzeWc/view.
93 DEMAREE, Gaston R., 'Hydrolog. Sci. J.'; BLOMME, A, *Les Manuscrits Des Cinque Chroniques de Termonde. Oudheidkundige Kring Der Stad & Des Voormaligen Lands van Dendermonde*, Gedenkschriften Tweede-Reeks, D IV (Dendermonde, Netherlands, 1892), 246 in DEMAREE, 2010. Demarée has transcribed many contemporary accounts of the severe winter in the above paper.

another, everybody in danger of his life tried to save himself (by going) to the second floor and attic of his house. It was horrible; at 10 o'clock in the morning of the 24th, what a level the waters have reached…Outside and within the Canal Gate, as far as the eye could see: nothing other than water. Like the River Dijle, which seriously overflowed its banks on all sides, the River Voer did the same. In short, the whole Lower Town was flooded; there was no street that was not like a stream. *(Lovens-Nieuws, no 9, Sondag 29 Februarii 1784, pp. 130-131)*[94]

The long winter of 1783-1784 affected not only Europe, but also the eastern United States, where it has been described as one of the three worst winters during the 18th century, the others being 1740-1741 and 1779-1780. The winter began in mid-November and lasted until spring, during which time Chesapeake Bay was iced over, thus closing many channels and harbours; the Mississippi River was frozen over at New Orleans between 13th and 19th of February, and after the ice had melted, the river was inundated with broken ice, floes reaching as far as the Gulf of Mexico some 100 kilometres to the south.[95] The period from December 1783 to February 1784 saw the lowest winter average temperature of -3.8°C, ever recorded. This is 4.8°C lower than the 225-year average.[96]

In order to emphasize the harshness of the winter during 1783-1784 in the eastern United States, Ludlum, 1966, compiled the following records:

Longest in early American history (last snow in late April),

Near record depth of snow cover,

Near record low temperatures,

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[94] DEMAREE, Gaston R., 'Hydrolog. Sci. J.'
[95] THORDARSON, Thorvaldur and SELF, Stephen, 'Atmospheric and Environmental Effects of the 1783-1784 Laki Eruption: A Review and Reassessment'; WOOD, Charles A., 'Climatic Effects of the 1783 Laki Eruption'.
[96] SIGURDSSON, Haraldur, 'Volcanic Pollution and Climate: The 1783 Laki Eruption', *EOS* 63, no. 32 (10 August 1982): 601–3, https://doi.org/10.1029/EO063i032p00601; D'ARRIGO, Rosanne et al., 'The Anomalous Winter of 1783-1784: Was the Laki Eruption or an Analog of the 2009-2010 Winter to Blame?'

Greatest seasonal snowfall ever in New Jersey,

Longest period of below zero temperatures ever in New England,

Longest freezing ever of Chesapeake Bay,

Longest and coldest winter in Maine,

Freezing of Charleston Harbour (ice skating occurred),

Freezing of Mississippi River in New Orleans,

Ice floes in Gulf of Mexico 100 km south of New Orleans.[97]

The cold winter also caused ice bridges to form over the St. Lawrence River near Quebec City, Canada during the years 1784, 1785 and 1787.[98] For some, however, the long cold winter began in the early summer of 1783. Inuit legends chronicle the story of the Kauwerak people living in extreme northwest Alaska some 5000 kilometres from Quebec, which tell of a disastrous summer of extreme cold, famine, deserted villages and death; this led to it being called, “the summer that did not come”. The legends have been backed up by Alaskan tree ring data that seem to point to a Laki connection. Nevertheless, despite this evidence, the effect of the Laki eruption on the climate of North America remains controversial.[99]

The question that now arises is whether the Laki eruption was the driving force behind the severity of the 1783-1784 winter, or if there was some other reason. Benjamin Franklin writing in 1784 certainly thought that the eruption was to blame. See Chap. 1:3:3. This idea was generally accepted until a paper by D’Arrigo et al, 2011, convincingly suggested that the extreme harshness of the winter was caused by a combined negative phase of the North Atlantic Oscillation (NAO) and an El Niño-

[97] LUDLUM, David McWilliams, *Early American Winters, 1604-1820*, vol. 1, 2 vols, History of American Weather (Boston, Mass.: American Meteorological Society, 1966); WOOD, Charles A., ‘Climatic Effects of the 1783 Laki Eruption’.
[98] HOULE, Daniel, MOORE, Jean-David, and PROVENCHER, Jean, ‘Ice Bridges on the St. Lawrence River as an Index of Winter Severity from 1620 to 1910’, *Journal of Climate* 20 (15 February 2007): 757–64, https://doi.org/10.1175/JCLI4025.1.
[99] HOULE, Daniel, MOORE, Jean-David, and PROVENCHER, Jean; D’ARRIGO, Rosanne D. and JACOBY, Gordon C., ‘Northern North American Tree-Ring Evidence for Regional Temperature Changes after Major Volcanic Events’, *Climatic Change* 41, no. 1 (January 1999): 1–15, https://doi.org/10.1023/A:1005370210796; JACOBY, Gordon C., WORKMAN, Karen W., and D’ARRIGO, Rosanne D., ‘Laki Eruption of 1783, Tree Rings, and Disaster for Northwest Alask Inuit’, *Quaternary Science Reviews* 18, no. 12 (1999): 1365–71; D’ARRIGO, Rosanne et al., ‘The Anomalous Winter of 1783-1784: Was the Laki Eruption or an Analog of the 2009-2010 Winter to Blame?’

Southern Oscillation (ENSO) warm event, a situation which also occurred during the winter of 2009-2010.[100] However, various authors had already begun to query the role played by Laki in causing this bad weather. Sadler and Grattan, 1999, concluded that: "*There is little doubt that volcanic activity has a climatic effect but the historical temperature record indicates a surface cooling that in most cases falls within expected annual variation,*" and Brazdil et al, 2009, were of the opinion that: "*The winter 1783-1784 can be taken as a typical, if severe, winter during the 'Little Ice Age'*".[101]

1:4 Conclusion

In this chapter we have reviewed the geology of Iceland and placed Laki within this context. The eruption of 1783-1784, which was the second largest basaltic lava flow in recorded history, proved catastrophic, killing the majority of the island's livestock, mainly through chronic fluorosis, and over 20% of the population through starvation; it also left its mark over most of the Northern Hemisphere.

Writing in his journal, Gilbert White said that "The summer of the year 1783 was an amazing and portentous one, and full of horrible phenomena". The beginning of February saw a two-month long period of devastating earthquakes in Sicily and southern Italy which killed an estimated 35,000 to 50,000 people and destroyed many towns and villages. In the second half of the year, minor quakes and tremors occurred in France, the Low Countries, Germany and Switzerland. Unfortunately, the misery of the Calabrian earthquakes was compounded by eruptions of Etna, Stromboli and Vulcano during the second half of February. There was also more volcanic activity in Iceland, with the short-lived Island of Nýey being formed by a submarine eruption during the early part of the year.

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[100] D'ARRIGO, Rosanne et al., 'The Anomalous Winter of 1783-1784: Was the Laki Eruption or an Analog of the 2009-2010 Winter to Blame?'; ANGELL, J. K. and KORSHOVER, J., 'Surface Temperature Changes Following the Six Major Volcanic Episodes between 1780 and 1980', *Journal of Climate and Applied Meteorology* 24 (September 1985): 937–51, http://dx.doi.org/10.1175/1520-0450(1985)024<0937:STCFTS>2.0.CO;2; WOOD, Charles A., 'Climatic Effects of the 1783 Laki Eruption'; THORDARSON, Thorvaldur, 'Volatile Release and Atmospheric Effects of Basaltic Fissure Eruptions'; THORDARSON, Thor and SELF, Stephen, 'The Laki (Skaftár Fires) and Grímsvötn Eruptions in 1783–1785'; THORDARSON, Thorvaldur et al., 'The 1783–1785 A.D. Laki-Grímsvötn Eruptions II: Appraisal Based on Contemporary Accounts'; BRAZDIL, Rudolf et al., 'European Floods during the Winter 1783/1784: Scenarios of an Extreme Event during the Little Ice Age'.

[101] SADLER, J. P. and GRATTAN, J. P., 'Volcanoes as Agents of Past Environmental Change', *Global and Planetary Change* 21 (1999): 181–96, http://cadair.aber.ac.uk/dspace/bitstream/handle/2160/236/Volcanoes%20as%20agents%20of%20past%20environmental%20change.pdf?sequence=1&isAllowed=y; BRAZDIL, Rudolf et al., 'European Floods during the Winter 1783/1784: Scenarios of an Extreme Event during the Little Ice Age'.

Perhaps the most notable effect of the Laki eruption was the appearance of the hot, dry, sulphurous fog which spread over much of the northern hemisphere from North America in the West, to China in the East. It made the eyes smart, triggered headaches, and caused considerable suffering to asthmatics and those suffering from other bronchial complaints. In places, crops were damaged either by acid rain or acid volatiles in the fog. There were heatwaves throughout northern and western Europe, but a bitterly cold summer over the eastern North American seaboard. Not all the effects were bad, however, as record harvests were reported from eastern and southern Europe. One strange effect was to make the sun appear blood red owing to the density of the haze.

From July to September the fog was accompanied by violent storms with much thunder and lightning, hurricane force winds, driving rain and the occasional fireball. From all over Europe there were reports of loss of life and structural damage to a great many buildings. Inevitably, the general public were extremely worried by these events, so much so in fact, that the French astronomer, de la Lande, was induced to write a letter, which was widely published in Britain and France, emphasising the fact that these phenomena were not so unusual after all. Gennari, writing from Padua said the same reassurances were being made in Italy.

The winter of 1783-1784 proved to be long and hard with record snow falls and low temperatures in many places. The River Thames in London was frozen over, as were the Dutch canals, and many European rivers. When the thaw came, rivers burst their banks through being overburdened with melted snow and ice which was unable to soak away due to the frozen or waterlogged ground: there was severe flooding in many places which caused great distress for the people. According to Brazdil et al, 2009, "The floods during the winter 1783/1784 are the most spectacular covered by instrumental and documentary data at the broader European scale and provide a valuable insight into the severity and magnitude of such events."[102] In this connection we have looked at the epigraphic markers that were used to record these events and

[102] BRAZDIL, Rudolf et al., 'European Floods during the Winter 1783/1784: Scenarios of an Extreme Event during the Little Ice Age'.

can see that they are useful even today to compare recent flooding with past and possible future inundations. To quote Brazdil, "*Learning from past events remains an important step in better understanding and providing more effective protective measures for possible future events*".[103]

Finally, it would appear that Franklin and other commentators may have been incorrect in ascribing the severe winter conditions in 1783-1784 to the Laki eruptions. There had been disquiet about this theory for some time, but the matter now seems to have been resolved by D'Arrigo et al, who suggest that the conditions were most likely caused by a combined negative phase of the North Atlantic Oscillation and an El Niño-Southern Oscillation warm event.

[103] BRAZDIL, Rudolf et al.

CHAPTER 2 – Literature

The 1980s saw a growing interest in the effects that volcanic eruptions had on global climate. This was due in no small measure to the eruption of Mount St. Helens in May 1980, and thirty years later, the eruption of Eyjafjallajökull in April 2010 which caused the closure of Europe's air space for six days, and affected the economic, political and social activities in Europe and countries across the world.[104] Unsurprisingly, the main attention has focussed on large explosive eruptions such as Krakatau 1883, Tambora 1815 and Mt. St. Helens 1980. However, since the 1990s, and the publication of a series of papers by Thordarson and his colleague, Stephen Self, which emanated from Thordarson's PhD thesis entitled, *"Volatile Release and Atmospheric Effects of Basaltic Fissure Eruptions"*, the Laki eruption has become something of a growth industry. Not that Laki was unknown to the scientific community beforehand, but also, it was partly due to Thorarinsson's paper, *"Greetings from Iceland: ash-fall and volcanic aerosols in Scandinavia"*, that really put Laki on the map and introduced it to a far larger audience.[105] In addition, it was fortuitous that interest in the Laki eruption was further stimulated by inter-disciplinary research into a variety of related topics viz: traces of volcanic sulphate found in Greenland ice-cores;[106] long chronologies of tree-ring and pollen records, indicating periods of environmental stress;[107] the long-distance transportation of Icelandic micro-tephras[108] and archaeological research into the desertion of settlements due to external forces.[109]

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[104] WIKIPEDIA, 'Effects of the April 2010 Eyjafjallajökull Eruption', Wikipedia, 29 January 2016, https://en.wikipedia.org/wiki/Effects_of_the_April_2010_Eyjafjallaj%C3%B6kull_eruption; DURAND, Michael, 'Greetings from Iceland: Ash-Falls and Volcanic Aerosols in Scandinavia. Geografiska Annaler 63A, 109-18.', *Progress in Physical Geography* 31, no. 1 (February 2007): 89–93, https://doi.org/10.1177/0309133307073887.

[105] THORDARSON, Thorvaldur, 'Volatile Release and Atmospheric Effects of Basaltic Fissure Eruptions'; THORARINSSON, Sigurdur, 'Greetings from Iceland: Ash-Falls and Volcanic Aerosols in Scandinavia', *Geografiska Annaler Series A-Physical Geography* 63, no. 3/4 (1981): 109–18, http://www.jstor.org.distant.bu.univ-rennes2.fr/stable/520822?seq=1#page_scan_tab_contents.

[106] HAMMER, C. U., CLAUSEN, H. B., and DANSGAARD? W., 'Past Volcanism and Climate Revealed by Greenland Ice Cores', *Journal of Volcanology and Geothermal Research* 11 (1981): 3–10, http://ac.els-cdn.com.distant.bu.univ-rennes2.fr/0377027381900718/1-s2.0-0377027381900718-main.pdf?_tid=53fd839e-4ea5-11e7-8aed-00000aacb361&acdnat=1497185944_9d977e60da09724a0759655fe24153ff.

[107] BAILLIE, M. G. L. and MUNRO, M. A. R., 'Irish Tree Rings, Santorini and Volcanic Dust Veils', *Nature* 332 (24 March 1988): 344–46, https://doi.org/10.1038/332344a0; BAILLIE, M. G. L., 'Dendrochronology and Past Environmental Change', *Proceedings of the British Academy* 77 (1992): 5–23, http://www.britac.ac.uk/pubs/proc/files/77p005.pdf; PAYNE, Richard J., EDWARDS, Kevin J., and BLACKFORD? Jeff J., 'Volcanic Impacts on the Holocene Vegetation History of Britain and Ireland? A Review and Meta-Analysis of the Palynological Evidence', n/d, https://pdfs.semanticscholar.org/c6f2/5eb3aafe947103bb2ffe902d33b3f281d960.pdf.

[108] DUGMORE, Andrew, 'Icelandic Volcanic Ash in Scotland', *Scottish Geographical Magazine* 105, no. 3 (1989): 168–72, https://doi.org/10.1080/14702548908554430.

[109] BURGESS, C., 'Volcanoes, Catastrophe and the Global Crisis of the Late Second Millennium BC', *Current Archaeology* 117, no. Disasters special issue (08/2012 extract on line 1989): 325–29, https://www.archaeology.co.uk/articles/features/volcanoes-catastrophe-and-the-global-crisis-of-the-late-second-millennium-bc.htm; DODGSHON, R. A., GILBERTSON, D. D., and GRATTAN, J. P., 'Endemic Stress, Farming Communities and the Influence of Icelandic Volcanic Eruptions in the Scottish

A random selection of recent publications showed that there were authors from 67 towns in 21 countries who were actively engaged in working on Laki. The following table of four popular websites illustrates the number of hits that the name Laki generated at the time of writing, 21st August 2020.

Table 2:1 Laki hits on four popular websites 21st August 2020

Site	Search terms				
	Laki	Laki volcano eruption	Laki volcano	Laki eruption	Volcano Laki
Google	207.000.000	114.000	401.000	219.000	384.000
Yahoo	14.800.000	46.000	54.500	55.200	98.700
Bing	15.000.000	45.700	54.300	35.500	98.500
Google Scholar	773.000.	4.870	3.940	6.400	3.940

Admittedly, whilst the majority of hits solely under the name of Laki, have nothing to do with the volcano – Laki being the eponym for a multitude of different things which range from the name of a credit card, a hotel in Macedonia, to a character in a Manga novel, amongst others – there are many thousands that do, and it is these that we will now examine.

The literature relating to the Laki eruption and the winter of 1783-1784 can be divided into three main sections, namely:

1. Contemporary and near contemporary
2. Academic
3. Popular

Highlands', *Geological Society, London, Special Publications*, Special Publications, 171 (2000): 267–80, https://doi.org/10.1144/GSL.SP.2000.171.01.20.

2:1 Contemporary and Near Contemporary Records

There are many different records that fall under this category, perhaps the most important being eyewitness accounts. These are often in the form of diaries, journals, and common-place books, but the means by which the general public were acquainted with information, especially from abroad, was most often by letters and reports that were published in local newspapers. However, we must be very careful not to take all such reports at face value as they may include elements of conjecture and hearsay. A well-known example of this is the statement made by Benjamin Franklin in 1784 that *"During several of the summer months of the year 1783, when the effect of the sun's rays to heat the earth in these northern regions should have been greater, there existed a constant fog over all Europe, and great part of North America".*[110] One cannot be certain where Franklin obtained his American information, as he was living in France during the period from June to December 1783. We can only surmise that he may have based his idea on a speculation by de Lamanon, or possibly a report emanating from one of the trading companies working on the northwest coast of America such as the Hudson's Bay Company or the North West Company.[111]

Unfortunately, we cannot regard eyewitness accounts as reliable or even useful unless it can be shown that the informant was contemporaneous with, and in the vicinity of the described event, and that he had recorded these events within a short space of time afterwards; and if he was just a reporter, that he had accurately communicated the oral or first-hand written reports that he had obtained. Even when these parameters are satisfied, simultaneous eyewitness accounts of the same event may substantially differ.

2:1:1 Eyewitness Accounts of the Laki Eruption

Eyewitness accounts of the Laki eruption itself have been critically analysed by Thordarson, 1995 & 2003 and Thordarson et al, 2003. Apart from describing the eruption and its immediate aftermath, these records also give us valuable information

[110] FRANKLIN, Benjamin, 'Meteorological Imaginations and Conjectures'.
[111] STOTHERS, Richard B, 'The Great Dry Fog of 1783'.

concerning the environment and social response of the population. The most famous and the most detailed description of the eruption appeared in three Eldrits (Books of Fire) written by a parish priest, the Reverend Jón Steingrímsson. The first two were written to accompany letters sent to the authorities in 1783 whilst Laki was still erupting. The third, which is the most complete, was written to inform the public with this "chastisement of the Lord for their reformation."[112]

Although Steingrímsson's Eldrit does contain a few significant errors, we are fortunate in having other eyewitness accounts which supply additional information enabling us to correct them. See Table 2:2. Thordarson's analysis of these sources shows that their reliability is highly variable, the most accurate and therefore the most reliable being written by those who actually witnessed the eruption, whilst reporters who were not witnesses and relied upon hearsay, communicated much fallacious information about the events, thus making their reports of very little practical use.[113]

A prime example of this, and a very readable, but far from accurate account, based entirely on hearsay evidence, is *"Journal of a Tour in Iceland in the summer of 1809"* by the botanist, William Jackson Hooker, and printed for private circulation in 1811. He took his information from a translation of a Danish pamphlet written by Magnus Stephensen and published in 1785.[114] Stephensen, together with H.C.D.W. von Levetzow, were sent by the Danish government in 1784 to investigate the Laki eruption and its effect on the Icelandic community. Stephensen's descriptions were, to a large extent, based on Steingrimsson's accounts, but the facts are often distorted and his map of the lava flow and vent locations in the northern part of the Síða highlands were very inaccurate, probably because he never ventured very far into them.[115]

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112 THORDARSON, Thorvaldur, 'The 1783–1785 A.D. Laki-Grímsvötn Eruptions I: A Critical Look at the Contemporary Chronicles', *Jokull* 53 (January 2003): 1–10; STEINGRIMSSON, Jón, *Fires of the Earth: The Laki Eruption1783-1784*.
113 THORDARSON, Thorvaldur, 'The 1783–1785 A.D. Laki-Grímsvötn Eruptions I: A Critical Look at the Contemporary Chronicles'.
114 STEPHENSEN, Magnus, *Kort Beskrivelse over Deri Nye Vulcans Ildsprudning i Ves- Ter-Skaptefields-Syssel Paa Island i Aaret 1783. (A Short Description of the New Volcanic Eruption in WesternSkaftafellshire in the Year 1783.* (Copenhagen, Denmark: Nicolaus Möller, 1783); HOOKER, William Jackson, *Journal of a Tour in Iceland in the Summer of 1809*, Unpublished (Yarmouth: Printed by J. Keymer, 1811), 407–26, http://baekur.is/en/bok/000180699/0/11/Journal_of_a_Tour_in_Iceland_Bls_11.
115 THORDARSON, Thorvaldur, 'The 1783–1785 A.D. Laki-Grímsvötn Eruptions I: A Critical Look at the Contemporary Chronicles'; PALSSON, S, *Ferðabók Sveins Palssonar: Dagbækur og ritgerðir 1791-1797(The travel account of Sveinn Palsson. Notebooks and essays through 1791-1797)*, 2nd ed. (Reykjavik: Örn og Örlygur, 1983).

Table 2:2 Eldrit* and other contemporary accounts of the Laki eruption. Modified from Thordarson, 2003

Authors	Title	Comments
Jón Steingrímsson	A short compendium of the recent volcanic outburst in western Skaftafellshire	Prestbakki, 4th July 1783
Jón Eiríksson	Extract from agent Erichsens letter	Ljotarstadir 11th July 1783
Johan C. Sünckenberg	Report to the Directors of the Iceland Division of the Royal Monopolistic Commerce	Stykkisholmur 24th July 1783
Lýður Guðmundsson	Report by Lýður Guðmundsson sheriff of W-Skaftafellshire to Chief Prefect Thodal	Oxara 26th July 1783
Lýður Guðmundsson	Letter from Lýður Guðmundsson	2nd August 1783
Ólafur Stephensen	Extract from Prefect Stephensen's letter to Deputy Erichsen	15th August 1783
Jón Steingrímsson and Sigurður Ólafsson	A simple, but true narrative of the eruption in Skaftafellshire in the year 1783	Kirkjubaejarklaustur 24th Aug. 1783
Sigurður Ólafsson	About the earth fire in Skaftafellshire	Kirkjubaejarklaustur 27th Aug. 1783
Jón Steingrímsson	Summary from a letter to Reverand Bjarni Jónsson	Prestbakki, 31st August 1783
Svendborg	Extract from assistant Svendborg's letter to agent Pontoppidan	Hafnarfjodur 31st August 1783
Lýður Guðmundsson	Letter from Lýður Gudmundsson sheriff of Western Skaftafellshire	1st September 1783
Árni Thorarinsson	Narrative by Reverend Thorarinsson	Undated, written in October 1783
Einar Björnsson	Relation by one clergyman, who in the summer 1783 travelled back and forth across across S-Iceland from Múlashire through Skaftafellshire	Undated, written in Autumn 1783
Jón Eiríksson	A Narrative on the Eruption in Western-Skaftafellshire in Iceland	Copenhagen December 1783
Saemundur M. Hólm	About the Earth Fire in Iceland in the Year 1783	Copenhagen 25th February 1784
Sveinn Pálsson	The story of the earth fire that broke out in Eastern Iceland in the year 1783, as it was observed in Skagafjörður; progress of the eruption and its various effects	Written in Spring 1784
Magnús Stephensen	A short description of the new volcanic eruption in Western Skaftafellshire in the year 1783	Copenhagen 1785
Jón Pétursson	About the perceptible effects of the volcanic haze in Northern Iceland in 1783	Unpublished, the original script is lost. Information on its content is preserved in a rebuttal by M. Stephensen 26th June 1786
Jón Steingrímsson	A complete description on the Síða volcanic fire	Prestbakki 24 November 1788
Sveinn Pálsson	Book of Fire, additions to the descriptions of the Skaftá Fires (Laki eruption) 1783	Written in 1783 and 1794

2:1:2 Newspapers and Journals

The unusual weather that occurred during the summer of 1783, and the winter of 1783-1784 was often reported in contemporary newspapers and journals. However, the spread of intelligence in the 18th century often took weeks or even months to reach the newspapers. The following table, 2:3 shows just how slowly information regarding the Laki eruption percolated through from Iceland to European cities, having arrived at Copenhagen on 1st of September 1783.[116]

It is interesting to note the difference in time that the news took to arrive at different destinations throughout Europe after its arrival in Copenhagen on 1st of September, viz. 17 days to reach The Hague; 21 days, St. Petersburg; 25 days, London; 29 days, Paris; and 54 days, Barcelona.

As we saw in Chapter 1, many British publications carried news regarding bad weather in Europe and elsewhere, as well as local information. Grattan and Brayshay use these to great effect in their paper: *An Amazing and Portentous Summer.*[117] In this they not only analyse weather reports from nineteen British newspapers and journals, but also ascertain how the population as a whole reacted to these strange phenomena. It seems that the educated classes calmly regarded these events as a natural product of nature, whilst the superstitious country people regarded them with a sense of fear and apprehension.

Gratton and Brayshay are of the opinion that the newspapers of the time were read mostly by the well-educated and wealthier classes, but this may not necessarily have been the case.[118] It can be argued that literacy was not particularly high during the 18th century, or at least not amongst the poorer classes, but some contemporary observers seemed to think otherwise. . In 1726, César de Saussure wrote a letter to his family in Switzerland, in which he said:

[116] DEMAREE, Gaston R. and OGILVIE, Astrid E. J., 'L'éruption Du Lakagigar En Islande Ou "Annus Mirabilis 1783". Chronique d'une Année Extraordinaire En Belgique et Ailleurs', 136.
[117] GRATTAN, John and BRAYSHAY, Mark, 'An Amazing and Portentous Summer: Environmental and Social Responses in Britain to the 1783 Eruption of an Iceland Volcano'.
[118] GRATTAN, John and BRAYSHAY, Mark.

Table 2:3 First newspaper reports of the Laki eruption in some European cities.

(after Demarée and Ogilvie 2016)

18 September	The Hague	Oprechte Donderdagse Haarlemse Courant
19 September	Vienna	Das Wienerblättchen
20 September	Louvain	L'Esprit des Gazettes, Feuille hebdomadaire
20 September	Vienna	Wiener Zeitung
22 September	Brussels	Gazette des Pays-Bas
22 September	St Petersburg	St. Peterburgische Zeitung
23 September	Derby	Derby Mercury
25 September	Stockholm	Dageliga Tidningar, Eller Dagligt Allehanda
26 September	London	The London Gazette
27 September	Ghent	Den Vlaemschen Indicateur
27 September	Florence	Gazetta Universale
29 September	Reading	Reading Mercury
30 September	Leeds	Leeds Intelligencer
30 September	Manchester	Manchester Mercury
30 September	Paris	Gazette de France
1st fortnight in October	Bouillon	Journal politique, ou Gazette des gazettes
1 October	Edinburgh	Caledonian Mercury
1 October	Luxembourg	Journal historique et littéraire
1 October	Berne	Nouvelles de divers Endroits
2 October	Hereford	The British Journal or Pugh's Hereford Journal
3 October	Chelmsford	Chelmsford Chronicle
3 October	Belfast	The Belfast News-Letter
4 October	Brussels	Journal politique de Bruxelles
4 October	Newcastle	The Newcastle Chronicle
4 October	Norfolk	Norfolk Chronicle
8 October	Warsaw	Suplement do Gazéty Warszawskjey
10 October	Avignon	Le Courrier d'Avignon
15 October	Wroclaw	Schlesische privilegirte Zeitung
17 October	Madrid	Gazeta de Madrid
24 October	Lisbon	Supplemento a' Gazeta de Lisboa
25 October	Barcelona	Gazeta de Barcelona

> All Englishmen are great newsmongers. Workmen habitually begin the day by going to coffee-rooms in order to read the latest news. I have often seen shoeblacks and other persons of that class club together to purchase a farthing paper. Nothing is more entertaining than hearing men of this class discussing politics and topics of interest concerning royalty.[119]

Fifty years later, another observer noted that*: "Our peasantry now read the 'Rights of Man' on mountains and moorside and by the wayside."*[120]

The eighteenth century saw a vast increase in the production of newspapers. In 1712, there were 12 London newspapers, and about 23 provincial papers by 1723. New papers were produced throughout the century and annual sales rose rapidly, from about 2.5 million in 1713, to 7.3 million in 1750, 12.6 million in 1775 and 16 million in 1801.[121]

It can be argued that the huge expansion in newspaper production during the 18th century cannot be accounted for just by selling papers to the well-educated and wealthier classes, but by sales to the less well-off, to the man in the street, as depicted by de Saussure. To add credence to this argument, it is worth considering the following from James Lackington's Memoirs, first published in 1791.

> Before I conclude this letter, I cannot help observing, that the sale of books in general has increased prodigiously within the last twenty years. According to the best estimation I have been able to make, I suppose that

[119] van MUYDEN, Madame, *A Foreign View of England in the Reigns of George I and George II : The Letters of César de Saussure to His Family.* (London: John Murray, 1902), 162, https://books.google.fr/books?id=7_wJAwAAQBAJ&pg=PA162&lpg=PA162&dq=all+englishmen+are+great+newsmongers&source=bl&ots=E16Ju6c80L&sig=ioI-6c0hhQWL8lSJfKO5yzmAY1M&hl=en&sa=X&ved=0ahUKEwj--NbK07fSAhVkFMAKHetxCFoQ6AEIJzAC#v=onepage&q=all%20englishmen%20are%20great%20newsmongers&f=false.
[120] MATHIAS, T. J., *The Pursuits of Literature: A Satirical Poem in Four Dialogues with Notes*, 9th ed. (London: T. Becket, 1799), 238, https://books.google.fr/books?id=0MoIAAAAQAAJ&pg=PA238&vq=%22read+the+Rights+of+Man+on+mountains,+and+moors,+and%27+by+the+way+side%3B,+and+shepherds+make+the+analogy+between%22&source=gbs_quotes_r&cad=6#v=onepage&q=%22read%20the%20Rights%20of%20Man%20on%20mountains%2C%20and%20moors%2C%20and%27%20by%20the%20way%20side%3B%2C%20and%20shepherds%20make%20the%20analogy%20between%22&f=false.
[121] BLACK, Jeremy, *Eighteenth-Century Britain : 1688-1783* (Basingstoke, Hampshire; New York: Palgrave, 2001), 122; BLACK, Jeremy, 'From Woodcuts to Steam Press', *BBC History Magazine Supplement*, May 2002, 13.

> more than four times the number of books are sold now than were sold twenty years since. The poorer sort of farmers, and even the poor country people in general, who before that period spent their winter evenings in relating stories of witches, ghosts, hobgoblins, &c. now shorten the winter nights by hearing their sons and daughters read tales, romances, &c. and on entering their houses, you may see Tom Jones, Roderick Random, and other entertaining books, stuck up on their bacon-racks, &c…In short, all ranks and degrees now READ.[122]

Judging from contemporary reports, it seems fair to assume that newspapers were well read by all classes of society, and their contents widely discussed, even if not necessarily believed. Of course, the more outré the articles, the more they would have been passed on by word of mouth, thus spreading any alarm already felt by the more ignorant members of the population.

We must now ask ourselves whether the weather reports were accurate or not. Reporting in newspapers was usually of a fairly sober nature at that time, and so it is safe to assume that if the weather had been extreme, rather more colourful adjectives than usual would have been used. Grattan and Brayshay have taken an interesting and more unusual approach to this question by counting the number of adjectives used by the writers of over 160 separate newspaper reports published between 10th of June and 3rd of September, 1783, together with the letters of Gilbert White, Horace Walpole and William Cooper; a list of those adjectives is listed below. However, it would be as well to exercise caution when reading these narratives, as the latter part of the 18th century saw the birth of the Romantic Movement, and the increased use of literary hyperbole, which added a great deal of sensationalism as well as authority to the reports.[123]

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[122] LACKINGTON, James, *Memoirs of the Forty-Five First Years of the Life of James Lackington, the Present Bookseller, Finsbury-Square, London / Written by Himself : In Forty-Seven Letters to a Friend ; with a Triple Dedication to the Public, to Respectable Booksellers, to Sordid Booksellers.*, 10th ed. (London: the author, 1795), 243, https://books.google.fr/books?id=5F1gAAAAcAAJ&pg=PA243&lpg=PA243&dq=james+lackington+the+sale+of+books+in+general&source=bl&ots=mzo3gPfa40&sig=NVENeLx4S9U6zym8FtTVX8be3e0&hl=en&sa=X&ved=0ahUKEwi0v8XR-LfSAhVmCsAKHfAHAxAQ6AEIOzAG#v=onepage&q=james%20lackington%20the%20sale%20of%20books%20in%20general&f=false.

[123] GRATTAN, John and BRAYSHAY, Mark, 'An Amazing and Portentous Summer: Environmental and Social Responses in Britain to the 1783 Eruption of an Iceland Volcano'.

Table 2:4 Order of adjectives used to describe extreme weather events occurring between 10th June and 3rd September 1783. Grattan and Brayshay (1995)

Adjective	Count	Percentage
violent	46	25.1
tremendous	27	14.8
dreadful	23	12.6
remarkable	17	9,3
alarming	14	7,8
awful	11	6,0
extraordinary	9	4,9
terrible	9	4,9
amazing	7	3,8
unusual	7	3,8
singular	6	3,3
severe	4	2,2
shocking	1	0,5
surprising	1	0,5
portentious	1	0,5
Total	183	100,0

The sources used are as follows: Aberdeen Journal, Bristol Journal, Bury Post and Universal, Caledonian Mercury, Cambridge Chronicle and Journal, Edinburgh Advertiser, Exeter Flying Post, General Evening Post, Ipswich Journal, London Gazette, London Packet, Morning Chronicle and London Advertiser, Morning Herald and Daily Advertiser, Norfolk Chronicle, Parker's Advertiser and Morning Intelligence, Sherborne Mercury, Whitehall Evening Post, York Courant, Gilbert White, "The Natural History of Selbourne", Peter Cunningham, "The Letters of Horace Walpole", William Cowper, "Letters".

It will be noticed that the most frequently used adjective occurring in the table was 'violent', which together with 'tremendous' and 'dreadful' accounted for over half those listed. According to the newspapers listed in the above table, four violent storms in July, namely those of the 2nd, 4th, 7th and 10th, injured 27 people and caused the death of at least 24. There was much damage to property, and in the storm of the 10th of July alone, there were reports that at least 64 sheep, 7 cattle, 9 horses, a pig, and a hen had been killed in locations throughout Britain.[124] It would thus seem that the wording used to describe these storms, which although sensational, was also accurate and only served to illustrate their severity. We must also bear in mind that then as now, a lot of articles were syndicated and so the same reports often appear in more than one newspaper.

There were many Continental newspapers and journals that gave graphic descriptions of the unusual weather during the summer of 1783 and the winter of 1783-1784, and it would be invidious to pick out any one in particular. However, papers by various authors have highlighted these, and many examples can be found in: Thordarson, 1995; Demarée and Ogilvie, 2001; Demarée, 2006; Brazdil et al, 2009, Demarée and Ogilvie, 2016.[125]

2:1:3 Books, Official Reports and Learned Journals

The most famous eyewitness account of the Laki eruption, was that written by Jón Steingrímsson, and published as a book on the 17th of November 1788. See table 2:2.

However, there were many other publications concerning different aspects of the eruption and associated events that were published within the space of a few years, and many of these can be found listed by the authors named above. Of particular importance are the *Philosophical Transactions of The Royal Society, London*, and the *Journal de Paris*. Special mention must be made, however, of van Swinden's paper: "*Observations on the cloud (dry fog) which appeared in June 1783",* and was printed in the annual report of the Meteorological Society of Manheim for 1783. It describes the Laki haze and its effects in great detail; Brugman's book published in 1783 provided detailed information regarding vegetation affected by the haze, and of a more general nature, but just as important to our understanding of the years 1783-1784, Gilbert

[124] GRATTAN, John and BRAYSHAY, Mark.
[125] THORDARSON, Thorvaldur, 'Volatile Release and Atmospheric Effects of Basaltic Fissure Eruptions'; DEMAREE, G. R. and OGILVIE, A. E. J., 'Bon Baisers d'Islande: Climatic, Environmental and Human Dimensions, Impacts of the Lakagigar Eruption (1783-1784) in Iceland.'; DEMAREE, Gaston R., 'Hydrolog. Sci. J.'; BRAZDIL, Rudolf et al., 'European Floods during the Winter 1783/1784: Scenarios of an Extreme Event during the Little Ice Age'; DEMAREE, Gaston R. and OGILVIE, Astrid E. J., 'L'éruption Du Lakagigar En Islande Ou "Annus Mirabilis 1783". Chronique d'une Année Extraordinaire En Belgique et Ailleurs'.

White's *"The Natural History and Antiquities of Selborne in the County of Southampton",* which was first published in 1789 and has been in print ever since.

2:1:4 Weather Logs and Diaries

These are published or unpublished sources that systematically list details of weather and related phenomena on a daily basis and may also remark on specific aspects of the Laki haze. A list of many of these can be found in Thordarson, 1995.[126]

Although many observers were monitoring the weather there was no universal system of measurement. Just to consider two, the temperatures listed by the *Journal de Paris* were recorded three times a day, using the Réaumur scale, which was commonly used in Europe at the time; those listed by *The Gentleman's Magazine* used Fahrenheit, and were recorded, up to three times a day. Thomas Barker used an unusual piece of equipment, a thermometer about a yard (91 cm) long, divided downward from 0 to 95, the distance being 2 feet 2 inches (66cm). The freezing point on this thermometer was at the division 76, while division 12 corresponded to 80°F. (26.7°C.). His temperatures were recorded both inside as well as outside and twice a day, but not at the same time every day. He also had to convert his measurements to Fahrenheit.

The recording of barometric pressure was equally diverse as many different types of instruments and scales were used. In the examples shown above, the *Journal de Paris* used the old pre-revolutionary scale of point, ligne and pouce or Paris inch, and details of these can be seen in the conversion scale below. Both *The Gentleman's Magazine* and Thomas Barker used the Imperial system of inches, tenths, and hundredths of an inch.

Table 2:5 Pre-revolutionary Measurements of Length

Unit	Relative Value	SI Value	Imperial Value
point	$1/12^3$	~0.188mm	~0.007 ins
ligne	$1/12^3$	~2.256mm	~0.088 ins
pouce/Paris inch	$1/12^3$	~27.07mm	~1.066 ins

[126] THORDARSON, Thorvaldur, 'Volatile Release and Atmospheric Effects of Basaltic Fissure Eruptions', 325 et seq.

Why were an increasing number of people, many of them amateurs, from priests to country gentlemen, taking an interest in making meteorological observations? This period was known as "The Age of Reason" or "The Age of Enlightenment", an intellectual movement spanning, according to some scholars, the period from the beginning of the scientific revolution in the 1620s until the early 19th century, which saw the spread of new ideas throughout Europe and North America.[127] According to Ingram et al. there were four main reasons. The first was the "pure spirit of enquiry", which was in keeping with the age; the second was the search for a more efficient system of agriculture; the third which may have been a means to discredit astrology;ather whilst the fourth was medicine, as there was a growing belief in the medical profession that climate and weather were extremely important contributing factors in the incidence of disease.[128] This theory, the Neo-Hippocratic hypothesis, was predicated on the ideas of the Greek physician and philosopher, Hippocrates of Chios, who thought that a disease was due to the imbalance between an organism and the environment, including weather and climate. These ideas were taken up by the English physician, Thomas Sydenham, in the mid. 17th century, who believed that there was an interaction between climate, health and environment, and that the health of a person depends upon the air he breathes, the water he drinks and the topography of the place where he lives as well as the succession of dry, wet, cold, and warm seasons.[129] So successful was the revival of this doctrine that it led to the founding of the *Société Royale de Médecine* in Paris, and the *Societas Meteorologica Palatina*, which was set up by Karl Theodor, the elector of the Palatinate, in Mannheim in 1780. It consisted, at its maximum, of an international chain of 31 simultaneously recording weather stations, and a total of 37 which recorded for one year or longer, stretching from Greenland to Rome, from La Rochelle to Moscow, with even one branch in Cambridge, Mass., USA. Each station used a standard set of instruments and took measurements three times a day, at 7am, 2pm and 9pm, the results being entered on a pre-printed set of forms

[127] WIKIPEDIA, 'Age of Enlightenment', Wikipedia, 15 March 2017, https://en.wikipedia.org/wiki/Age_of_Enlightenment#Scientific_and_literary_journals.

[128] INGRAM, M. J., UNDERHILL, D. J., and FARMER, G., 'The Use of Documentary Sources for the Study of Past Climates', in *Climate and History: Studies in Past Climates and Their Impact on Man* (Cambridge, New York, Melbourne: Cambridge University Press, 1985), 544, https://books.google.fr/books?id=hro8AAAAIAAJ&pg=PA180&dq=types+of+documentary+%26+historical+evidence&hl=en&sa=X&ved=0ahUKEwjY5s2MoJ_SAhWMKcAKHUTMBHMQ6AEIRDAG#v=onepage&q=types%20of%20documentary%20%26%20historical%20evidence&f=false.

[129] DEMAREE, G. R. and OGILVIE, A. E. J., 'Bon Baisers d'Islande: Climatic, Environmental and Human Dimensions, Impacts of the Lakagigar Eruption (1783-1784) in Iceland.'; BRAZDIL, Rudolf et al., 'Historical Climatology In Europe – The State Of The Art', *Climatic Change* 70, no. 3 (June 2005): 363–430, https://doi.org/10.1007/s10584-005-5924-1; HIPPOCRATES, 'Airs, Waters, Places', in *Hippocratic Writings*, ed. LLOYD, Geoffrey Ernest Richard, trans. CHADWICK, John and MANN, William Neville, Pelican Classics (Harmondsworth, 1978), 384, http://www.classics.ucsb.edu/classes/cla109/Hippocrates.pdf.

which were collected annually, collated, translated into Latin and published in an annual volume, *Ephemerides Societatis Meteorologicae Palatinae*. Unfortunately, the undertaking was abandoned when Mannheim was occupied by Napoleon's troops in 1795, the final published statistics being those for 1792.[130] A list of the weather stations involved with the dates of their participation is shown in the following table.

Table 2:6 Locations participating in data gathering for the Societas Meteorologica Palatina from 1781-1792

Location	Date	Location	Date	Location	Date
Berlin	1781-88	Godthaab, Greenland	1787	Padua	1781-92
Bologna	1782-84, 1787-92	Göttingen	1783-85, 87	Prague	1781-87 1789-91
Brussels	1782-92	Hohenpeissenberg	1781-91	Pyshmen, Urals	1790-91
Buda	1781-92	Ingolstadt	1781-82	Regensburg	1781-91
Cambridge, Mass., USA	1782-87	La Rochelle	1782-90	Rome	1782-92
Copenhagen	1782-88	Mannheim	1781-92	St. Petersburg	1783-92
Delft	1784-85	Marseilles	1782-92	St. Zeno, Bavaria	1781
Den Haag	1782-83	Middelburg	1782-88	Sagan, Poland	1781-92
Dijon	1783-84	Moscow	1783-89, 1791-92	Spydeberg, Norway	1783-86
Düsseldorf	1782-84	Mount St. Andex, Bavaria	1781-92	Stockholm	1783-92
Eidsberg	1787	Mount St. Gothard, Switzerland	1781-92	Tegernsee, Bavaria	1781-89
Erfurt	1781-88	Munich	1781-92	Würzburg	1781-88
Geneva	1782-89				

Details from Cassidy 2004, amended

Owing to the difficulties of communication and the standardisation of instruments, collaborative recording of data was extremely difficult to achieve. However, despite these obstacles, the Palatine Society:

[130] DEMAREE, Gaston R., 'The Ancien Regime Instrumental Meteorological Observations In Belgium Or The Physician With Lancet And Thermometer In The Wake Of Hippocrates', *Sartoniana* 17 (2004): 12–41, http://www.sartonchair.ugent.be/file/19; BRAZDIL, Rudolf et al., 'Historical Climatology In Europe – The State Of The Art'; CASSIDY, David C., 'Meteorology in Mannheim: The Palatine Meteorological Society, 1780-1795', *Sudhoff's Archiv* 69, no. 1 (1985): 8–25, http://www.dcassidybooks.com/palatine.pdf.

> […] achieved a control of its members and a standardisation of their readings unparalleled until the advent of state weather bureaus over half a century later. The reliability of the extensive data that it produced proved equally outstanding and of use to meteorologists ever since.[131]

Needless to say, the Ephemerides has many records of the Laki haze and its associated weather, and further details of these can be found in Thordarson, 1995.

Meanwhile, meteorological phenomena were also being monitored by the *Société Royale de Médecine (1778-1793*), mentioned above, and the Dutch society, *Geneeskundige Correspondentie Societeit (1779-1802)* to try to find a correlation between climate and disease. A vast amount of statistical information was collected and published regarding the state of the weather and the occurrence of epidemics which were rife throughout Europe during the latter part of the century. However, it would be unwise to accept all published information at face value. For example, after analysing the volumes produced by the Societeit, Willem Wenckebach, a mathematics professor from Utrecht, found that there were a large number of printing mistakes and other errors; the small amount of data that he could check against the original registers was nearly all incorrect, thus causing him to reject it as unsuitable.[132]

The Société Royale had a large number of correspondents, not only in France, but at various times in the Island of Santo Domingo, London, Holland, Belgium, and Germany amongst other places.[133] The wide coverage of the Société's network enabled the medical profession to associate the onset of epidemics with the strange state of the weather, the protracted Laki haze, and a hot summer accompanied by violent storms

[131] CASSIDY, David C., 'Meteorology in Mannheim: The Palatine Meteorological Society, 1780-1795'.
[132] ZUIDERVAART, Huib J., 'An Eighteenth-Century Medical–Meteorological Society in the Netherlands: An Investigation of Early Organization, Instrumentation and Quantification. Part 2', *British Journal for the History of Science* 39, no. 1 (March 2006): 49–66, https://doi.org/10.1017/S0007087405007594; DEMAREE, G. R. and OGILVIE, A. E. J., 'Bon Baisers d'Islande: Climatic, Environmental and Human Dimensions, Impacts of the Lakagigar Eruption (1783-1784) in Iceland.'
[133] HISTOIRE de SOCIETE ROYALE de MEDECINE, *Histoire de Société Royale de Médecine. Années M.DCC.LXXXIV & LXXXV* (Paris: Théophile Barrois, 1788), https://books.google.fr/books?id=z6DduCmKVe4C&pg=RA1-PA132&lpg=RA1-PA132&dq=soci%C3%A9t%C3%A9+royale+de+m%C3%A9decine+size&source=bl&ots=Mkje5qlMTX&sig=Qqm0Izv9R1bNTwhnPZIjSffLcS4&hl=en&sa=X&ved=0ahUKEwin1rDz1O_SAhWKBsAKHQmzCPgQ6AEIQzAG#v=onepage&q=soci%C3%A9t%C3%A9%20royale%20de%20m%C3%A9decine%20size&f=false; DEMAREE, G. R. and OGILVIE, A. E. J., 'Bon Baisers d'Islande: Climatic, Environmental and Human Dimensions, Impacts of the Lakagigar Eruption (1783-1784) in Iceland.'

An example of a meteorological table composed from information supplied by members of the Société's network can be seen in Figure 2:1.

2:1:5 Maritime Records

Apart from information regarding the weather, which one would naturally expect to appear in ships' logs, there are several instances of captains recording unusual occurrences, for example, there are at least two reports of the Nýey eruption in May 1793; those of Captain Mindelberg, a report by the Danish Captain, Pedersen, and his assistant, Svendborg, from the vessel, Forsken, and one regarding the Laki haze from an unnamed captain of a ship sailing from Norway to Groningen between the 19th of June and the 2nd of July. See also Figures 2:2 & 2:3.

> From this it is disclosed, that the ocean was covered then from 25th to the 30th, June by a continuous haze, which often, especially on the 29th and 30th, was so dense that it nearly removed all view: but the sulphurous odour was not present. Indeed, the winds, which blew on the ocean on these days, were different from those which we observed at Groningen or Franeker.[134]

[134] WOOD, Charles A., 'Climatic Effects of the 1783 Laki Eruption'; VAN SWINDEN, S.P., 'Observations on the Cloud (Dry Fog) Which Appeared in June 1783'; DEMAREE, G. R. and OGILVIE, A. E. J., 'Bon Baisers d'Islande: Climatic, Environmental and Human Dimensions, Impacts of the Lakagigar Eruption (1783-1784) in Iceland.'

Figure 2:1 Meteorological Table for January 1784 from the Histoire et Mémoires de la Société Royale de Médecine

Histoire de la Société Royale de Médecine, année 1784, pag. 104.

NOMS DES VILLES.	Nombre des jours de pluie.	Quantité de pluie.	Vents dominans.	TEMPÉRATURE.
		Pouc. lign.		
Tivoli, *Ile Saint-Domingue*		16. 6, 0.	N.	
Bagdad, *Asie*			N.	
New-York, *Amérique*			N. & O.	
Perpignan, *Roussillon*			N. & N. E.	
Mont-Louis, *Roussillon*			E. & O.	froide & humide.
Rieux, *Languedoc*		5. 2, 6.	O. & S. E.	idem.
Castelnaudary, *Languedoc*			O.	idem.
Montpellier, *Languedoc*		2. 0, 4.	N. E.	variable.
Arles, *Provence*		1. 10, 6.	N. & E.	froide & humide.
Dax, *Gascogne*			S.	douce & humide.
Saint-Sever-Cap, *Gascogne*		4. 0, 6.	S. & N.	
Tarascon, *Foix*			N. & N. E.	froide & humide.
Manosque, *Provence*		1. 0, 0.	N. E. & N. O.	idem.
Castel-Sarrazin, *Languedoc*			S. & S. O.	douce & humide.
Nismes, *Languedoc*		2. 3, 6.	N.	froide & humide.
Cavaillon, *Provence*			N. & N. O.	
Mont-Dauphin, *Dauphiné*			N.	idem.
Mézin, *Guyenne*			O.	
Caussade, *Quercy*			O.	assez douce & humide.
Vabres, *Rouergue*			N. O.	
Oléron, *Béarn*			S. & S. O.	
Rhodès, *Rouergue*			N. O. & S.	
Saint-Paul-trois-Châteaux, *Dauphiné*		1. 7, 0.	N. & S. O.	froide & humide.
Mende, *Gévaudan*			S. & N.	froide & sèche.
Bordeaux, *Guyenne*		2. 5, 0.	N. O.	froide & humide.
Grenoble, *Dauphiné*		2. 7, 6.	S. E. & N. O.	idem.
Clermont-Ferrand, *Auvergne*			S.	
Argentat, *Limosin*			E. & O.	idem.
Ville-Franche, *Beaujolois*			N.	idem.
Brive-la-Gaillarde, *Limosin*			N. O.	idem.
La Rochelle, *Aunis*		2. 2, 8.	N. E.	idem.
Mont Luçon, *Bourbonnois*			N. N. O.	idem.
Saint-Maurice-le-Girard, *Poitou*			N. & N. O.	idem.
Poitiers, *Poitou*		3. 3, 10.	S. & S. O.	douce & humide.
Lons-le-Saunier, *Franche-Comté*			S. & S. O.	froide & humide.
Seure, *Bourgogne*		2. 5, 6.	N. E. & N.	idem.
Beaune, *Bourgogne*			N. & N. E.	idem.
Pontarlier, *Franche-Comté*		3. 10, 6.	S. E.	idem.
Grand-Combes-des-Bois, *Fr.-Comté*			S. O. & O.	idem.
Besançon, *Franche-Comté*			O. & E.	
Dijon, *Bourgogne*		1. 11, 4.	N.	
Chinon, *Touraine*			N. E.	froide & humide.
Vannes, *Bretagne*			N. O.	idem.
Auxerre, *Bourgogne*			N.	idem.
Wolsberg, *Autriche*			S.	
Mulhausen, *Alsace*		2. 1, 6.	N. E. & S. O.	idem.
Orléans, *Orléanois*			N. E.	idem.
Montargis, *Gâtinois*			S. & E.	idem.
Troyes, *Champagne*		1. 4, 6.	N.	idem.
Brest, *Bretagne*			N. E.	froide & humide.
Mayenne, *Maine*			N. E.	idem.
Etampes, *Ile de France*			N. & N. E.	
Chartres, *Beauce*			N. N. E.	idem.
Saint-Brieux, *Bretagne*			O.	idem.
Saint-Dié, *Lorraine*			S.	idem.
Saint-Malo, *Bretagne*			N. O. & N. E.	idem.
Obernheim, *Alsace*			N. O.	
Haguenau, *Alsace*		3. 11, 3.	S. E.	idem.
Ratisbonne, *Allem.*			N. E.	
Mirecourt, *Lorraine*			N. & N. E.	idem.
Paris, *Ile de France*		0. 4, 6.	N. & O.	idem.
Laigle, *Normandie*				idem.
Montmorency, *Ile de France*		0. 11, 9.	N. E. & N.	idem.
Metz, *Pays Messin*		1. 2, 0.	N.	idem.
Rouen, *Normandie*			N. S.	idem.
Laon, *Ile de France*		1. 6, 0.	S. & S. O.	idem.
Montdidier, *Picardie*			N. O.	idem.
Cambray, *Cambresis*		0. 8, 0.	S	idem.
Arras, *Artois*			N. E. & N. O.	
Lille, *Flandre*		1. 10, 4.	S.	idem.
Dunkerque, *Flandre*			O. & S. O.	
Amsterdam, *Hollande*				
			Vents dominans.	*Température moyenne.*
			N. & N. E.	froide & humide.

Image Google Books

2:1:6 Pictorial Records

One must be careful when using contemporary illustrations, usually in the form of engravings, paintings, etchings, or drawings, as they may not present an accurate portrayal of the event in question. Most likely, they would have been drawn afterwards, by artists with varying degrees of competence and no doubt with a good deal of artistic licence; the artist may have put in what he imagined, what he thought his audience wanted to see, his own experiences of the event coloured through time, or he may have been working from hearsay evidence, with conflicting views from several different witnesses. But having said that, illustrations can certainly enliven a report, especially for those who are very unlikely to have witnessed the event in question.

There are two interesting sketches of Nýey in the Icelandic National Archives and Museum of Natural History, Reykjavík. The first, is a lively representation of the eruption that formed the island and is included at the end of an eyewitness report by Captain Mindelberg of the brig, Boesand, which he wrote to the Danish Government. He first saw a column of smoke on 1st of May, and entered his ship's log as follows:

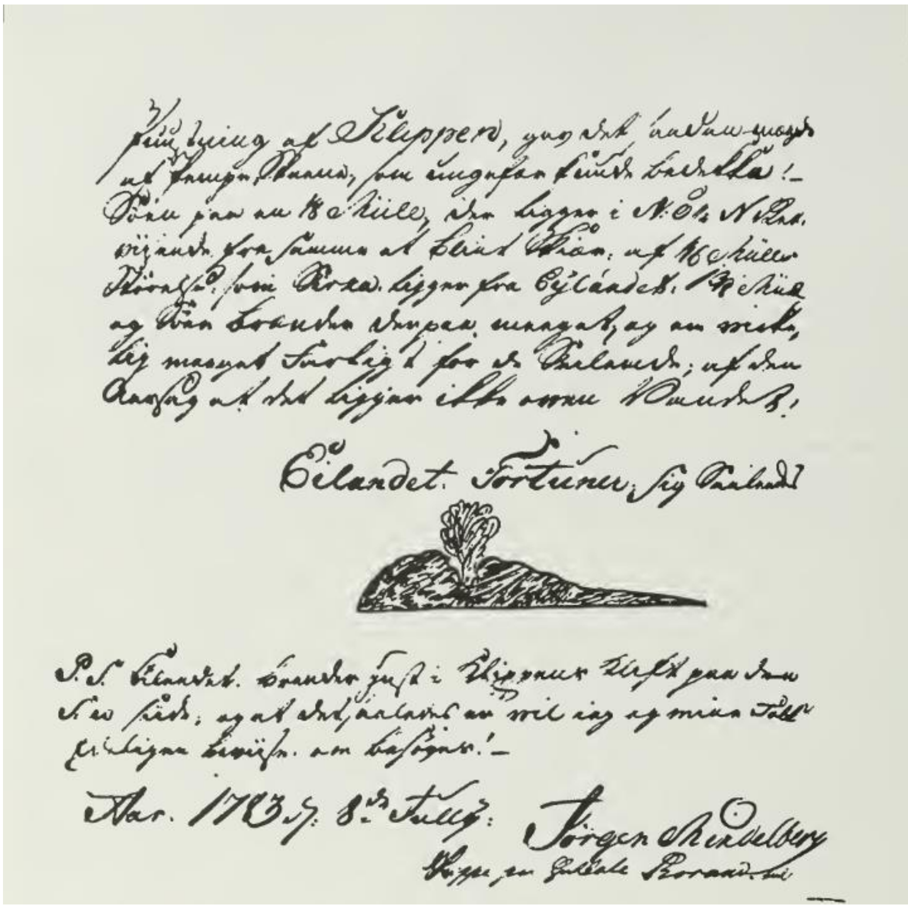
> At three o'clock in the morning we saw smoke rising from the sea and thought it to be land; but on closer consideration we concluded that this was a special wonder wrought by God and that a natural sea could burn…When I caught sight of this terrifying smoke I felt convinced that Doomsday had come.

On the 3rd of May the ship approached the smoke, but *"when we had come within half a mile of the island we had to turn away for fear that the crew might faint owing to the enormous stench."*[135]

[135] THORARINSSON, Sigurdur, *Surtsey : The New Island in the North Atlantic*, ed. EYSTEINSSON, Solvi (New York: Viking, 1967); WOOD, Charles A., 'Climatic Effects of the 1783 Laki Eruption'.

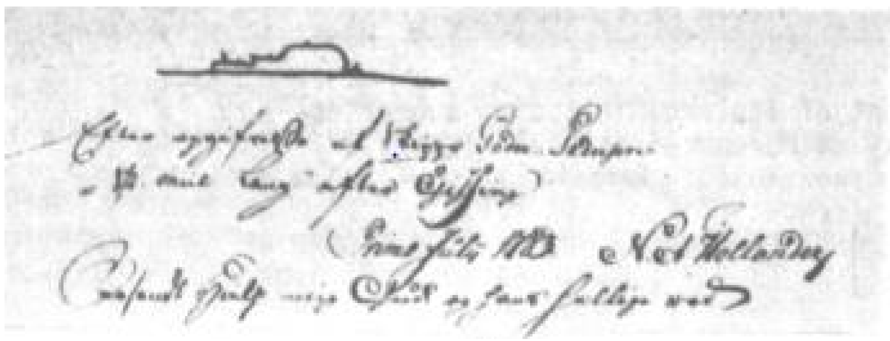
The first sketch, which was made by Mindelberg, shows what appears to be an island shaped rather like a whale with a long tail and a cavity in the middle of the body erupting a mass of smoke and flame. Pederson's sketch is far less graphic, is in outline only and shows no eruption taking place.

Figure 2:2 Captain Mindelberg's sketch of the new island of Nýey in the course of formation



National Archives of Iceland

Figure 2:3 Captain Pedersen's sketch of Nýey



National Archives of Iceland

Before the advent of photography, events were often depicted by prints or engravings, either appearing as illustrations in books, or by being sold separately. Some examples of these are illustrated below. The first (Fig. 2:4) is a copperplate engraving by Franz Erbam, of Ice during high water in the River Vltava in Prague from 27 – 28 February 1784; a view of the Charles‘ Bridge from the south, looking downstream, whilst the other (Fig. 2:5), by B. Winckler, is a coloured print of an idealised view of Charles' Bridge, also looking north, showing the devastation and panic on the east side of the river, caused by the February flood.

There are two other interesting illustrations regarding the European floods that were printed on the front covers of two booklets by Wilhelm Rothammer (Figs. 2:6 & 2:7). These were published in 1784 and describe the devastation caused by a huge quantity of ice on the River Danube at Regensburg, in south-east Germany. The first engraving is far more detailed than the second and shows the Stone *Bridge* (Steinerne Brücke) also known as the Dettlinger *Bridge* (Dettlinger Brucke) which had been severely damaged by the breaking up of the ice dam on 28th – 29th of February and the inundation to the surrounding land. Note the flooded houses with just their rooftops showing. The second engraving shows the same bridge without any apparent damage and drawn with far less detail.

Not only the European floods, but the Great Frost of 1784 provided interesting subjects for artists, see Fig. 2:8, the River Meuse and Fig. 2:9, the Tyne Bridge.

<u>2:1:7 Myths and Legends</u>

Much more questionable sources of information are the myths and legends passed down by word of mouth from one generation to another, and eventually find themselves in print. Such an example that seems to be based on fact is the Inuit legend concerning the Kauwerak people mentioned in Chapter 1, which appears to confirm that there was an extremely bitter winter in 1783-1784, in the extreme northwest of Alaska.

Figure 2:4 Ice on the River Vltava during the flood in Prague on 27th – 28th February 1784 showing and the Charles' Bridge when viewed from the south. Copperplate engraving by Franz Erbam

Photo: Prague Museum

Figure 2:5 Dégât arrive à Prague par la Moldau 1784. Coloured print by B.Winckler

Photo: **The Mariners' Museum and Park**

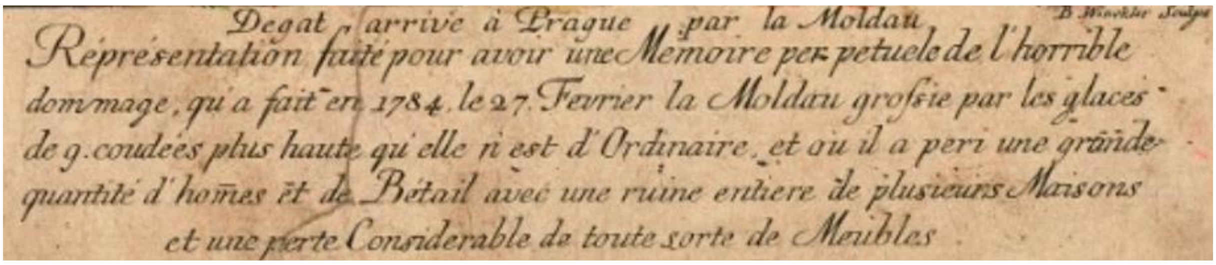
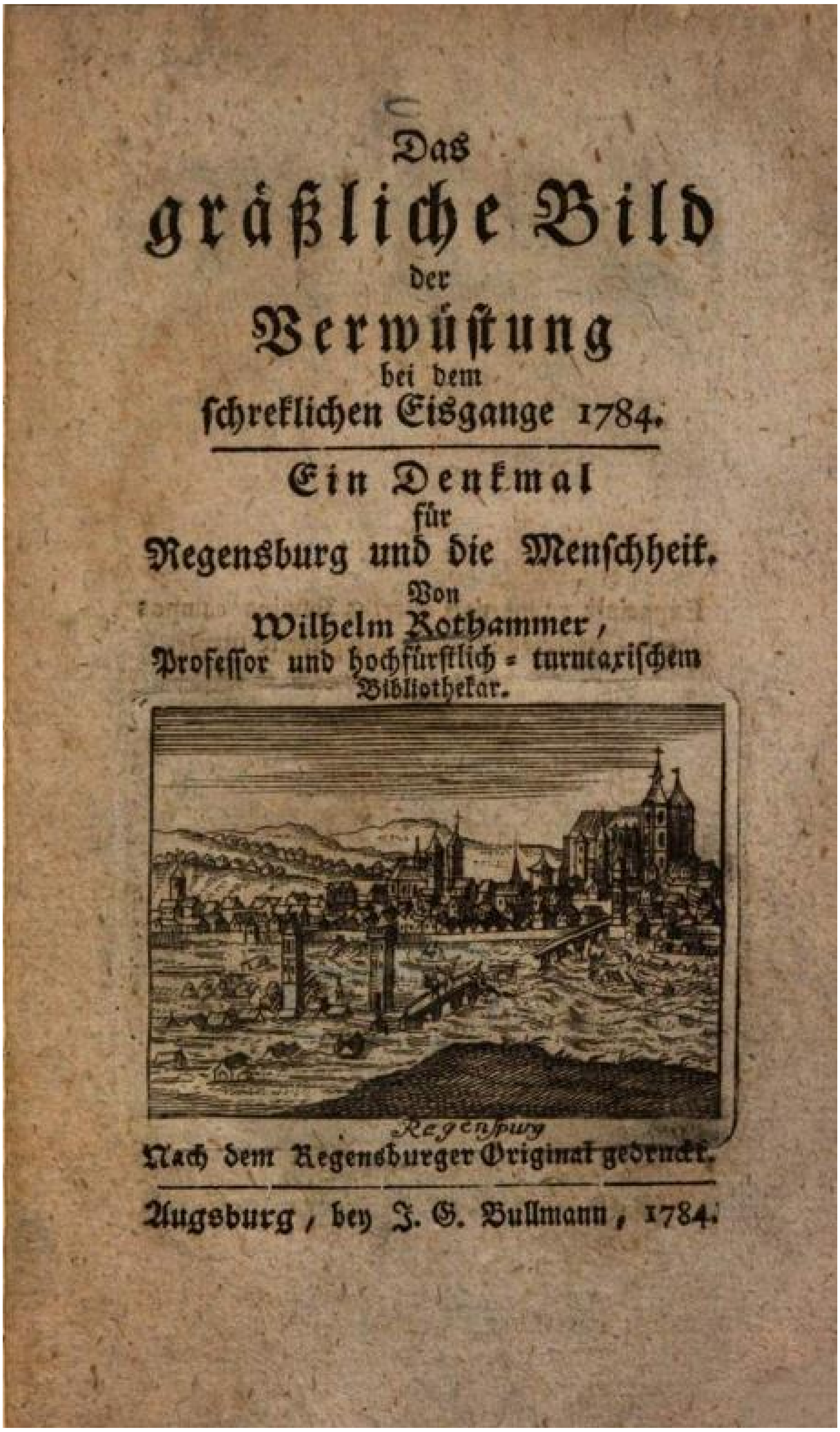


Figure 2:6 View of damage to the Steinerne Brücke, Ravensberg and inundation of nearby houses, 28th – 29th February 1784


Das
gräßliche Bild
der
Verwüstung
bei dem
schreklichen Eisgange 1784.

Ein Denkmal
für
Regensburg und die Menschheit.
Von
Wilhelm Rothammer,
Professor und hochfürstlich = turntaxischem
Bibliothekar.

Regenspurg

Nach dem Regensburger Original gedruckt.

Augsburg, bey J. G. Bullmann, 1784.

Bayerische StaatsBibliothek – europeana collections

Figure 2:7 Another view of damage to the Steinerne Brücke


Das
gräßliche Bild
der
Verwüstung
bei dem
schreklichen Eisgange
1784.

Ein
Denkmal der Leiden
für
Regensburg
und die
Menschheit.
zwote vermehrte Auflage.

Bayerische StaatsBibliothek – europeana collections

Figure 2:8 Ijsvermaak voor Rotterdam, ca. 1784. – A winter scene on the frozen Meuse at Rotterdam. Watercolour drawing by unknown artist

Rijksmuseum http://hdl.handle.net/10934/RM0001.COLLECT.242576

The winter scene portrayed in this picture is very appealing as it shows the hustle and bustle on the frozen River Meuse at Rotterdam. To the right is the old main gate, in the middle of the picture an ice-bound ship, and on the left a row of trees with a windmill in the distance. There are many groups of people on the ice, some skating and some in sledges being pushed by skaters. On the left is a horse-drawn ijsschuit or ice boat, carrying four persons, to the right, a horse-drawn sleigh with two people, and in the foreground a boy pulls a sled carrying a small child and possibly his mother carrying a kettle. In the background on the right, a group of five people are talking, and in a sky interspersed with cloud, a wedge of geese can be seen flying in a V formation.

Figure 2:9 The Tyne Bridge – The Great Frost, 1784. Watercolour by an Unknown Artist

Tyne & Wear Archives & Museums

This is a view of the new stone bridge over the River Tyne, which was completed in 1781, the previous bridge having collapsed in the disastrous floods of 1771. It shows the Tyne frozen from shore to shore with several boats trapped in the ice. Oddly enough, two of the boats appear to be in full sail, when in all probability their sails would have been furled. The scene is not nearly as lively as that on the River Meuse (Fig. 2:12) with just a few people venturing on the frozen river. There appear to be one or two skaters on the right, a man carrying a sack over his shoulders, and four children, one of whom seems to have fallen over. There are two women in the middle foreground, the one on the left is collecting something, possibly coal, from the shore and putting it in a wooden tub, whilst the other is standing up with a bowl tucked under her left arm. To the left a sailor gazes at the boats in the background.

2:1:8 Religious Sources

Published sermons and other acts of religious devotion can help us to understand the perceptions of the population in times of crisis and their responses to it. For example, the following was written in a report from Milan dated 29th of June, 1783: "On the 21st of this month, a solemn procession was held to ask Heaven for an ending of the extraordinary rains that have not stopped for approximately 5 weeks."[136] And according to the *Edinburgh Advertiser*, 15th of July, 1783, priests in France were accused of capitalising on the fears of the common people. The red sun and smoky atmosphere had, "*alarmed the superstitious part of the people, who had been wrought upon by their priests to believe that the end of the world was at hand*".[137] Parishioners near Broué, in northern France, dragged their priest out of bed and forced him to perform a rite of exorcism on the cloud.[138]

Meanwhile, in Hildburghausen, Thüringia Wald, in central Germany, there was great consternation because reports were circulating that one of the local volcanoes, the Gleichberg, had come to life. It appears the local population were so worried that:

> Public prayers were ordered in all churches. The inhabitants of the villages of the district run away because they fear that the Gleichberg will collapse, and the physicists pretend that a new fire-spitting mouth will be opened there. (*Supplément aux Nouvelles de divers Endroits, Bern, No. 59, 23rd July, 1783)*.[139]

[136] JOURNAL POLITIQUE ou GAZETTE des GAZETTES, 'Milan (le 29 Juin.)', *Journal Politique ou Gazette des Gazettes* Août, no. Premiere Quinzaine (1783): 26, https://books.google.fr/books?id=vsNFAAAAcAAJ&pg=PA1&source=gbs_selected_pages&cad=2#v=onepage&q&f=false.
[137] GRATTAN, John and BRAYSHAY, Mark, 'An Amazing and Portentous Summer: Environmental and Social Responses in Britain to the 1783 Eruption of an Iceland Volcano'.
[138] THE ECONOMIST, 'The Summer of Acid Rain', The Economist, 19 December 2007, http://webcache.googleusercontent.com/search?q=cache:C5qib5o1_ugJ:www.economist.com/node/10311405+&cd=10&hl=en&ct=clnk&gl=fr.
[139] DEMAREE, G. R. and OGILVIE, A. E. J., 'Bon Baisers d'Islande: Climatic, Environmental and Human Dimensions, Impacts of the Lakagigar Eruption (1783-1784) in Iceland.'

The Great Meteor of the 18th of August,1783, was a subject which featured in at least two sermons, and shows the fear or superstitious dread of the ministers preaching them. The first report is from the *Morning Post and Daily Advertiser, 21st of August*:

> A Methodist preacher, who saw the aerial phenomenon on Monday night last, described it the following evening in his sermon thus: I saw heaven open, and lo! A prodigy! A revelation! in flames, a huge beast with seven heads and ten horns: seven crowns and ten comets issued; and like a wounded whale, gasped in the vacuum for the period of one hour, till at last the great mystery suddenly fell! Michael prevailed, and hurled the dragon down head-long.[140]

The General Evening Post of 26th of August, reported that:

> A Methodist preacher in his sermon on Sunday, informed his audience, that the meteor seen a few evenings ago, and which went over their heads, was a warning gun, but they might rest assured that the next which came would not fly so high, but blow their brains out.[141]

The floods in Germany were also an opportunity not to be missed by the local priests, in order to bring their parishioners to heel. The floods were an example of the Lord's punishment. The priest, Heinrich Coenen, used this idea to expound some religious propaganda. He saw:

> The misery experienced by the people of Mülheim on the Rhine in the time of this flood not as a mere coincidence, or as an unavoidable natural event, but openly claimed that it was a deserved punishment for their

[140] PAYNE, Richard J., 'Meteors and Perceptions of Environmental Change in the Annus Mirabilis AD1783-4'.
[141] PAYNE, Richard J.

> sins. The Lord has punished them, but will cease to punish them if they live along the rules of the [Catholic] religion.[142]

Several other priests preached similar sermons, viz: Aloys Merz from Augsburg, Christian Wilhelm Demler from Jena and Johann Gottlob Hartmann from Eutzsch, a village in Wittenberg. Full references for these and for Heinrich Coenen can be found in Brazdil et al. 2009, as above.

It was reported that in Liège on the 2nd of March, 1784: “In order to thank Providence for such a distinguished favour [in saving the town of Liège], a solemn mass has been sung in all churches as thanksgiving.” In the same Journal, it was announced from Bruxelles that: “The high prices of food supplies and especially fish, caused by the severity of this long-lasting winter has forced the bishops everywhere to depart from the severity of the fast during Lent.”[143] (Easter Sunday was the 11th of April that year)

2:2 Academic Publications

Before discussing present day publications, it would seem appropriate to look at the differences between them and their 18th century forerunners, and the similarities they both share. The fundamental thing they have in common is the authors’ desire to communicate their findings to a wider audience. Today a huge number of journals are published where scientists can promulgate their research, but it was quite different in the late 18th century, as there were very few outlets where researchers could communicate their ideas. The two most prestigious journals being the “*Journal des Sçavans*”, from 1665-1792, and “*The Philosophical Transactions of the Royal Society*”, from 1665 onwards. They were joined in 1731 by the first fully peer-reviewed journal, “*Medical Essays and Observations*”, published by the Philosophical Society of Edinburgh and were followed - leaving medical journals aside - by the “*Transactions of the American Philosophical Society*” in 1771.

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142 BRAZDIL, Rudolf et al., ‘European Floods during the Winter 1783/1784: Scenarios of an Extreme Event during the Little Ice Age’.
143 JOURNAL HISTORIQUE ET LITTERAIRE, ‘Liége (le 2 Mars)’, *Journal Historique et Littéraire* 1784 (15 Mars1784): 451–53, https://babel.hathitrust.org/cgi/pt?id=hvd.hxiglu;view=1up;seq=427.

Whereas much of the research which is published today is peer-reviewed, this was not a normal occurrence during the 18th century, and if it were not printed in a reputable journal, how would it be communicated and commented upon? One way was by having pamphlets published which promoted the author's ideas. These in turn could generate more pamphlets which either agreed or disagreed with the author and quite a little pamphlet war could ensue between those who agreed and those who disagreed with the original premise. A prime example of this are the pamphlets published both for and against smallpox inoculation. See Appendix No 14. The following publication written by Dr. John Coakley Lettsom, is a typical, if rather verbose, illustration of this: *"An Answer to Baron Dimsdale's Review of Dr. Lettsom's Observations on the Baron's Remarks Respecting a Letter upon General Inoculation"*[144].

The Laki eruption and its impact can be viewed from several different perspectives, and it's good to see that academic debate is still being carried on in public much as it was in the 18th century, albeit in learned journals or over the internet. A case in point is the long-running debate over the exceptionally cold winter of 1783-1784. D'Arrigo et al. 2011, in their paper entitled, *"The anomalous winter of 1783-1784: Was the Laki eruption or an analog of the 2009-2010 winter to blame?"* were of the opinion that the Laki eruption had had no effect on the winter at all. They state that *"Evidence thus suggests that these winters were linked to the rare but natural occurrence of negative NAO and El Niño events."*[145] They were supported in this belief by Lanciki et al. 2012, who argued against any stratospheric impact from Laki beyond its initial effects.[146] However, the Lanciki paper was called into question by Schmidt et al. 2012.[147] This paper in its turn was commented on by Cole-Dai et al. 2014[148], which generated a

[144] LETTSOM, John Coakley, *An Answer to Baron Dimsdale's Review of Dr. Lettsom's Observations on the Baron's Remarks Respecting a Letter upon General Inoculation.* (London: C. Dilly; and H. Payne, 1779), https://books.google.fr/books?id=t_1ZAAAAcAAJ&pg=PA46&lpg=PA46&dq=thomas+dimsdale+dr.+lettsom&source=bl&ots=q7Fz8YVji8&sig=rXTItfFaGash0ElznmicpEvdSIw&hl=en&sa=X&ved=0ahUKEwj0ztjq0LPTAhWSK1AKHS7DDyMQ6AEINDAE#v=onepage&q=thomas%20dimsdale%20dr.%20lettsom&f=false.
[145] D'ARRIGO, Rosanne et al., 'The Anomalous Winter of 1783-1784: Was the Laki Eruption or an Analog of the 2009-2010 Winter to Blame?'
[146] LANCIKI, Alyson et al., 'Sulfur Isotope Evidence of Little or No Stratospheric Impact by the 1783 Laki Volcanic Eruption', *Geophysical Research Letters* 39, no. 1 L01806 (10 January 2012): 1–5, https://doi.org/10.1029/2011GL050075.
[147] SCHMIDT, Anja et al., 'Climatic Impact of the Long-Lasting 1783 Laki Eruption: Inapplicability of Mass-Independent Sulfur Isotopic Composition Measurements.'
[148] COLE-DAI, Jihong et al., 'Comment on "Climatic Impact of the Long-Lasting Laki Eruption: Inapplicability of Mass-Independent Sulfur Isotope Composition Measurements" by Schmidt et Al', *Journal of Geophysical Research: Atmospheres* 119 (12 June 2014): 6629–35, https://doi.org/10.1002/2013JD019869.

further reply by Schmidt et al. 2014 to this criticism.[149] Finally, in 2017, Zambri et al. concluded that the unusually cold winter of 1783-1784 in Europe, "*appears to have been due to the eruption, which forced a negative phase of the North Atlantic Oscillation in conjunction with a positive phase of the El Nino Southern Oscillation.*"[150]

The one great advantage that present-day authors have over their 18th century colleagues is the power of the internet. Apart from its use in gathering information, it allows for discussion and the dissemination of ideas. Journals which have appeared in print are also being published over the net, whilst others are published solely in this medium, and this will be happening more and more in the future. As Richard Fortey mused:

> Will journals in the old sense survive at all? It might well happen that visitors to the lines of (library) shelves with their runs of journals… will get fewer and fewer as internet access improves. If this happens one might wonder whether the next generation might lose contact with history itself, riding always on a few month's virtual journals, a gathering amnesia erasing the past as intellectual obsolescence creeps inexorably towards what was published the day before yesterday.[151]

Such is the pace of change.

2:3 Popular Literature

In the context of this thesis, the term "popular literature" is used to designate books, newspaper and journal articles, blogs etc. that are written for the general public, rather than a specialist audience. Although some popular articles regarding Laki may be

[149] SCHMIDT, Anja et al., 'Reply to Comment by Cole-Dai et al. on "Climatic Impact of the Long-Lasting Laki Eruption: Inapplicability of Mass-Independent Sulfur Isotope Composition Measurements"', *Journal of Geophysical Research: Atmospheres* 119 (12 May 2014): 6636–37, https://doi.org/10.1002/2013JD021440.
[150] ZAMBRI, Brian, ROBOCK, Alan, and SCHMIDT, Anja, 'Modeling Climate Impacts of the 1783-1784 Laki Eruption in Iceland', in *Pages Zaragoza 2017 5th Open Science Meeting 9-13 May. Abstract Book* (Zaragoza, Spain, 2017), 420, http://pastglobalchanges.org/osm2017/downloads/osm-abstract-book-zaragoza-2017.pdf.
[151] FORTEY, Richard, *Dry Store Room No. 1: The Secret Life of the Natural History Museum* (London, New York, Toronto, Sydney & New Delhi: Harper Perennial, 2008), 313.

written by experts working in that field, some are written by journalists or others who have little understanding of the subject and this in turn can lead to oversimplification or distortion of the facts. Perhaps the best introductions to Laki are a book called: *"Island on Fire"* by husband and wife team, Alexandra Witze and Jeff Kanipe and an article in The Economist called *"The summer of acid rain".* These not only explain the eruption and its aftermath in a clear and concise way, but *"Island of Fire"* also has chapters on Laki today, the different ways volcanoes can kill and what would happen if and when another huge eruption occurs.

A choice example of the sensational comes from the Mail on-line article entitled, *"And you thought THIS eruption was nasty! When an Icelandic volcano erupted in 1783, many feared it was the end of the world... ".* One or two quotes from the article which was written when Mt. Eyjafjallajokull was erupting in 2010, are prime examples of this style of writing:

> Before the year was out some 23,000 people would die of respiratory failure and related conditions in what was to become the greatest natural disaster to hit modern Britain.
>
> In some parts of eastern and central England entire families of farm workers (and it was typically the rural workers who toiled each day outdoors, breathing in great lungfuls of polluted air) were virtually wiped out.
>
> Towns and villages used to burying only a handful of people each season, suddenly had to deal with four times the usual number of deaths.
>
> As quickly as the grave- diggers could excavate the plots, men fell to fill them. Little wonder then that many assumed the apocalypse was fast approaching.[152]

[152] CHALMERS, Sarah, 'And You Thought THIS Eruption Was Nasty! When an Icelandic Volcano Erupted in 1783, Many Feared It Was the End of the World...', 24 April 2010, http://www.dailymail.co.uk/news/article-1268405/And-thought-THIS-eruption-nasty-When-Icelandic-volcano-erupted-1783-feared-end-world-.html#ixzz2obJJEtJB.

Serious journals and web pages can sometimes have articles with eye-catching titles. For example, on 18th of May, 2005, the New Scientist, a respected scientific journal, presented an excellent overview entitled: *"Blasts from the past: Europe's Year of Awe"*, whilst the BBC came up with: *"Volcano 'drove up UK death toll'"* in May, 2004, and *"When a killer cloud hit Britain"* in May, 2007.[153]

From the sensational we shall now move on to the lightweight. For example: *"Laki Volcano Eruption Iceland"* which appears on the contributor site, *globerove*. Unfortunately, although written for an audience who were probably just interested in the barebones of the eruption and not the detailed science underlying it, it suffers from an over-simplification of the facts, and also from presenting the conjecture that Laki may have "contributed significantly" as one of the causes of the French Revolution, as a proven fact. [154]

One of the problems with articles produced by newspapers either in print or on the internet is slack editing. This, of course, can lead to entirely the wrong impression being given, and the following example will serve to prove the point. In an article entitled, *"Volcanic ash cloud may have killed 10,000 UK people in 1783"*, there is one piece of information which is clearly incorrect and should have been noticed at the time. A quote from *"A Disastrous History of the World and other histories of disasters"* by John Withington, said: "*According to some recently advanced theories it reduced the world's existing population of about 1 million human beings to just 10,000 through the effects of cold and acid rain*."[155] This, of course, is completely irrational if it is meant to relate to the Laki eruption – there were around 40,000 people left alive in Iceland after the event – but these figures could relate to the super-eruption of Mt. Toba in Sumatra some 71,000 years ago.[156]

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[153] PAIN, Stephanie, 'Blasts from the Past: Europe's Year of Awe - Environment - 21 May 2005 - New Scientist', 21 May 2005, http://www.newscientist.com/article/mg18625002.400-blasts-from-the-past-europes-year-of-awe.html?page=1#.VQv9m-FFXOA; RINCON, Paul, 'BBC News: Volcano "Drove up UK Death Toll"', 25 May 2004, http://news.bbc.co.uk/2/hi/science/nature/3745749.stm; WALKER, Dan, 'BBC NEWS | Science/Nature | When a Killer Cloud Hit Britain', 19 January 2007, http://news.bbc.co.uk/2/hi/science/nature/6276291.stm.
[154] GLOBEROVER, 'Laki Volcano Eruption Iceland | Globerove', accessed 7 May 2015, http://globerove.com/Iceland/Laki-Volcano-Eruption-Iceland/529.
[155] MIRROR.CO.UK, 'Volcanic Ash Cloud May Have Killed 10,000 UK People in 1783', Mirror Group, 16 April 2010, http://www.mirror.co.uk/news/uk-news/volcanic-ash-cloud-may-have-killed-10000-215101.
[156] AMBROSE, Stanley H., 'Late Pleistocene Human Population Bottlenecks, Volcanic Winter, and Differentiation of Modern Humans', *Journal of Human Evolution* 34, no. 6 (1998): 623–51, https://doi.org/10.1006/jhev.1998.0219.

A completely different approach to the effects of Laki is that taken by Catherine Smith in her book, “The Stars of Robert Burns”, a study of the life of Scotland's National Bard, which has a chapter describing the influence Laki may have had over Burns’ life.[157] Two other authors echo the same theme, Kevin Williamson and Alec Ross on the heraldscotland.com and orkneynews.scot sites.[158]

Understandably, Laki is not a subject that immediately springs to mind when thinking about novels, but there are at least three which use the volcano as a backdrop. The first, “*L'Année du Volcan*”, is the 11th in the *“Enquiries of Nicolas le Foch*” series of detective novels by the French Author, Jean-François Parot, starring Nicolas Le Floch, the commissaire of police at the Châtelet. The background history behind this story has been well-researched. Briefly, the plot involves murder, intrigue and political machinations which lead inexorably to the French Revolution.[159]

The Gods of Laki is a fast-paced thriller by the American writer, Chris Angus, that is told from three different perspectives, each at a different point in time. The story starts in 940 A.D., when Runa, a 16-year old Viking girl, and a few companions who have fled their homeland, land on Iceland and find shelter in a cave on Laki. Moving forward to the present we meet Ryan Baldwin, a former secret service agent who now runs a geo-thermal company and has been hired by an American senator, Shelby Graham to protect his daughter, Samantha, who is a volcanologist working on Laki. Meanwhile, Samantha has upset a group of Iranians who have invested heavily in Iceland’s failing economy. The scene then moves back to 1940 when we meet Fritz Kraus, a German geology student studying at the University of Iceland, who becomes involved in a Nazi plot that may change the world forever.

[157] SMITH, Catherine, *The Stars of Robert Burns* (Glasgow: Masonic Publishing, 2009).
[158] WILLIAMSON, Kevin, ‘The Ploughman and the Volcano | Herald Scotland’, heraldscotland.com, 12 January 2014, http://www.heraldscotland.com/comment/columnists/the-ploughman-and-the-volcano.23137941; ROSS, Alec, ‘Robert Burns & the Laki Volcano of 1783’, The Orkney News, 6 March 2017, https://theorkneynews.scot/2017/03/06/robert-burns-the-laki-volcano-of-1783/.
[159] PAROT, Jean-François, *L’Année Du Volcan* (Paris: Jean-Claude Lattès, 2013).

The plot is fast and furious weaving a thread of science and fantasy with many twists and turns. The protagonists find themselves guided by an unseen intelligence, and eventually they come to realize that is Laki who has been in charge all along.[160]

The Devil's Breath is a murder mystery which uses the unusual events following the Laki eruption as a background to the novel's plot. The story has been well researched, and the author uses some little-known sources in order to add authenticity to the narrative.

As a mysterious poisonous fog rolls over the English countryside, bringing death and destruction in its wake, Dr Thomas Silkstone uses his considerable skills to investigate why so many are dying in Oxfordshire and beyond. Amid the chaos and confusion, however, Thomas soon discovers that the fog is not the only killer on the loose. As day merges into night, storms rage and meteorites tear across the sky, paranoia spreads like wildfire and many villagers believe the end of the world is nigh.[161]

During the years 1783 and 1784, William Cowper, an eighteenth-century poet, composed his masterpiece, *"The Time-Piece"*, a poem in six books. The second stanza of Book II, *"The Task"* alluded to a volcanic eruption, the appearance of an exceptional meteor on 18th of August, and the dry fog, whilst the third stanza, to the Sicilian earthquakes. A short extract from the second stanza is given below.[162]

[160] ANGUS, Chris, *The Gods of Laki: A Thriller* (New York: Yucca Publishing, 2015).
[161] HARRIS, Tessa, *The Devil's Breath*, Dr Thomas Silkstone Mysteries 3 (London: Constable, 2015).
[162] COWPER, William, 'The Task', in *The Time Piece*, vol. II, VI vols (Philadelphia: Bennett and Walton, 1811), 212, https://books.google.fr/books?id=1KIDAAAAQAAJ&pg=PA4&source=gbs_selected_pages&cad=2#v=onepage&q&f=false.

Fires from beneath, and meteors† from above,
Portentous, unexampled, unexplain'd,
Have kindled beacons in the skies ; and th' old
And crazy earth has had her shaking fits
More frequent, and forgone her usual rest.
Is it a time to wrangle, when the props
And pillars of our planet seem to fail,
And Nature‡ with a dim and sickly eye
To wait the close of all ? But grant her end

† *August 18, 1783.*
‡ *Alluding to the fog that covered both Europe and Asia during the whole summer of 1783*

Whilst Laki, in the popular imagination, has been blamed for a multitude of sins, no one has, until now, accused it for not allowing the production of whisky in France.

In an article appearing in the magazine, Télérama the Laki eruption has, surprisingly, been blamed for the interdicts of 1793 and later, and these effectively prohibited the development of the industry by forbidding the distillation of grain, as this was needed to feed the population.[163]

2:4 Conclusion

Apart from the Laki eruption, the year 1783 was noteworthy for the other natural disasters and the unusual weather phenomena that occurred. From Calabrian earthquakes which killed many thousands of people, to ferocious storms accompanied by ball lightning, extremely cold winters for the next two or three years, not only in Europe, but as far away as North America, and massive floods throughout Northern Europe, all these and many others were reported in contemporary records, perhaps the most important being the eyewitness accounts. However, just because an account has been written down proves nothing without verification, only that someone, somewhere, wrote something down on a piece of paper; proof of this is shown quite clearly by the varying accuracy of the accounts of the Laki eruption itself.

[163] ROCH, Jean-Baptiste, 'France, la soif du malt', *Télérama*, 22 November 2017, 32–40.

Then as now, newspapers were an important means of disseminating information, the only problem being the time it took to reach the reader. As we have seen from table 2:3, news of the eruption reached Copenhagen on 1st of September and finally arrived in Barcelona 54 days later, or some 138 days after the event.

Official reports, diaries, ships logs, weather logs and contemporary books written about a particular event are also important sources of information, and these may be considerably enhanced if backed up by contemporary illustrations. Of special interest are learned journals written at the time or soon after, which may have published detailed information not available elsewhere, for example, van Swinden's paper: "*Observations on the cloud (dry fog) which appeared in June 1783",* and the books written by Brugmans and Gilbert White.

We are on much safer ground with modern academic publications, which are often published in both paper and/or virtual formats. They have usually been peer-reviewed, unlike their 18th century counterparts; however, like their predecessors, they offer a platform for robust debate. The great advantage that authors of modern journals have is access to the internet and all the information that can be garnered in this way.

Although some popular literature that has been written for a non-specialist audience is written by experts in the field, much has been composed by journalists who have little or no knowledge of the subject. The information given can be incorrect, un-proven, over-simplified, sensationalised or suffer from bad editing, and as such, cannot solely be relied upon. There are, of course, notable exceptions, two of which have been previously mentioned, viz. *"Island on Fire"* by husband and wife team, Alexandra Witze and Jeff Kanipe and an article in The Economist entitled *"The summer of acid rain".*

Popular fiction is not a subject that crosses one's mind when discussing Laki, but at least three novels have been written using the volcano or its eruption as a backdrop, whilst the eruption, August 18th meteors, and the floods in Calabria, are mentioned in a contemporary poem by William Cowper.

Perhaps the last word in Laki literature should go to the Télérama article which blames Laki for the failure to produce Scotch whisky in France.

CHAPTER 3 – Design for Living

Before embarking on an investigation into the effects that the Laki eruption had on the health of the European population, it would seem appropriate to scrutinise the conditions under which people were living, the diseases they had to endure, and the competence of the medical profession.

In this chapter we shall look at the main carriers of infection and then discuss in detail some of the diseases which afflicted people living in the latter part of the 18th century. These may not necessarily have been fatal in themselves, but could have been exacerbated by living conditions, the weather, or other extraneous factors. In addition, we shall examine the incidence of maternal mortality in lying-in hospitals in both England and France, namely through the work of Heberden and Tennon and review the state of the medical profession in both of those countries during this period.

Unfortunately, we cannot be 100% certain as to the identity of the diseases which were then prevalent, as for the most part, descriptions were somewhat imprecise by modern standards. Diagnoses which were quite understandable at the time have little meaning for us today[1]. We shall see this later in the chapter when we look at the London Bills of Mortality. The only sure way we could be certain as to the identity of a particular malady would be to find some indisputable traces of the disease on the victims' bodily remains, either by alterations to the skeleton such as those produced by tuberculosis, leprosy and syphilis, or by DNA or lipid analysis.[2]

In addition, we shall examine the various health hazards that this volcanic eruption posed to the European populace as a whole.

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[1] COX, Margaret, *Life and Death in Spitalfields, 1700-1850*, vol. 21, CBA Occasional Papers (York: Council for British Archaeology, 1996), 73–74, http://archaeologydataservice.ac.uk/archiveDS/archiveDownload?t=arch-284-1/dissemination/pdf/cba_op_021.pdf.

[2] Roberts, Charlotte, 'The Archaeology of Disease Documented in Skeletons', Gresham College, 26 October 2015, http://www.gresham.ac.uk/lectures-and-events/the-archaeology-of-disease-documented-in-skeletons; CONNELL, Brian et al., *A Bioarchaeological Study of Medieval Burials on the Site of St Mary S991-2007pital: Excavations at Spitalfields Market, London E1,* vol. 60, MOLA Monographs 60 (London: Museum of London Archaeology, 2012), 109–31; Thompson, Andrew, 'Malaria and the Fall of Rome', BBC History, 17 February 2011, http://www.bbc.co.uk/history/ancient/romans/malaria_01.shtml; Brothwell, Don, *Digging up Bones*, 1st ed. (London: Trustees of the British Museum, 1963), 136–39.

3:1 Living Conditions

Living conditions must have been, by present-day standards, squalid in the extreme. Without the benefit of modern plumbing, cleanliness and sanitation were almost non-existent. It was not only among the poor that this insanitary state existed. Dr. Samuel Johnson, for example, when talking about his friend, the poet, Kit Smart, remarked: "*Another charge was that he did not love clean linen; and I have no passion for it*."[3] James Boswell, Johnson's biographer , and a member of the Scottish landed gentry, washed so seldom, that his odour was infamous.[4]

3:1:1 Housing

The growth of cities and towns during the 1700s placed enormous pressures on the availability of cheap housing. With many people coming to towns to find work, slum areas grew quickly. Living conditions in many towns consequently became unimaginable. Many families were forced to live in single rooms in ramshackle tenements or in damp cellars, with no sanitation or fresh air.[5]

John Aikin, commenting in 1795, had this to say about the rapidly growing mill town of Manchester:

> In some parts of the town, cellars are so damp as to be unfit for habitations […] I have known several industrious families lost to the community, by a short residence in damp cellars [...]The poor often suffer much from the shattered state of cellar windows. This is a trifling circumstance in appearance, but the consequences to the inhabitants are of the most serious kind. Fevers are among the most usual effects; and I have often known consumptions which could be traced to this cause. Inveterate

[3] BOSWELL, James, *The Life of Samuel Johnson, LL.D. : Comprehending an Account of His Studies and Numerous Works, in Chronological Order ; a Series of His Epistolary Correspondence and Conversations with Many Eminent Persons ; and Various Original Pieces of His Composition, Never before Published ; the Whole Exhibiting a View of Literature and Literary Men in Great Britain, for Nearly Half a Century during Which He Flourished.*, vol. 1 (London: Charles Dilley, 1791), 214.
[4] ASHENBURG, Katherine, *The Dirt on Clean: An Unsanitized History* (New York: North Point Press, 2007), 127.
[5] WHITE, Matthew, 'Health, Hygiene and the Rise of "Mother Gin" in the 18th Century - See More at: Http://Www.Bl.Uk/Georgian-Britain/Articles/Health-Hygiene-and-the-Rise-of-Mother-Gin-in-the-18th-Century#sthash.JESwlgqJ.Dpuf', *British Library: Georgian Britain*, accessed 21 July 2015, http://www.bl.uk/georgian-britain/articles/health-hygiene-and-the-rise-of-mother-gin-in-the-18th-century.

rheumatic complaints, which disable the sufferer from every kind of employment, are often produced in the same manner [...] I am persuaded, that mischief frequently arises, from a practice common in many narrow back streets, of leaving the vaults of the privies open. I have often observed, that fevers prevail most in houses exposed to the effluvia of dunghills in such situations.[6]

Until the advent of the railways in the first half of the nineteenth century which allowed for the easy transportation of building materials throughout the country, buildings were usually constructed from locally available materials, such as, mud, wood, stone or brick, and roofed in likewise easily obtainable products, such as thatch.[7]

Generally, the one thing these buildings had in common, was lack of deep drainage, running water, damp proof courses, stone floors and cavity walls. The deficiency of not having deep drainage will be discussed below, and the lack of running water meant that the majority of the population had to get their drinking water from local wells, rivers, or from the parish pump. This was a wholly unsatisfactory state of affairs because the water supply could easily become contaminated, and this is, indeed, what caused the cholera outbreak in London during the following century.[8]

Earthen instead of stone floors, the lack of damp proof courses and no cavity walls meant that the majority of houses suffered from penetrating and rising damp, which must have contributed in no small matter to the general debility of the population.[9]

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[6] AIKIN, John, *A Description of the Country from Thirty to Forty Miles Round Manchester* (London: John Stockdale, 1795), 193, https://books.google.fr/books?id=euZWAAAAcAAJ&pg=PA193&lpg=PA193&dq=in+some+parts+of+the+town,+cellars+are+so+damp&source=bl&ots=VFrJkxm7PM&sig=aJJObwwwZg-7DJomtga1MARmRQg&hl=en&sa=X&ved=0ahUKEwif-P_Vlp7XAhVDuRoKHYTuDHkQ6AEIJjAA#v=onepage&q=in%20some%20parts%20of%20the%20town%2C%20cellars%20are%20so%20damp&f=false.

[7] PRIZEMAN, John, *Your House: The Outside View*, Blue Circle Book (London: Hutchhinson, 1975), 42–95; JOHNSON, Matthew H., *English Houses 1300-1800: Vernacular Architecture, Social Life* (Harlow, New York: Longman, Pearson Longman, 2010), 20–21.

[8] CARMICHAEL, Ann G, ‘Cholera: Pandemic Pestilence’, in *Plague, Pox & Pestilence: Disease in History*, 1st ed. (London: Weidenfield and Nicolson, 1997), 144–45; SNOW, Stephanie J., ‘Commentary: Sutherland, Snow and Water: The Transmission of Cholera in the Nineteenth Century’, *International Journal of Epidemiology* 31, no. 5 (2002): 904–11, https://doi.org/:10.1093/ije/31.5.908.

[9] RAZZELL, Peter, ‘The Growth of Population in Eighteenth-Century England: A Critical Reappraisal’, *The Journal of Economic History* 53, no. 4 (December 1993): 766–69.

3:1:2 Grotty, Smelly, Smoky

A traveller approaching a large town would be aware of his imminent arrival by the all-pervading smell. Piles of rubbish and sewage would be dumped outside the town limits by night-soil men with no pretence of hygienic disposal. Once inside the town, the streets and ditches were awash with human excrement and urine, which was either thrown out of upstairs windows, much to the discomfort of passers-by, or deposited into the streets at night. Animals travelling to and fro between market, farm, and slaughterhouse, left their ordure to mingle with the human excrement and ever-present mud. Dead animals were left to putrefy where they lay, or thrown into nearby rivers and ditches, whilst slaughterhouses contributed their share of offal and other animal remains. A special problem for Londoners was the "poor holes'' which were large, deep, open pits used for the burial of the poor, often situated close to houses or businesses. These were only covered over with earth when full. Water from overflowing burial vaults flowed into cellars, and cesspits leaked into wells and contaminated the water supply.[10] The following article from The Morning Chronicle of 9th February 1778 sheds some light on the situation at the time. See Fig. 3:1.

London, however, was not alone in suffering the consequences of inadequate burial space for the dead. The cemetery of Les Innocents in Paris had been in constant use since at least the 12th century, and a source of worry and complaint from the mid-16th century.[11] The overcrowding had become so bad by the beginning of the 14th century that charniers, long arched galleries, had been built around the cemetery in order to store bones that had been exhumed from earlier burials, thus making room for more bodies.[12] See figure 3:2. Whilst this may have been a partially effective measure, it proved inadequate and conditions got so bad that large pits were dug about 25-30 pieds (8-10 metres) deep, which held up to 1500 bodies. One of the gravediggers said that he had buried 90,000 bodies in a period of less than 30 years. This equates to

[10] WALLER, Maureen, *1700: Scenes from London Life*, 1st ed. (London: Hodder & Stoughton, 2001), 95; STONE, Lawrence, *The Family, Sex and Marriage in England, 1500-1800*, Reprint (London: Weidenfield and Nicolson, 1977), 77–79.
[11] THOURET, Michel-Augustin, *Rapport Sur Les Exhumations : Du Cimetière et de l'église Des Saints. Innocents; Lu Dans La Séance de La Societe Royale de Médecine, Tenue Au Louvre Le 3 Mars 1789* (Paris: Ph-Denys Pierres, 1789), http://gallica.bnf.fr/ark:/12148/bpt6k6466946s/f16.image.
[12] DUFOUR, Valentin, 'Une étude sur le cimetière, le charnier et la fresque peinte en 1425.', in *La Danse macabre des SS. Innocents de Paris d'après l'édition de 1484 précédée d'une étude sur le cimetière, le charnier et la fresque peinte en 1425*, Collection de documents rares ou inédits relatifs à l'histoire de Paris (Paris: Léon Willem, Paul Daffis, 1874), 54, http://gallica.bnf.fr/ark:/12148/bpt6k6417409q/f7.item.r=cave.

Figure 3:1 Interment of the Poor

One of the great ſources of putrid diſorders, in this metropolis, is the little attention paid to the interment of the poor. In ſome burial grounds, near the centre of this city, the graves, or pits, for the reception of the lower ſort of people, are made ſufficiently wide to contain four, five, or ſix wooden coffins abreaſt, and deep enough to hold twice as many in depth: theſe pits, after each burial, are covered with a few looſe boards and a little mould to keep the coffin from common view; but they are never covered up till the whole complement of corpſes has been interred. When this is done, a ſecond grave is opened upon the ſame plan, cloſe to the firſt, leaving the ſides of the former coffins ſtill expoſed; by which means theſe wholeſale receptacles of the dead become ſo offenſive, as frequently to oblige the Miniſters and others, upon funeral duty, to ſtand at a conſiderable diſtance, to avoid the horrid ſtench ariſing from them. Barely to mention the exiſtence of a nuſance of this kind, is ſufficient to ſhock every man of reflection and humanity; and the teſtimonies of numerous writers confirm the inſalubrity of ſuch a practice, which may, in a city like this, produce the moſt fatal conſequences.

The Morning Chronicle 9th February 1778[13]

some 2,100,000 burials over the 700-year period that the cemetery was open.[14] The insalubrity of the place was extremely bad, "*le sol du cimetière exhait des odeurs méphistiques*"[15], but nothing was done to remedy the situation. An investigation by the

[13] THE MORNING CHRONICLE, 'Interment of the Poor', *The Morning Chronicle*, 9 February 1778, https://www.bl.uk/collection-items/article-about-the-burial-of-the-dead-in-london-from-the-morning-chronicle.
[14] THOURET, Michel-Augustin, *Rapport Sur Les Exhumations : Du Cimetière et de l'église Des Saints. Innocents; Lu Dans La Séance de La Societe Royale de Médecine, Tenue Au Louvre Le 3 Mars 1789*, 7; DUFOUR, Valentin, 'Une étude sur le cimetière, le charnier et la fresque peinte en 1425.', 33–34.
[15] DUFOUR, Valentin, 'Une étude sur le cimetière, le charnier et la fresque peinte en 1425.', 18.

court of Louis XV in 1763 recorded local stories of meat that rotted before one's eyes, a perfumery unable to sell its wares because of the overpowering stench of the cemetery, tapestry merchants whose wares changed colour if exposed for long periods of time in Les Halles, and wine merchants whose barrels yielded only vinegar if they stayed in the cellar too long. Owing to the obduracy of the clergy, still nothing was done until February 1780, when the weight of soil collapsed a cellar wall belonging to a house in the rue de Lingerie, spilling a noxious mass of soil and putrefying bodies into the basement. The cemetery was at last closed by an edict on 4th September that year.[16]

Some hundred years earlier, John Evelyn had this to say about conditions in London:

> … I am perswaded, that the frequency of Church-yards , and Charnel-Houses contamminate the Aer, in many parts of this Town, as well as the Pumps and Waters, which are any thing near unto them, so that those Pipes and Conveyances which passe through them (obnoxious to many dangerous accidents) ought either to be directed some other way, or very carefully to be looked after.[17]

Madrid was certainly no better. Baretti describes his reactions when entering the city having crossed the Manzanares river:

> But it is impossible to tell how I was shock'd at the horrible stink that seized me the instant I trusted myself within that gate! So offensive a sensation is not to be described. I felt a heat all about me, which was caused by the fetid vapours exhaling from numberless heaps of filth lying all about.[18]

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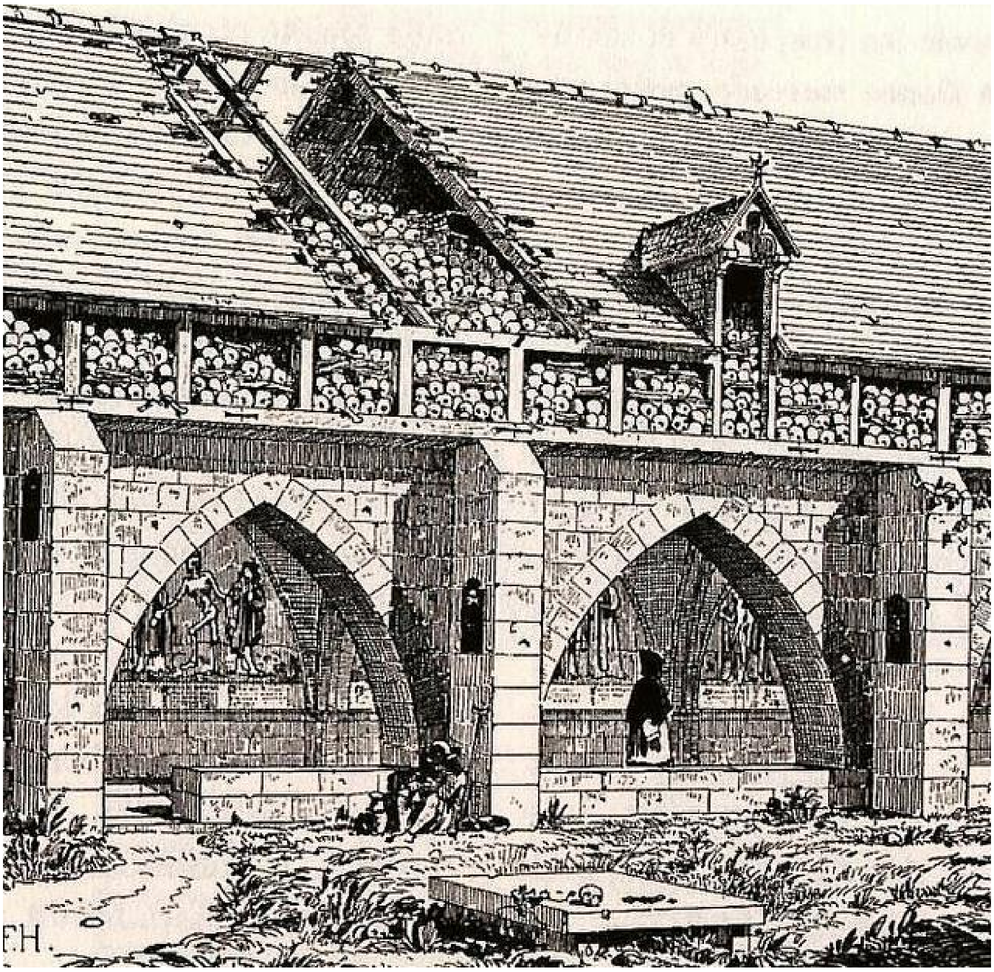
[16] SCHOMBURG, Josef M., 'Les Innocents', Paris Promenades, undated, https://www.paris-promenades.com/en/site_text/III.htm.
[17] EVELYN, John, *Fumifugium or the Inconvenience of the Aer and Smoak of London Dissipated. Together with Some Remedies Humbly Proposed by J.E. Esq; to His Sacred Majestie and Parliament Now Assembled* (London: Printed by W. Godbid for Gabriel Bedel, and Thomas Collins, 1661), 21.
[18] BARETTI, Joseph, *A Journey from London to Genoa, through England, Portugal, Spain and France*, vol. 2 (London: T. Davies and L. Davis, 1770), 255–56, https://ia902205.us.archive.org/12/items/journeyfromlondo02bareiala/journeyfromlondo02bareiala.pdf.

Figure 3:2 Charniers at the cemetery de l'église des Saints Innocents, Paris



Charniers at the Holy Innocents Cemetery/ Wikipedia- Public Domain

He goes on to say: *"I cannot as yet tell you anything of Madrid, but it stinks like a Cloaca Maxima."*[19]

Charles Burney was not overly impressed by the town of Cambrai:

> "At Cambray one of the most pleasantly situated of all I passed thro', this is true to a supreme degree, the houses and people being so dirty as to strike the inhabitants of the neighbouring towns with wonder."[20]

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[19] BARETTI, Joseph, 2:256.
[20] BURNEY, Charles, *Music, Men and Manners in France and Italy, 1770 : Being the Journal Written by Charles Burney during a Tour through Those Countries Undertaken to Collect Material for a General History of Music / Transcribed from the Original Manuscript in the British Museum, Additional Manuscript 35122, and Edited with an Introduction by H. Edmund Poole.* (London: Eulenburg Books, 1974), 7; VARDI, Liana, *The Land and the Loom : Peasants and Profit in Northern France, 1680-1800*

Buchan, whose "Domestic Medicine" was published in 1790 agreed with this sentiment:

> The peasants of most countries seem to hold cleanliness in a sort of contempt. Were it not for the open situation of their houses, they would often feel the bad effects of this disposition. One seldom sees a farm-house without a dunghill before the door, and frequently the cattle and their masters lodge under the same roof. Peasants are likewise extremely careless with respect to change of apparel, keeping their houses etc. clean.[21]

If we look at two other examples, we see that until the 1760s, the majority of houses in Edinburgh had no latrines, and as soon as St. Giles' clock struck 10.00 p.m. everyone, with the cry of 'Gardyloo', emptied the day's excrements out of the close-stools and chamber pots into the street where they lay until cleared up early the following morning.[22]

In Sheffield in the 1770s, channels which filled up with garbage and excrement, ran down the centre of every street, while pigs wandered around and acted as scavengers. Every three months the sluice gates of the Barker Pool above the town were opened, and the streets flooded with water for a proper cleansing.[23]

(Durham, NC: Duke University Press, 1993), 19–20, https://babel.hathitrust.org/cgi/pt/search?q1=burney&id=uc1.b4353392&view=1up&seq=7.

[21] BUCHAN, William, *Domestic Medicine: Or, a Treatise on the Prevention and Cure of Diseases by Regimen and Simple Medicines. With an Appendix Containing a Dispensatory for the Use of Private Practitioners*, 11th ed. (London and Edinburgh: A. Strahan and T. Cadell (London), J. Balfour, and W. Creech (Edinburgh), 1790), 102, https://ia802604.us.archive.org/31/items/domesticmedicin00buchgoog/domesticmedicin00buchgoog.pdf.

[22] DEFOE, Daniel, *A Tour through the Whole Island of Great Britain : Divided into Circuits or Journies ... Interspersed with Useful Observations : Particularly Fitted for the Perusal of Such as Desire to Travel over the Island / Originally Begun by the Celebrated Daniel De Foe, Continued by the Late Mr. Richardson, Author of Clarissa, and Brought down to the Present Time by a Gentleman of Eminence in the Literary World.*, 7th ed., vol. 1 (London, 1769), 87; GRANT, James, *Cassell's Old and New Edinburgh*, vol. 2 (London, Paris & New York: Cassell, Petter, Galpin & Co., 1881), 193, http://www.oldandnewedinburgh.co.uk/; LAING, David, 'Proposals for Cleaning and Lighting the City of Edinburgh in the Year 1735 with Explanatory Remarks', *Proceedings of the Society of Antiquaries of Scotland* 3 (1859 1857): 177, http://archaeologydataservice.ac.uk/archives/view/psas/contents.cfm?vol=3&CFID=57910&CFTOKEN=D9996585-698D-4BDE-B68660EE4581E760; BROTHERSTON, John H.F, *Observations on the Early Public Health Movement in Scotland* (London: H.K. Lewis, 1952), 79.

[23] LEADER, Robert Eadon, *Sheffield in the Eighteenth Century*, 1st ed. (Sheffield: The Sheffield Independent Press, 1901), 156–57, https://ia801409.us.archive.org/20/items/sheffieldineigh00leadgoog/sheffieldineigh00leadgoog.pdf; ROBERTS, Samuel, *Autobiography and Select Remains of the Late Samuel Roberts* (London: Loàngman, Brown, Green & Longmans, 1849), 21–22, https://ia902701.us.archive.org/28/items/autobiographysel00robe/autobiographysel00robe.pdf.

The following report, by the Conseil d'hygiène publique et de salubrité. Séance du 9 mai 1859. Canton de Clary', agreed with earlier assessments:

> The cause of ill-health can be traced to the filth of the inhabitants who pile refuse around their houses or on the public roads, to the cesspools and ponds which are never cleaned out, and the proximity of the cemetery, located in the heart of the parish. The workers' houses lie close together, the floor is below-ground, the windows small, the beds gathered in a single room often contain a number of persons of both sexes. This promiscuity, which is so very improper, impairs the children's health and explains the incidence of scrofulous diseases and epidemics.[24]

Birch in his *Medical History of Hastings* has written:

> While most people washed their faces every day many did not wash their bodies from year to year. Baths were rarely taken for water was a precious commodity. Lack of skin cleanliness and dental hygiene made body odour unpleasant. Ladies used to wear sachets of sweet-smelling herbs in their armpits to make less noticeable the smell of their bodies. Disease was regarded as being due to filth and smell. It was hard to keep houses clean. Floors remained unswept for it was advised that the filth be left to lie. 'The more dirt is moved the worse it stinketh.' […] Vermin thrived. Many people had to contend with lice and fleas in their clothing and hair."[25]

M. Déjean wrote in his *Traité des odeurs* that "*Everyone has their own rule for baths: some take one every eight days, others every fortnight, others once a month, and*

[24] Archives départemental du Nord, M 264/2 quoted in VARDI, Liana, *The Land and the Loom : Peasants and Profit in Northern France, 1680-1800*, 20.
[25] BIRCH, C. Allan, 'The Medical History of Hastings' (Typescript, Undated), 8–9, East Sussex Record Office.

several every year for eight or ten days in succession, when the weather is most suitable."[26]

It is no wonder that in such conditions, outbreaks of bacterial stomach infections were the norm, and these could be so severe as to kill their victims within the space of a few days.[27]

Apart from the bad smells and contamination of the water supply, dwellers in large towns and London in particular, had to put up with choking, sulphurous coal smoke which was given off by thousands of domestic fires, as well as from various industrial processes operated by such people as dyers, brewers, lime-burners and soap-boilers.[28]

Evelyn, commenting about the bad air and its detrimental effects, said:

> For is there under Heaven such Coughing and Snuffing to be heard, as in the London Churches and Assem(b)lies of People, where the Barking and Spitting is incessant and most importunate.[29]

> […] the inhabitants of London, and such as frequent it, find it in all their Expectorations; the Spittle, and other excrements which proceed from them, being for the most part of a blackish fuliginous Colour.[30]

> The Consequences then of all this is, that (as was said) almost one half of them who perish in London, dye of Phthisical and Pulmonic distempers; That the Inhabitants are never free from Coughs and

[26] DEJEAN, M, *Traité Des Odeurs : Suite Du Traité de La Distillation* (Paris: Chez Veuve Savoye, 1777), 467, https://books.google.fr/books?id=PBtdAAAAcAAJ&pg=PA2&source=gbs_toc_r&cad=3#v=onepage&q&f=false.
[27] STONE, Lawrence, *The Family, Sex and Marriage in England, 1500-1800*, 77–79.
[28] WALLER, Maureen, *1700: Scenes from London Life*, 96.
[29] EVELYN, John, *Fumifugium or the Inconvenience of the Aer and Smoak of London Dissipated. Together with Some Remedies Humbly Proposed by J.E. Esq; to His Sacred Majestie and Parliament Now Assembled*, 10.
[30] EVELYN, John, 12.

> importunate Rheumatisms, spitting of Impostumated and corrupt matter: for remedy whereof, there is none so infallible, as that, in time, the Patient change his Aer and remove into the Country.[31]

Just over 100 years later, Georg Lichtenberg, on a visit from Germany in 1775, wrote a letter to a friend in which he said that the street outside was *"enveloped in so thick a cloud of coal smoke*" that he was *"writing by the light of a candle (at half past ten in the morning)*".[32]

3:2 Food

Research suggests that the average level of nutrition was low and that a substantial proportion of the population subsisted on diets which fall significantly below the standards recommended by modern-day nutritional experts. In other words, the food consumed during this period was “a modern dietician’s nightmare”.[33]

The rich ate a bulky though unbalanced diet. There was a high intake of protein but few vegetables, as these were thought to cause melancholy and flatulence, and little fruit, white meats, milk, whey, butter, eggs, and cheese. Thus, many of the more affluent in society ran the risk of Vitamin A, C & D deficiency.[34]However, for those who could afford it, there was a great variety of food-stuffs available. The French traveller, Henri de Valbourg Misson when writing in his memoirs agreed with this:

> The *English* eat a great deal at Dinner; they rest a while, and to it again, till they have quite stuff’d their Paunch. Their Supper is moderate: Gluttons at Noon, and abstinent at Night. I always heard they were great Flesh-eaters, and I found it true. I have known several People in *England*

[31] EVELYN, John, 13.
[32] COCKAYNE, Emily, *Hubbub, Filth, Noise & Stench in England 1600-1770* (New Haven and London: Yale University Press, 2007), 146 quoting Mare, Margaret L. and Quarrell, W.H. (eds. and trans.), Lichtenberg’s Visits to England as described in his Letters and Diaries (New York, London: B.Blom, p. 111).
[33] SHARPE, J. A., *Early Modern England: A Social History 1550-1760*, 2nd ed. (London: Hodder Arnold, 1997), 49; HARRIS, Bernard, ‘Public Health, Nutrition and the Decline of Mortality: The McKeown Thesis Revisited’, *Social History of Medicine* 27, no. 4 (December 2004): 14, https://doi.org/10.1093/shm/17.3.379.
[34] SHARPE, J. A., *Early Modern England: A Social History 1550-1760*, 49.

that never eat any Bread, and universally they eat very little: They nibble a few Crumbs, while they chew the Meat by whole Mouthfuls. Generally speaking, the English Tables are not delicately serv'd. There are some Noblemen that have both *French* and *English* Cooks, and these eat much after the *French* Manner: But among the middling Sort of People, they have ten or twelve Sorts of common Meats, which infallibly take their Turns at their Tables, and two Dishes are their Dinners; a Pudding, for instance, and a piece of roast Beef: Another time they will have a Piece of boil'd Beef, and then they salt it some Days beforehand, and besiege it with five or six Heaps of Cabbage, Carrots, Turnips, or some other Herbs or Roots, well pepper'd and salted, and swimming in Butter: A Leg of roast or boil'd Mutton, dish'd up with the same Dainties, Fowls, Pigs, Ox-tripes, and Tongues, Rabbits, Pigeons, all well moisten'd with Butter, without larding: Two of these Dishes, always serv'd up one after the other, make the usual Dinner of a substantial Gentleman, or wealthy Citizen.[35] See Appendix 2 for Smollett's experiences of Italian and French food.

Hannah Glasse, who wrote one of the century's most popular cookery books, '*The Art of Cookery Made Plain and Easy'*, lists more than 160 different ingredients which were organized according to the months in which they were in season.[36] As an example of the kind of food that one could eat at a well-stocked hostelry, if one could afford it, see Figure 3:3, a bill of fare at the Bush Tavern, Bristol, for Christmas 1790. Not all inns were as well provided as this, however, as the following damning report made by Charles Burney when visiting Saint-Omar, makes clear:

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[35] MISSON, Henri de Valbourg, *M. Misson's Memoirs and Observations in His Travels over England with Some Account of Scotland and Ireland*, trans. OZELL Mr. (London: D. Browne, A. Bell, J. Darby, A. Bettesworth, J. Pemberton, G. Rivington, J. Hooke, R. Cruttenden, T. Cox, J. Batley, F. Clay, and E. Symon, 1719), 313–14, https://ia601407.us.archive.org/1/items/mmissonsmemoirs00ozelgoog/mmissonsmemoirs00ozelgoog.pdf.

[36] GLASSE, Hannah, *The Art of Cookery, Made Plain and Easy : Which Far Exceeds Anything of the Kind yet Published, ... To Which Are Added, One Hundred and Fifty New and Useful Receipts, and a Copious Index. By a Lady.*, New (London: L. Wangford, 1775), 252–54, https://ia800205.us.archive.org/5/items/TheArtOfCookery/The_Art_of_Cookery.pdf; OLSEN, Kirstin, *Daily Life in 18th-Century England*, 1st ed., Daily Life Through History (Westport, Connecticut; London: Greenwood Press, 1999), 232–42, https://books.google.fr/books?id=o_hwrAoqxmQC&pg=PA242&lpg=PA242&dq=diet+18th+century&source=bl&ots=LkMfDZ8IDR&sig=FDfm_R7Dqc5-8XDgp91Qxpk_BTM&hl=en&sa=X&ved=0ahUKEwjsu52fpfrVAhWLfRoKHYpMCRE4ChDoAQg3MAM#v=onepage&q=diet%2018th%20century&f=false.

"I was forced to put up at a miserable house in the suburbs, where I could get nothing to eat after my sea-sickness and total depletion, but stinking maquerel; a salad with stinking oil; and an omlet made of stinking eggs."[37]

Not only was the food eaten by the poor, meagre and monotonous, but it accounted for most of the family's budget. In England, at least, approximately two thirds of the income would be spent on food and drink, and the rest used for rent, clothing, fuel and boots.[38]The common people could afford little meat and the bulk of their diet consisted of coarse quality brown bread made from rye or barley, whilst white bread made from wheat, although more expensive, became popular, and the spread of potatoes improved nutrition. Fruit and vegetables were eaten when in season and pulses and greens became more common.[39]Although boring when compared to the food eaten by the middle classes, it would have provided the bulk of calories needed by a manual worker. It has been calculated that the average daily protein intake of the poorest 20% of the population was less than 2,000 calories i.e. 6 hours of light work or 1 hour of heavy labour. If this calculation is correct, one wonders how large building projects were ever completed. Of course, not all the poor were so restricted in their diet. Servants working in town expected to eat the same as their masters and mistresses, whilst those on large farms might enjoy a higher daily intake of calories by being allowed to share some of the farmer's food. An unskilled labourer, however, was in a much more precarious position, and in years of dearth, he and his family might well go hungry.[40]Of course, the country dweller could also resort to poaching rabbits, hares, pheasants and other game, and this must have helped fill many a poor man's pot, although the penalties if caught, could be quite Draconian.[41]

One must also remember that the quality of food could be extremely variable, ranging from the unadulterated and fresh to the adulterated, rancid, and rotten. Of course, it

[37] BURNEY, Charles, *Music, Men and Manners in France and Italy, 1770 : Being the Journal Written by Charles Burney during a Tour through Those Countries Undertaken to Collect Material for a General History of Music / Transcribed from the Original Manuscript in the British Museum, Additional Manuscript 35122, and Edited with an Introduction by H. Edmund Poole.*, 3; VARDI, Liana, *The Land and the Loom : Peasants and Profit in Northern France, 1680-1800*, 236.
[38] PORTER, Roy, *English Society in the 18th Century*, Revised edition, The Penguin Social History of Britain (London: Penguin Books, 1991), 215–16.
[39] PORTER, Roy, 215–16; WALLER, Maureen, *1700: Scenes from London Life*, 186.
[40] SHARPE, J. A., *Early Modern England: A Social History 1550-1760*, 49–51; WALLER, Maureen, *1700: Scenes from London Life*, 252.
[41] COCKAYNE, Emily, *Hubbub, Filth, Noise & Stench in England 1600-1770*, 88.

would be helpful if one could trust one's food providers. Town dwellers, both rich and poor, were at the mercy of others, and at each point in the supply chain, from growth, harvest, slaughter, market, larder, pan to consumption, they had to rely on the honesty and integrity of the producer, wholesaler, vendor and cook.[42] See Fig. 3:3 which gives a good idea of what a well-stocked tavern might offer its customers at Christmas. The following entries from James Woodforde's diary give one an idea of the largesse that the local gentry enjoyed upon occasion, although it may seem excessive to us.

Parson Woodforde was invited to a dinner for six people on 28th January 1780, that included, a Calf's Head; boiled Fowl and Tongue; a Saddle of Mutton roasted on the Side Table; and a fine Swan roasted with Currant Jelly Sauce for the first Course. The Second Course a couple of Wild Fowl called Dun Fowls; Larks; Blamange; Tarts etc. etc. and a good Desert of Fruit after amongst which was Damson Cheese.[43]

Parson Woodforde was invited to dine with the Bishop of Norwich on 4th September 1783. This was a grander occasion than before with, of course, a lot more food. He writes:

> There were 20 of us at the Table and a very elegant Dinner the Bishop gave us. We had 2 Courses of 20 Dishes each Course, and a Desert after of 20 Dishes. Madeira, red and white Wines. The first Course amongst many other things were 2 Dishes of prodigious fine stewed Carp and Tench, and a fine Haunch of Venison. Amongst the second Course, a fine Turkey Poult, Partridges, Pidgeons and Sweetmeats. Desert - amongst other things, Mulberries, Melon, Currants, Peaches, Nectarines and Grapes.[44]

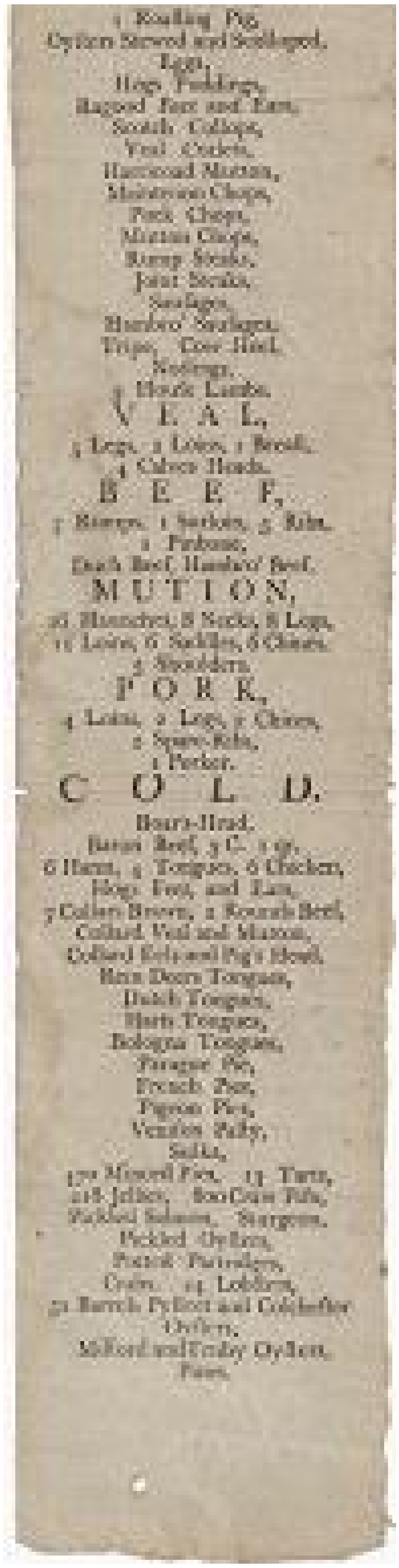
[42] COCKAYNE, Emily, 88,104.
[43] WOODFORDE, James, *A Country Parson: James Woodforde's Diary 1759-1802* (Oxford, New York, 1985), 66.
[44] WOODFORDE, James, *A Country Parson: James Woodforde's Diary 1759-1802* (Oxford, New York, 1985), 84.

Figure 3:3 Bill of Fare, Bush Tavern, Bristol

BILL of FARE, at
J. WEEKS's, Bush-Tavern,
CORN-STREET, Bristol.
For CHRISTMAS 1790.

DOE VENISON,

Bristol Record Office: B.R.O. 14182/HB/X/28



VEAL,

BEEF,

MUTTON,

PORK,

COLD.

3:3 Disease Carriers and their diseases

Poverty was, however, a major cause of heavy outbreaks of disease, with many people living on the edge of subsistence, having a minimum of warmth, clothing, and shelter, and with the ever-present threat of starvation hanging over their heads. It is not surprising, therefore, that bodies weakened by malnutrition readily succumbed to diseases such as typhus, tuberculosis, and smallpox.[45]

3:3:1 Disease Vectors

The main carriers of disease can be classified as follows:

Mechanical Vectors

These are any objects or substances that are capable of carrying infectious organisms but where the disease does not replicate or develop either within or on the vector. The vector simply acts as a means of transport. The air, for example, may transmit organisms from one person to another, tuberculosis and influenza being two case in point where the bacteria and viruses respectively are spread as aerosol droplets through the air.[46]

Recent research has shown, that coughing and sneezing creates a fine mist of pathogen rich mucosalivary droplets which can be released at a speed of between 33 to 100 feet per second (10-30 m/s), can cover a distance up to 23 to 27 feet (7-8 m), and remain airborne from a fraction of a second to several minutes.[47]

Water can also serve as a means of transporting disease carrying organisms. Perhaps the two most well-known of these are typhoid, caused by the bacterium, Salmonella

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[45] MINGAY, G. E., *A Social History of the English Countryside* (London: Routledge, 1990), 58 These comments could equally apply to Europe.
[46] NATIONAL HEALTH SERVICE, 'Tuberculosis (TB) - Symptoms', NHS Choices, 3 December 2014, http://www.nhs.uk/Conditions/Tuberculosis/Pages/Symptoms.aspx; Centers for Disease Control and Prevention, 'Influenza (Flu)', Centers for Disease Control and Prevention, 12 September 2013, http://www.cdc.gov/flu/about/disease/spread.htm; RELLO, Jordi and POP-VICAS, Aurora, 'Clinical Review: Primary Influenza Viral Pneumonia', *Critical Care* 13, no. 6 (21 December 2009): 235, https://doi.org/10.1186/cc8183; WIKIPEDIA, 'Smallpox', Wikipedia, accessed 13 October 2015, https://en.wikipedia.org/wiki/Smallpox.
[47] BOUROUIBA, Lydia, 'Turbulent Gas Clouds and Respiratory Pathogen Emissions: Potential Implications for Reducing Transmission of COVID-19', *JAMA* 323, no. 18 (26 March 2020): 1837–38, https://doi.org/10.1001/jama.2020.4756.

typhi, and cholera, which is caused by the comma-bacillus, Vibrio cholera. Both of these organisms are transported mainly by unhygienic water supplies, although insect vectors may occasionally be involved.[48]

A third mechanical vector is contaminated food. Improperly preserved foods, for example, may harbour the extremely fatal toxin, Clostridium botulinum, which is one of the most powerful toxins known, whilst in 2011, food contaminated with the bacterium E-coli, was responsible for the deadliest outbreak of bacterial food poisoning in Germany as well as in Europe, and this resulted in the deaths of 53 people, having infected more than 3,950[49].

Human Vectors

Human beings may carry disease from one to another, smallpox and tuberculosis being notable examples. In addition, some people, having recovered from a disease, become carriers of that disease. About 30% of surviving typhoid cases become carriers, excreting the bacterium in their faeces and urine for several weeks, with about 5% becoming long-term carriers, harbouring, and shedding the organisms for many years.[50]

Animal Vectors

Whilst perhaps the most widely known of these is the black rat, which may, under certain conditions, be a plague carrier, various other animals may also harbour diseases which are caught by human beings.[51] Cattle, sheep, goats, pigs, deer and rabbits are all natural reservoirs of brucellosis; milkmaids used to catch cow-pox from the udders of infected animals, and bovine tuberculosis can be caught by drinking

[48] CLOUDSLEY-THOMPSON, John Leonard, *Insects and History*, World Naturalist (London: Weidenfield and Nicolson, 1976); FOTEDAR, R, 'Vector Potential of Houseflies (Musca Domestica) in the Transmission of Vibrio Cholerae in India', *Acta Tropica* 78, no. 1 (15 January 2001): 31–34, https://doi.org/10.1016/S0001-706X(00)00162-5.
[49] Wikipedia, 'List of Foodborne Illness Outbreaks by Death Toll', https://en.wikipedia.org/wiki/List_of_foodborne_illness_outbreaks_by_death_toll, (accessed 11/04/2016).
[50] CLOUDSLEY-THOMPSON, John Leonard, *Insects and History*, 130; ACUTE COMMUNICABLE DISEASE CONTROL, 'Typhoid Fever, Carrier', Acute Communicable Disease Control Manual (B - 73), February 2016, 1–3, http://publichealth.lacounty.gov/acd/procs/b73/DiseaseChapters/B73Typhoidfevercarrier.pdf. (accessed 23/05/2016
[51] KONKOLA, Kari, 'More Than a Coincidence? The Arrival of Arsenic and the Disappearance of Plague in Early Modern Europe', *Journal of the History of Medicine and Allied Sciences* 47, no. 2 (1992): 186–209.

unpasteurised milk from infected cows.[52] Recent research by Zhiqiang Wu and colleagues has found bats housing 79 virus families including 19 which affect mammals. These do not appear to harm the bats as they appeared healthy and disease free.[53]

Bats are able to spread their virome in four ways: by air, droplet, oral-faecal indirect contact and direct physical association. As several diseases such as Ebola, Marburg and SARS have been blamed on bats, it is tempting to surmise whether these animals could have been agents of disease during the Early Modern period.[54] In this context we should mention SARS-CoV-2, the pathogen responsible for Covid-19, which may have been spread from bats to other animals and from them, to the human food chain.

Insect Vectors

Insect vectors are far more important than animals for the purposes of this study. Body lice (Fig. 3:15) are the carriers of typhus which is carried in their faeces which are then either scratched into small abrasions or inhaled, thus causing the infection.[55]

Houseflies (Fig. 3:4), blue bottles (Fig.3:5), green bottles and cockroaches (Fig. 3:6), which feed upon refuse, faeces, decaying filth and human food, are known to harbour huge quantities of pathogens, whilst mosquitos can carry malaria amongst other diseases, and black rats can carry fleas infected with bubonic plague.[56]

Flies carry several hundred species of pathogenic organisms and are believed to

[52] Al-NASSIR, Wafa, 'Brucellosis', Medscape, 15 March 2016, http://emedicine.medscape.com/article/213430-overview; DAVIES, P.D.O., 'Tuberculosis in Humans and Animals: Are We a Threat to Each Other?', *Journal of the Royal Society of Medicine* 99, no. 10 (October 2006): 539–40, https://doi.org/10.1258/jrsm.99.10.539.(accessed 23/05/2016).
[53] MARLOW, Jeffrey, 'The Rich, Frightening Diversity of the Bat "Virome"', 2, http://blogs.discovermagazine.com/the-extremo-files/2016/03/21/228/, (accessed23/05/2016); WU, Zhiqiang et al., 'Deciphering the Bat Virome Catalog to Better Understand the Ecological Diversity of Bat Viruses and the Bat Origin of Emerging Infectious Diseases', 609.
[54] MARLOW, Jeffrey, 'The Rich, Frightening Diversity of the Bat "Virome"', ibid 1.
[55] WHO, 'Typhus Fever (Epidemic Louse-Borne Typhus)', accessed 2 December 2015, http://www.who.int/ith/diseases/typhusfever/en/. http://www.who.int/ith/diseases/typhusfever/en/, (accessed 2/12/2015)
[56] RILEY, James C., *The Eighteenth-Century Campaign to Avoid Disease* (Basingstoke, Hampshire: Macmillan, 1987), 134; WHO, 'Cockroaches', WHO, accessed 18 April 2016, http://www.who.int/water_sanitation_health/resources/vector288to301.pdf; WIKIPEDIA, 'Cockroaches', Wikipedia, 15 April 2016, https://en.wikipedia.org/wiki/Cockroach#As_pests.

transmit at least 65 diseases to both animals and humans.[57] Riley also reported that in a study carried out in Beijing, on a total of 384,193 flies that had been caught, it was estimated that those from a slum area carried 3,683,000 bacteria each, whilst those from the cleanest area, 1,941,000.[58] Writing about outdoor defecation in the third world, Royte says that:

> Flies breeding and feeding on faeces are one of the main vehicles delivering infectious organisms back to humans 1 gram of faeces can contain 10 million viruses, 1 million bacteria, and 1,000 parasitic cysts, which infect us through minute openings in our skin or by contaminating food and water.[59]

Figure 3:4 Common Housefly – Musca domestica

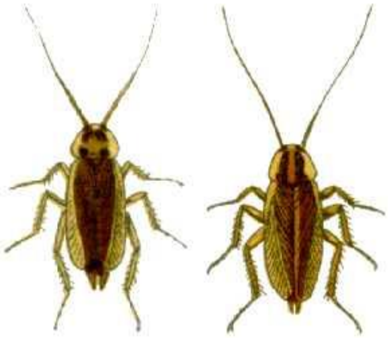
By Gladson Machado - Own work. Licenced under CC BY-SA 3.0 via Wikimedia Commons
https://commons.wikimedia.org/wiki/File:Closeup_of_House_fly.JPG#/media/File:Closeup_of_House_fly

[57] RILEY, J. C., 'Insects and the European Mortality Decline', *American Historical Review* 91, no. 4 (October 1986): 850; WHITTINGTON, Andrew E., 'Cockroach versus Fly – Which Is Germier?', *ResearchGate Questions* (blog), 18/04 2014, https://www.researchgate.net/post/Cockroach_versus_fly-which_is_germier; JUNQUEIRA, Ana Carolina M. et al., 'The Microbiomes of Blowflies and Houseflies as Bacterial Transmission Reservoirs', www.nature.com/scientificreports, 24 November 2017, https://www.nature.com/articles/s41598-017-16353-x.pdf; KHAMESIPOUR, Faham, et al., 'A Systematic Review of Human Pathogens Carried by the Housefly (Musca Domestica L.)', *BMC Public Health* 18, no. 1049 (22 August 2018): 1–16, https://doi.org/10.1186/s12889-018-5934-3. https://www.researchgate.net/post/Cockroach_versus_fly-which_is_germier, (accessed 19/04/2016)
[58] RILEY, J. C., 'Insects and the European Mortality Decline', 851.
[59] ROYTE, Elizabeth, 'A Place to Go', *National Geographic Magazine*, August 2017, 102.

Figure 3:5 Bluebottle – Calliphora vomitoria

By Mrs KirstenHollister (Own work) [CC BY-SA 3.0 (http://creativecommons.org/licenses/by-sa/3.0) or GFDL (http://www.gnu.org/copyleft/fdl.html)], via Wikimedia Commons

Figure 3:6 German Cockroach-Blattella germanica



By Saphan (http://www.ento.csiro.au) [FAL], via Wikimedia Commons

3:3:2 Diseases

The range of common diseases that anyone living in the 18th century was likely to encounter was large by present day standards, and unfortunately, as the medical profession was ill-equipped to deal with them, death was never far away. Fear of contagion must have been ever present. A simple cut or broken bone might be the harbinger of an infection such as sepsis, tetanus, or gangrene, which, without the benefit of modern antibiotics, would lead ultimately to death.[60] As research just published (16th January 2020) estimates that one in five deaths around the world is caused by sepsis, one has to wonder what the percentage would have been in the 18th century.[61]

Bacillary dysentery or Shigellosis

Bacillary dysentery or Shigellosis is caused by one of four species of Shigella, namely: Shigella sonnei, Shigella flexneri, Shigella boydii or Shigella dysenteriae. However, the virulent and potentially fatal form of the disease is caused by the organism, Shigella dysenteriae, which is the only one of the four species of Shigella capable of causing a major epidemic. In the developing world, the fatality rate can be as high as 30%.[62] In severe forms of the disease the patient passes bloody stools at the outset, and becomes toxic and restless, with a rapid feeble pulse, and death may result from circulatory failure or haemolytic uraemic syndrome. Other symptoms include abdominal pain, cramps, fever and vomiting.[63] The principal method of transmission of the disease is by direct faecal-oral spread of bacteria via contaminated, fingers, whence it is conveyed to food such as salads, poultry or raw vegetables. It may also be transmitted by flies which have alighted on exposed human faeces, and large outbreaks have occurred through faecal pollution of water supplies.[64]

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[60] WILLS, Simon, *How Our Ancestors Died: A Guide for Family Historians;* (Pen & Sword, 2013), 200–202.
[61] KEMPKER, Jordan A. and MARTIN, Greg S., 'A Global Accounting of Sepsis', *The Lancet* 395, no. 10219 (18 January 2020): 168–70, https://doi.org/10.1016/S0140-6736(19)33065-X.
[62] SURESHBABU, Jaya, 'Shigella Infection: Epidemiology', Medscape, 26 June 2014, http://emedicine.medscape.com/article/968773-overview#a6. http://emedicine.medscape.com/article/968773-overview#a6, (accessed 19/11/2015)
[63] SKIRROW, M. B., 'Enterobacteria and Miscellaneous Enteropathogenic and Food-Poisoning Bacteria: Shigella Infections', in *Oxford Textbook of Medicine*, ed. Weatherall, D.J., Ledingham, J. G. G., and Worrell, D. A., 3rd ed., vol. 1 (Oxford: O.U.P., 1996), 553–54.
[64] SKIRROW, M. B., 'Enterobacteria and Miscellaneous Enteropathogenic and Food-Poisoning Bacteria: Shigella Infections'; SURESHBABU, Jaya, 'Shigella Infection: Epidemiology'. ibid

Bronchitis

Bronchitis is an inflammation of the bronchi of which there are two types, acute and chronic. Acute bronchitis is usually caused by a viral or bacterial infection which can develop after a cold or influenza. It can also be caused or exacerbated by various forms of air pollution and smoke. Symptoms include sore throat, wheezing, chest pain, fatigue, fever, aching body, stuffy or runny nose, vomiting, and diarrhoea. However, the main symptom is a persistent cough, which may last about 3 weeks. Even after the infection clears up, there may still be a dry cough which lingers for days or weeks.[65]

The signs and symptoms of chronic bronchitis, which is defined as lasting for 3 months or more, include coughing, wheezing, and chest discomfort. The coughing may produce large amounts of mucus. It is particularly prevalent amongst people who are continually exposed to dust and fumes, and it may be aggravated by high concentrations of sulphur dioxide or other pollutants in the air.[66]

Brucellosis

This is a generalised infection of humans caused by one of four species of Brucella, namely: Brucella melitensis, Brucella abortus, Brucella suis and Brucella canis. The disease is transmitted by direct or indirect contact with the natural animal reservoirs, especially, cattle, sheep, goats, pigs, deer and rabbits, or their infected products or tissue, the usual method of infection being unpasteurised milk.

Other symptoms not mentioned may include chest pain which is worse on breathing, palpitation due to an arrhythmia, abdominal pain with constipation, and confusion with

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[65] NIH, National Heart, Lung, and Blood Institute, 'What Are the Signs and Symptoms of Bronchitis?', U.S. Department of Health & Human Services, 4 November 2011, http://www.nhlbi.nih.gov/health/health-topics/topics/brnchi/signs. http://www.nhlbi.nih.gov/health/health-topics/topics/brnchi/signs, accessed (21/11/2015)

[66] MEDICINENET, 'Chronic Bronchitis', MedicineNet.com, 23 January 2015, http://www.medicinenet.com/chronic_bronchitis/page3.htm; BELL, Michelle L. and DAVIS, Devra L., 'Reassessment of the Lethal London Fog of 1952: Novel Indicators of Acute and Chronic Consequences of Acute Exposure to Air Pollution', *Environmental Health Perspectives* 109, no. Suppl. 3 (June 2001): 389–94, http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1240556/; BELL, Michelle L., DAVIS, Devra L., and FLETCHER, Tony, 'A Retrospective Assessment of Mortality from the London Smog Episode of 1952: The Role of Influenza and Pollution', *Environmental Health Perspectives* 112, no. 1 (January 2004): 6–8, http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1241789/.

nightmares and somnambulism. High fever is usual, and the spleen is often enlarged and the liver palpable.

An infection from B. abortus can be life-threatening especially when resistance is low. If the disease takes on a chronic form, changes in the skeleton may occur, due to reactive arthritis, with the large joints and spine being particularly affected. Such changes make it possible to diagnose this disease in skeletal remains.[67]

Although a debilitating disease, mortality in brucellosis is very low, certainly less than 5% and probably less than 2%. It is usually the result of the rare instance of *Brucella* endocarditis or of severe CNS (central nervous system) involvement, often as a complication of endocarditis. Other fatal complications include, myocarditis and pericarditis.[68]

Common cold

As the saying goes, "Coughs and sneezes spread diseases". However, when their symptoms could presage such fatal diseases as plague, an all too recent memory in the minds of some, and fevers of various kinds, which could kill within a short time, they were looked upon not so much as afflictions in themselves, but as forerunners of something far more serious.[69]

The common cold virus, - and there are well over 200 implicated in the transmission of this disease - is spread through the air by aerosol transmission, direct contact with infected secretions but mostly by fomites, especially hand to hand contact.[70]

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[67] WEATHERALL, David John, LEDINGHAM, John Gerard Garvin, and WORRELL, David Alan, eds., *Oxford Textbook of Medicine*, 2nd ed., vol. 1, Oxford Medical Publications (Oxford: O.U.P., 1987), 5.261.
[68] Al-NASSIR, Wafa, 'Brucellosis'; JEROUDI, M. Oussama et al., 'Brucella Endocarditis', *British Heart Journal* 58, no. 3 (September 1987): 279–83, http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1216450/?page=1.
[69] WALLER, Maureen, *1700: Scenes from London Life*, 100.
[70] PAPPAS, Diane E. and HENDLEY, J. Owen, 'Transmission of Colds', in *Common Cold*, ed. ECCLES, Ronald and WEBER, Olaf, Birkhäuser Advances in Infectious Diseases (Basel, Boston, Berlin: Birkhäuser Verlag), 197–210, accessed 25 November 2015, https://books.google.ca/books?id=rRldiGE42IEC&pg=PA197&hl=en#v=onepage&q&f=false; ARROLL, Bruce, 'Common Cold', *BMJ Clinical Evidence* 2011 (16 March 2011), https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3275147/; WIKIPEDIA, 'Common Cold', Wikipedia, 15 November 2015, https://en.wikipedia.org/wiki/Common_cold.

Henri Misson, a French visitor to England, writing at the end of the seventeenth century, wrote: *"Rhumes. Un Rhûme qui s'invétére en Angleterre, est un commencement de maladie mortelle, particulierement pour les Etrangers. Il ne faut donc pas negliger en rhûme."*[71]

''Colds. A long-lasting cold in England is the beginning of a deadly illness, particularly for strangers. It's not wise, therefore, to neglect a cold."

Diphtheria

Diphtheria is a potentially fatal highly contagious bacterial infection that mainly affects the nose and throat, and sometimes the skin. It is caused by toxigenic strains of two types of bacteria, namely**:** Corynebacterium diphtheriae and Corynebacterium ulcerans It is usually confined to the upper respiratory tract and is characterized by a tough false membrane attached firmly to the underlying tissue which bleeds if removed by force. It may spread throughout the throat, larynx and bronchial tree where it may cause death by hypoxia. Diphtheria which is mainly an autumn disease is spread by coughs and sneezes, by direct contact with someone who has the illness or by objects that they have handled.[72]

Ergotism and other forms of Mycotoxicosis

Ergotism

There are two forms of ergotism which are caused by the fungus, Claviceps purpurea (Figs. 3:7 & 8), namely, gangrenous and convulsive. Victims of the gangrenous form may lose hands, fingers, toes, or even complete limbs, whilst

[71] MISSON, Henri de Valbourg, *Mémoires et observations faites par un voyageur en Angleterre : sur ce qu'il y a trouvé de plus remarquable, tant à l'égard de la religion, que de la politique, des moeurs, des curiositez naturelles & quantité de faits historiques.* (La Haye, The Hague, Netherlands: Henri van Bulderen, 1698), 375.
[72] NATIONAL HEALTH SERVICE, 'Diphtheria-Symptoms', NHS Choices, 16 February 2015, http://www.nhs.uk/Conditions/Diphtheria/Pages/Symptoms.aspx; LO, Bruce M., 'Diphtheria', Medscape, 18 August 2015, http://emedicine.medscape.com/article/782051-overview; CREIGHTON, Charles, *A History of Epidemics in Britain. Vol. 2 From the Extinction of Plague to the Present Time.*, 1st ed., vol. 2 (Cambridge: Cambridge University Press, 1894), 736–47; HINDMAN, Sarah M. and HARMON, G. E., 'Seasonal Distribution of Measles, Scarlet Fever and Diphtheria for Periods of High and Low Incidence', *American Journal of Epidemiology* 20, no. 3 (1934): 555, http://aje.oxfordjournals.org/content/20/3/555.extract#.

victims of convulsive ergotism suffer tonic/clonic seizures such as writhing, tremors and wry neck and in severe cases, coma and death.[73]

The contamination of grain with ergot (Claviceps purpurea) has spread death and destruction for thousands of years. An ancient Assyrian tablet, circa 600 BC, referred to the "noxious pustule in the ear of grain", and around 350 BC, one of the sacred books of the Parsees mentions "noxious grasses that cause pregnant women to drop the womb and die in child bed".[74]

Ergotism can be a very lethal disease. For example, during ten epidemics recorded in Russia from 1832 to 1864, between 11% to 66% of those who became sick died, with a mean mortality rate of 41.5%.[75]

Favourable conditions for the formation of Claviceps on rye occur if the preceding winter is cold, there is a wet and cloudy spring which lengthens the time the rye flowers are open, and the temperature is between 17.4° and 18.9°C.[76] These weather conditions may also be favourable for insect populations of aphids, thrips, midge and leaf hoppers, which serve as potential vectors of sticky spores, thus spreading the infection.[77]

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[73] LEE, M.R., 'The History of Ergot of Rye (Claviceps Purpurea)', *Journal of the Royal College of Physicians of Edinburgh* 39 (2009): 182, http://www.rcpe.ac.uk/sites/default/files/lee_3.pdfhttp://www.rcpe.ac.uk/sites/default/files/lee_3.pdf; MATOSSIAN, Mary Kilbourne, *Poisons of the Past: Molds Epidemics and History* (New Haven and London: Yale University Press, 1989), 9–12.

[74] KOSKINEN, Ari M. P., *Asymmetric Synthesis of Natural Products*, 2nd ed. (Chichester: Wiley-Blackwell, 2012), 10, 28; SCHIFF Jr., Paul L., 'Teachers' Topics: Ergot and Its Alkaloids', *American Journal of Pharmaceutical Education* 70, no. 5, Article 98 (15 October 2006): 1–10, http://archive.ajpe.org/aj7005/aj700598/aj700598.pdf.

[75] GRUNFELD, Abraham, 'Kurzer Auszug aus den die Mutterkornfrage betreffenden Arbeiten der russischen Literatur', in *Historische Studien aus dem Pharmakologischen Institute der Kaiserlichen Universität Dorpat*, ed. KOBERT, Rudolf (Halle, Saale, Germany: Tausch & Grosse, 1889), 49, http://personen.digitale-sammlungen.de/baltlex/Blatt_bsb00000347,00059.html?prozent= in MATOSSIAN, 1989, p. 12.

[76] MATOSSIAN, Mary Kilbourne, *Poisons of the Past: Molds Epidemics and History*, 13–14.

[77] GOVERNMENT of SASKATCHEWAN AGRICULTURAL KNOWLEDGE CENTRE
EWAN AGRICULTURAL KNOWLEDGE CENTRE, 'Ergot of Cereals and Grasses', Government of Saskatchewan, accessed 24 April 2016, http://www.saskatchewan.ca/business/agriculture-natural-resources-and-industry/agribusiness-farmers-and-ranchers/crops-and-irrigation/crop-protection/disease/ergot-of-cereals-and-grasses.

Ergotism epidemics usually occur from late summer onwards after the rye harvest, when ergot is at its most toxic, but can occur at any time as the Claviceps alkaloids are able to remain viable for up to eighteen months.[78]

There is a possibility that the dry fog produced by the Laki eruption caused the favourable conditions necessary for the production of ergot by blocking out the sunlight and thus maintaining a constant humidity, thereby allowing Clavicepspurpurea to thrive.[79] However, ergot poisoning, even if not fatal, may also affect the fertility of the population. This may be inferred by the drop in conceptions in August and September, after the harvest.[80]

Figure 3:7 Grains of barley infected with Claviceps purpurea

By Dominique Jacquin (Own work) [GFDL (http://www.gnu.org/copyleft/fdl.html) or CC BY-SA 3.0 (http://creativecommons.org/licenses/by-sa/3.0)], via Wikimedia Commons

[78] MATOSSIAN, Mary Kilbourne, *Poisons of the Past: Molds Epidemics and History*, 14.
[79] MATOSSIAN, Mary Kilbourne, 14.
[80] MATOSSIAN, Mary Kilbourne, 14, 61–67, 101–4, 156. An early account of the disease can be found in Tissot: *An Account of the Disease, Called Ergot, in French, from Its Supposed Cause, Viz. Vitiated Rye,* Phil. Trans. 1765 55, 106-126, 1 January, 1765, see also Johann Taub, *Die Geschichte der Kriebel-Krankheit*, Gottingen, 1782, and George Barger*, Ergot and Ergotism,* Gurney & Jackson, 1931

Figure 3:8 Claviceps purpurea on wheat

http://www.herbmuseum.ca/content/ergot-grains-claviceps-purpurea

Aspergillosis

Aspergillosis is a fungal infection caused by various species of Aspergillus, but usually Aspergillus fumigatus. A. fumigatus is the most common airborne fungus due to growth in a wide range of temperatures and is commonly found on rotting vegetation, dead leaves, compost heaps and stored cereals. Like all moulds, it likes damp conditions, and is thermotolerant, its optimum temperature for growth being between 37 and 43°C. The metabolites that this fungus manufactures can cause tremors and convulsions in men and animals, and as some of its metabolites are the same as those of ergot, it may, in addition, also produce hallucinations. It might well be that Aspergillus and not ergot has caused some of the epidemics in the past.[81]

Alimentary toxic aleukia (ATA)

This is a very severe form of toxicosis caused by trichothecenes such as T-2 mycotoxin, which have been produced by Fusarium tricinctum.[82] It is an exceptionally nasty disease, causing amongst other things, fever, vomiting, haemorrhaging from the skin, nose, throat and gums, necrosis, ulcerative sore throat and leukopenia. These features are similar to radiation poisoning, and quite different from those caused by most other bacterial or. mycotoxins.[83] ATA was identified as being the cause of some 100,000 deaths between 1942 and 1948 in the Russian grain belt, the death rate in some cases being as high as 60%.[84] In this particular case, the toxin was produced in grain that was overwintered in the fields and not harvested until the following year. Although the toxin starts to form in the autumn, it only reaches its maximum toxicity in the spring, particularly if there has been abundant snow with alternate freezing and thawing. The optimum temperature for its formation was thought to be between 5° and 14°C.but this has now been revised upwards to 25°C.owing to a strain of Fusarium toxin that was produced at this temperature in South Africa. As well

[81] MATOSSIAN, Mary Kilbourne, 13; VYAS, Jatin M., 'Aspergillosis', MedlinePlus, 19 May 2013, https://www.nlm.nih.gov/medlineplus/ency/article/001326.htm; LIFE Leading International Fungal Education, 'Fungal Infections: Aspergillus Fumigatus', LIFE Leading International Fungal Education, accessed 4 November 2015, http://www.life-worldwide.org/fungal-diseases/aspergillus-fumigatus; CRCC Centre de Recherche sur la Conservation des Collections, 'Aspergillus Fumigatus', MYCOTA, accessed 4 November 2015, http://mycota-crcc.mnhn.fr/site/specie.php?idE=89#ancre3.
[82] BAMBURG, James R., STRONG, Frank M., and SMALLEY, E. B., 'Toxins from Moldy Cereals', *Journal of Agricultural and Food Chemistry* 17, no. 3 (May 1969): 443, https://doi.org/10.1021/jf60163a022; MATOSSIAN, Mary Kilbourne, 'Mold Poisoning: An Unrecognised English Health Problem, 1550-1800', *Medical History* 25 (January 1981): 80, 84, http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1138987/pdf/medhist00092-0081.pdf; MATOSSIAN, Mary Kilbourne, *Poisons of the Past: Molds Epidemics and History*, 17–18.
[83] PITT, J. L., 'An Introduction to Mycotoxins', FAO Corporate Document Repository, accessed 7 November 2015, http://www.fao.org/docrep/x5036e/x5036E04.HTM#An%20introduction%20to%20mycotoxins; BAMBURG, James R., STRONG, Frank M., and SMALLEY, E. B., 'Toxins from Moldy Cereals', 443; MATOSSIAN, Mary Kilbourne, *Poisons of the Past: Molds Epidemics and History*, 14–19 For a full list of symptoms see p. 16 Table 2 .
[84] HOCKING, Ailsa D., 'Common Mycotoxigenic Species of Fusarium', FAO Corporate Document Repository, accessed 8 November 2015, http://www.fao.org/docrep/x5036e/x5036e07.htm.

as overwintering in fields, grain which has over 16% moisture is particularly liable to infection, but if it stored with a moisture content of less than 13°C.it will not be liable to mould growth, a situation I think most unlikely to have happened in eighteenth century Europe.[85]

Not only is this toxin an extremely strong poison, but it is also a potent immunosuppressant. It causes irreversible damage to the bone marrow, leading to characteristic reduction in white blood cells (leukopenia). Although continued consumption of T-2 toxin will ultimately lead to death, it is thought that many of the fatalities during these outbreaks of ATA probably occurred due to viral and bacterial infections with which their defective immune systems were unable to cope.[86]

It is quite possible, that in the past, what we now know to be ATA was mistaken for diphtheria or a combination of scarlet fever and diphtheria. However, with ATA no false membrane forms in the throat as it does with diphtheria, whilst scarlet fever is characterised by a high fever, sore throat and a sandpaper-like red rash, but no ulcerated throat or haemorrhaging.[87]

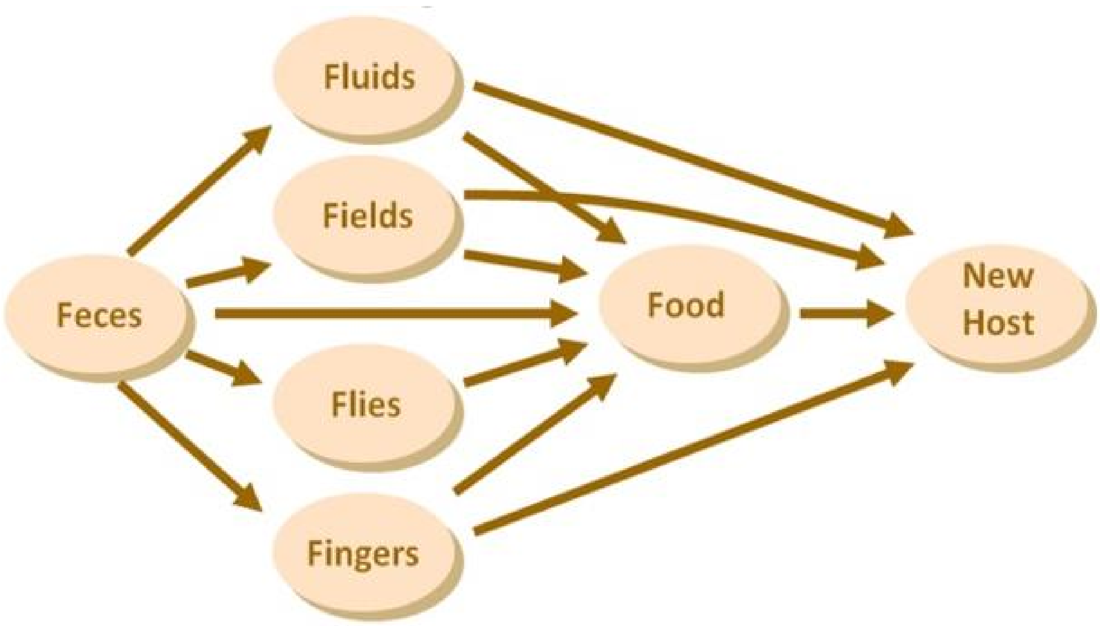
Infantile diarrhoea

According to the 2014 UNICEF Report, *Levels & Trends in Child Mortality*, 9% of deaths of all children under five are caused by infantile diarrhoea, thus making it one of the leading causes of mortality in children in this age group.[88]. This highly infectious disease is caused by a rotavirus which is transmitted by the faecal-oral route, either

[85] MATOSSIAN, Mary Kilbourne, *Poisons of the Past: Molds Epidemics and History*, 6–7, 17.
[86] MOSS, Maurice O., 'Mycotoxins', *Mycological Research* 100, no. 5 (May 1996): 520, https://doi.org/10.1016/S0953-7562(96)80001-3; MOSS, Maurice O., 'Mycotoxin Review - Fusarium', *Mycologist* 16, no. 4 (November 2002): 159, https://doi.org/10.1017/S0269-915X(02)00413-5.
[87] BAMBURG, James R., STRONG, Frank M., and SMALLEY, E. B., 'Toxins from Moldy Cereals'; MATOSSIAN, Mary Kilbourne, *Poisons of the Past: Molds Epidemics and History*, 17.
[88] YOU, Danzhen, HUG, Lucia, and CHEN, Yao, 'Levels & Trends in Child Mortality' (New York: UNICEF, 2014), 3, http://www.unicef.org/media/files/Levels_and_Trends_in_Child_Mortality_2014.pdf.

directly through contaminated hands, or indirectly via food, utensils, soil, flies, or contaminated drinking water.[89] See figure below:

Figure 3:9 The F-diagram, showing the different faecal-oral transmission routes



Wagner and Lanois, 1958

If this disease is a leading killer of young children under five today, I see no reason to doubt that it had the same effect during the 18th century, especially when considers the unclean living conditions that the majority of the population had to tolerate.

Influenza

Influenza is usually spread by person to person transmission through the transmission of aerosol sized particles generated by coughing, sneezing or talking. It can also be transmitted through the handling of objects that are contaminated by the virus.[90] The main symptoms include: high fever, runny nose, sore throat, muscle pains headache, dry cough, tiredness and shivering. Unfortunately, acute influenza may transform into either primary or secondary pneumonia which, which can lead to an extremely high

[89] BROWN, Joe, CAIRNCROSS, Sandy, and ENSINK, Jeroen H. J., 'Water, Sanitation, Hygiene and Enteric Infections in Children', *Archives of Disease in Childhood* 98, no. 8 (12 June 2013): 629, https://doi.org/10.1136/archdischild-2011-301528.
[90] RELLO, Jordi and POP-VICAS, Aurora, 'Clinical Review: Primary Influenza Viral Pneumonia'; WIKIPEDIA, 'Influenza', Wikipedia, accessed 21 September 2015, https://en.wikipedia.org/wiki/Influenza#Seasonal_variations.

rate of mortality.[91] The following table illustrates how an influenza epidemic spread throughout Britain in 1782, beginning in Torrington, North Devon in the south-west of England on 24 March and by the time it had finished in October had covered the majority of England and a large part of Scotland.

Table 3:1 The British 1782 influenza epidemic

Year	Town	Start of infection	End of infection
1782	Torrington, North Devon	24 March	Before June
	Newcastle	End of April	Mid-June
	London	12th-18th May	
	Eastern Counties	Mid-May	
	Surrey, Edinburgh, Portsmouth, Oxford Chester	3rd week of May 26th May	 July
	St. Albans	Before 28 May*	
	Plymouth	30th May	
	Ipswich, Yarmouth, York, Liverpool Glasgow	1st week in June	
	Barnstable	June	
	Musselburgh	9th June	
	Northumberland	July	3rd week of August
	Scotland	July height of epidemic	
	Gravesend	September	
	London	Beginning October	Both this and the Gravesend outbreaks were unusual occurrences. See below**
		(Hamilton, pp.8-9*, Creighton, pp.364, 365)	(Creighton, pp.364 365, Thompson.T. p. 155)

[91] RELLO, Jordi and POP-VICAS, Aurora, 'Clinical Review: Primary Influenza Viral Pneumonia'; WIKIPEDIA, 'Influenza'.

*Hamilton reported that the disease also affected horses and sheep but could not verify the matter.[92]

> **[…]two months after the late epidemical catarrh had entirely disappeared from England. The king's ships 'Convert' and 'Lizard' arrived in the Thames from the West Indies in September. Their crews were perfectly healthy till they reached Gravesend, where they took on board three custom-house officers; and in a very few hours after that the influenza began to make its appearance. Hardly a man in either ship escaped it; and many both of the officers and common seamen had it in a severe degree. Others who came to London from the West Indies in merchantmen in the end of September were attacked by influenza in their lodgings in the beginning of October.[93]

Doctors at the time could not agree as to how the disease was transmitted, some thinking it was the atmosphere due to a change in the weather, whilst others thought that it was a contagious disease. For a contemporary perspective on the transmission, symptoms and treatment of influenza see *Thompson pp.117-199* and the example given below, from Dr. Gray's account in the said work:

> Different opinions have been entertained respecting the manner in which this disease was produced and propagated. Some physicians thought it arose solely from the state of the weather in other words, that it was a common catarrh, occasioned as that complaint frequently is, by changes in the sensible qualities of the atmosphere, such as the increase of cold, or moisture and consequently, they supposed it unconnected with any disorder that had prevailed, or did at that time prevail in any other part. Others, admitted its cause to be a particular and specific contagion, totally

[92] HAMILTON, Robert, *A Description of the Influenza : With Its Distinction and Method of Cure* (London: J. Johnson, 1782), 10, https://books.google.fr/books?id=ZASYo__Yya0C&pg=PA1&lpg=PA1&dq=r+hamilton+description+influenza&source=bl&ots=D83fWwTZBb&sig=Zz84HzSsrSEKzqckciggHNX2WjY&hl=en&sa=X&redir_esc=y#v=onepage&q=r%20hamilton%20description%20influenza&f=false.

[93] CREIGHTON, Charles, *A History of Epidemics in Britain. Vol. 2 From the Extinction of Plague to the Present Time.*, 2:365.

different from, and independent of, the sensible qualities of the atmosphere, yet thought that cause was conveyed by, and resided in the air. But the greatest number concurred in opinion, that the influenza was contagious, in the common acceptation of that word that is to say, that it was conveyed and propagated by the contact, or at least by the sufficiently near approach, of an infected person.[94]

It appears from the 'Journal de Médecine,' that the Faculté de Médecine at Paris were of the first opinion ; at their Prima Mensis, the cause of La Grippe, as the epidemic was commonly called, is ascribed to, 'Les variations de l' atmosphere.'*

At Venice also several physicians ridiculed the common name of the disease (Russian catarrh), and thought the changes of the weather sufficient to account for it observing in support of their opinion, that the thermometer had sunk no less than ten degrees of Reaumur's scale (more than 22 of Fahrenheit's), between the 17th and 19th of July, about which time the disorder first appeared at that place. Other Italian physicians, however, were of a contrary opinion and one (the Chevalier Rosa, of Modena,) has published a treatise upon it, in which, it is said, he strongly and ably contends, that it was contagious.[95]**

*"'Cette cause en effet paroit suffisante, sans aller chercher des rapports entre la grippe dont nous parlons, et l'épidemie qui a parcourue les pays froids, ou celle qui regne actuellement en Angleterre sous le nom d'Influenza,'—Journal de Médecine, for August, 1782.''[96]

**"'Nos médecins rioient (sic) beaucoup sur cette dénomination vulgaire (Catarrhe Russe). En effet on a remarqué que les variations du thermomètre furent assez remarquables dans les mois de Juin, Juillet, et

[94] THOMPSON, Theophilus, ed., *Annals of Influenza, or Epidemic Catarrhal Fever, in Great Britain from 1510 to 1837* (London: Sydenham Society, 1852), 137, https://archive.org/details/b21302091.
[95] THOMPSON, Theophilus, 137–38.
[96] THOMPSON, Theophilus, 137 Footnote to page.

> Aout; surtout du 17 au 19 Juillet le thermomètre avec l'échelle de Reaumur (sic) a baissé 10 degrès,(sic) et c'est de ce tems que commença cette maladie. Les alternatives de chaud au froid furent donc, selon nos médecins, la seule cause de ce rhume, qui s'est répandu,' dans peu de jours, parmi les gens de tous les ordres et de toutes les conditions. Tous les médecins de l'Italie ne pensent pas comme ceux de Venise sur cette affaire ; le Dr. Gallicio de Vicenza, et le Dr. Sarga, de Vérone, prétendent que cette influence ait été une véritable peste, ou line maladie contagieuse. Le Chevalier Rosa, professeur a Modène, a donné, à cette occasion, un traité dans lequel il établit que notre maladie étoit contagieuse.'—Letter from Dr. Gallini, of Venice, to Dr. Gray."[97]

Notwithstanding the extensive spread of the disease, it was not a severe epidemic and very few people succumbed; "*of those who died, the greater part were old, asthmatic, or who had been debilitated by some previous indisposition*."[98] It is an interesting supposition that had they not died in the influenza epidemic, they may have been killed by the Laki dry fog the following year.

Malaria

A debilitating, and often fatal disease spread by the Anopheles mosquito. Its symptoms include: fever, headache, chills, muscle pains and diarrhoea, whilst its complications can be as varied as anaemia, permanent brain damage, jaundice, shock, pulmonary oedema, hypoglycaemia, kidney failure and damage to the spleen.[99] It was particularly prevalent in the marshy areas in Britain and France as the following contemporary accounts will make clear. The first is from Defoe's "*Tour through the whole island of Great Britain*", although it is, in all probability, a story that has been exaggerated over time, it gives a good idea of the conditions that the marsh people had to endure.

[97] THOMPSON, Theophilus, 137–38 Footnote to page 138.
[98] THOMPSON, Theophilus, 156.
[99] NATIONAL HEALTH SERVICE, 'Malaria - Complications', NHS Choices, 9 January 2014, http://www.nhs.uk/Conditions/Malaria/Pages/Complications.aspx.

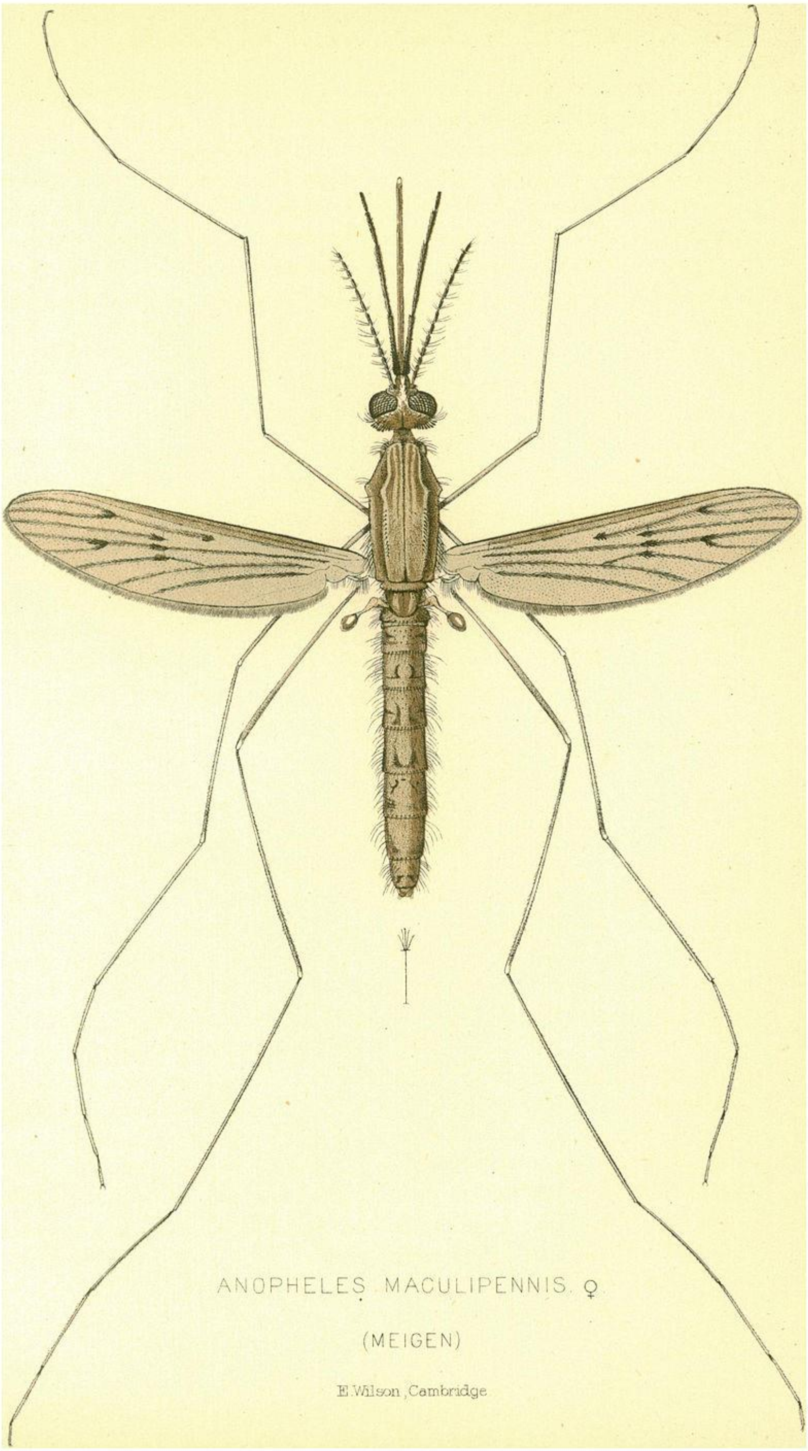
> That all along this Country it is very frequent to meet with Men that have had from 5 or 6, to 10 or 12 Wives; and I was informed, that in the Marshes, over-against Canvey Island, was a Farmer, who was then living with the 25th; and that his Son, who was but 35 Years old, had already had about 14. […] The Reason, as a merry Fellow told me, who said he had had about a Dozen, was this, That they being bred in the Marshes themselves, and seasoned to the Place, did pretty well; but that they generally chose to leave their own Lasses to their Neighbours out of the Marshes, and went into the Uplands for a Wife: That when they took the young Women out of the wholesome fresh Air, they were clear and healthy; but when they came into the Marshes amongst the Fogs and Damps, they presently changed Complexion, got an Ague or two, and seldom held it above half a Year, or a Year at most: And then said he, we go to the Uplands again, and fetch another. […]

The same traveller's tale was told not only in Essex, but also in Sussex and other marshy areas of England.[100]

A similar situation existed in France as can be seen in the following tables compiled by Jean-Baptiste Moheau, one of the pioneers of demography. See Figures 3:11 and 3:12. In his work "*Recherches et Considérations sur la population de la France 1778*", he compared numerous communities throughout France and entered information about the occupations and life expectancy of a particular place in a tabular format. In these tables he has compared the life expectancy of mountainous regions with that of marshy areas, and we can see that there is a considerable difference not only between the two, but within the regions themselves. In Grand Bois on the west coast, for example, life expectancy was 40 years and 8 months, whilst the inhabitants of Seillons, a poor hamlet situated in a rocky area with stagnant water in the nearby plains had a very poor survival rate with a life expectancy of only 16 years 5 months. However, the

[100] DEFOE, Daniel, *A Tour through the Whole Island of Great Britain : Divided into Circuits or Journies ... Interspersed with Useful Observations : Particularly Fitted for the Perusal of Such as Desire to Travel over the Island / Originally Begun by the Celebrated Daniel De Foe, Continued by the Late Mr. Richardson, Author of Clarissa, and Brought down to the Present Time by a Gentleman of Eminence in the Literary World.*, 1:10–11; ALLEN, Andrew, *A Dictionary of Sussex Folk Medicine* (Newbury, Berkshire: Countryside Books, 1995), 19–20.

Figure 3:10 Anopheles maculipennis



Drawing of a female Malaria mosquito from the species *Anopheles maculipennis By E. Wilson, Cambridge [Public domain], via Wikimedia Commons* life expectancy of people born in La Napoule, a marshy area, was only 8 years. Moheau concluded that mountainous areas were more salubrious than those with a marshy outlook but he was unable to offer an explanation.[101] Areas of swamp, salt marshes and stagnant water are the preferred breeding grounds of mosquitos, and as such would have been the ideal habitat for Anopheles.[102] It would seem reasonable to assume that the reason for the unhealthiness of the marshy areas both in Britain and Europe was due to malaria transmitted by the Anopheles mosquito. Whether the high mortality rate was due to malaria itself, or to one of the complications that can arise from the disease we shall probably never know.

Figure 3:11 Jean-Baptiste Morheau, Recherches et considérations sur la population de la France, p.198

[198] Suite de la TABLE II.

Situation et nature du Sol, et industrie des Habitans.

LIEUX.	HABITATIONS sur le sommet des montagnes.	VIE COMMUNE.	
		Ans.	*Mois.*
CABRIERS..........	Sur un roc vers le Sud-Ouest, entouré de montagnes nues à l'Est. Terroir sec, peu fertile..........	31	5
GRAND-BOIS	Découvert, sur-tout du côté de l'Ouest	40	8
LE CASTELLET......	Sur un roc, vers le Sud, et quelque peu à l'Ouest. Terroir fertile en vin et en huile, à deux lieues au Nord-Nord-Ouest de Toulon	29	
SEILLONS..........	Sur un roc nu, un peu au Sud. Terroir labourable, eaux stagnantes dans la plaine. Hameau très-pauvre.................	16	5
SIX-FOURS.........	Sur une montagne isolée et presqu'Isle. Terroir sec.	34	3
VENELLES	Assez élevé à une demi-lieue au Nord d'Aix......	36	

[101] MOHEAU, Jean-Baptiste, *Recherches et Considérations Sur La Population de La France 1778*, Collection Des Économistes (Paris: Librairie Paul Geuthner, 1912), 198, 201, http://gallica.bnf.fr/ark:/12148/bpt6k81343z.
[102] DOBSON, Mary, '"Marsh Fever" - The Geography of Malaria in England', *Journal of Historical Geography* 6, no. 4 (October 1980): 376, https://doi.org/10.1016/0305-7488(80)90145-0.

Figure 3:12 Jean-Baptiste Morheau ,Recherches et considérations sur la population de la France, p.201

Suite de la TABLE II.

Situation et nature du Sol, et industrie des Habitans.

LIEUX.	HABITATIONS dans des contrées marécageuses, marítimes.	VIE COMMUNE.	
		Ans.	*Mois.*
BERRE	Au fond et au Nord-Est d'un grand étang maritime.	25	2
FOS	Près de la mer, et sur une colline entourée de marais de l'Est à l'Ouest par le Sud	17	3
FRÉJUS	Terroir marécageux, à une demi-lieue de la mer, ayant au Nord de hautes montagnes	22	1
LA NAPOULE	Sur une plage maréca-geuse	8	
RAMATUELLE	Sur la plage	19	7

LIEUX.	HABITATIONS dans des contrées marécageuses, méditerranées.	VIE COMMUNE.	
		Ans.	*Mois.*
CORBIERES	Au Nord, et tout près de la Durance, découvert vers l'Est, et dominé à l'Ouest par une colline	17	6
JOUQUES	Au Sud de la Durance, près des canaux d'arrosage.	20	7
PERROLES	Au Sud, et tout près de la Durance	27	4
CUERS	A l'abri des vents du Nord, terroir complanté de vignes et d'orangers. Quelques eaux croupissantes	21	

Measles

Measles is an acute, highly infectious disease, caused by a virus of the paramyxovirus family, and is one of the leading causes of death among young children. About 85% of those people exposed to the virus will become, infected and approximately 95% of those infected will develop the disease It has a relatively high case-fatality rate, which in some African countries varies between 7.1% in small households to 12.8% in households of 8 or more members and 15.6% for children under 1 year old, especially in populations with high levels of malnutrition, a rate which I suggest could easily have obtained in Europe during the 18thcentury.[103]

Most measles-related deaths are caused by complications associated with the disease which usually occurs in winter and spring. It starts with a high fever, often greater than 40°C, followed by a cough, runny nose, red eyes, and after three to five days by a flat red rash, and photophobia. Small white spots may develop inside the mouth during the first stages of the disease (Koplik's spots). Complications are more common in children under the age of 5, or adults over the age of 30. The most serious include blindness, encephalitis, severe diarrhoea and related dehydration, ear infections, or severe respiratory infections such as pneumonia. Severe measles is more likely among poorly nourished young children, especially those with insufficient vitamin A, or whose immune systems have been weakened by other diseases.[104]

Pneumonia

Pneumonia is an inflammation affecting the alveoli of either one or both lungs. It is usually caused by viruses, bacteria, fungi, or rarely parasites and is a frequent complication of influenza. The symptoms include shaking chills, frequent coughing, pain in the chest and a very high temperature which may reach 40.55°C.[105] It was often

[103] HALSEY, Neal A., 'Measles in Developing Countries', BMJ, 16 December 2006, 6, http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1702417/pdf/bmj-333-7581-edit-01234.pdf; NANDY, Robin et al., 'Case-Fatality Rate during a Measles Outbreak in Eastern Niger in 2003', *Clinical Infectious Diseases* 42, no. 3 (2006): 322–28, https://doi.org/10.1086/499240.
[104] WHO, 'Measles', World Health Organisation Fact Sheet No 286, February 2015, http://www.who.int/mediacentre/factsheets/fs286/en/; WHO, 'Measles', World Health Organisation Immunization, Vaccines and Biologicals, 6 February 2014, http://www.who.int/immunization/topics/measles; GALE ENCYCLOPEDIA of MEDICINE, 'Measles', The Free Dictionary . com, 2008, http://medical-dictionary.thefreedictionary.com/measles.
[105] TURKINGTON, Carol and ASHBY, Bonny Lee, *The Encyclopedia of Infectious Diseases*, 3rd ed. (New York: Facts On File, 2007), 241–42, https://books.google.fr/books?id=4Xlyaipv3dIC&pg=PA242&redir_esc=y#v=onepage&q&f=false.

fatal before the advent of antibiotics. In the early 20th century the fatality rate was between 30% and 40%, and even now, the WHO say that worldwide, it accounts for 16% of all deaths of children under 5 years old, killing over 920,000 children in 2015.[106]As pneumonia had such a high death rate before the advent of antibiotics, it would be reasonable to think that the rate of mortality during the 18th century was even higher.

Pulmonary Tuberculosis

Pulmonary tuberculosis is recognised as being a disease of squalor, poverty, overcrowding, lack of decent sanitation and bad working conditions.[107] The disease has been known throughout human history, but it was only in the eighteenth and nineteenth centuries that it reached truly epidemic proportions in Britain and Europe, and it has been calculated that it killed one billion people throughout the world.[108] Tuberculosis is most commonly an infection of the lungs caused by the bacterium, Mycobacterium tuberculosis. Infection is almost invariably either by inhalation or ingestion of the organism, and once established may spread locally by direct invasion or more widely by the blood stream or lymphatics. Infections can, however, develop in areas outside the lungs, for example, the bones and joints, lymph nodes in the neck, when it is called scrofula, and the digestive, reproductive, urinary and nervous systems.[109]

Rickets

Rickets is a disease caused by a lack of Vitamin D, phosphorous or calcium which can lead to defective mineralization or calcification of bones before epiphyseal closure. It is a potentially devastating condition which can cause difficulties in walking, delayed

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[106] WHO, 'Pneumonia', World Health Organisation Fact Sheet No 331, November 2015, http://who.int/mediacentre/factsheets/fs331/en/; WIKIPEDIA, 'Pneumonia', Wikipedia, 9 2017, https://en.wikipedia.org/wiki/Pneumonia.
[107] WEISS, Kevin B. and ADDINGTON, Whitney W., 'Tuberculosis Poverty's Penalty', *American Journal of Respiratory and Critical Care Medicine* 157, no. 4 (1 April 1998): 1011, https://doi.org/10.1164/ajrccm.157.4.ed02-98.
[108] DANIEL, Thomas M., 'The History of Tuberculosis', *Respiratory Medicine* 100, no. 11 (November 2006): 1, http://dx.doi.org/10.1016/j.rmed.2006.08.006; WILLS, Simon, 'The White Plague: A History of Tuberculosis', *Your Family History*, November 2010, 38–41.
[109] NATIONAL HEALTH SERVICE, 'Tuberculosis (TB) Causes', NHS Choices, 3 December 2014, http://www.nhs.uk/Conditions/Tuberculosis/Pages/Causes.aspx; NATIONAL HEALTH SERVICE, 'Tuberculosis (TB) - Symptoms'.

growth, skeletal deformities such as bowed legs and thickened wrists and ankles, bone pain, osteomalacea, convulsions, tetany and hypotonia. It also increases the risk of pneumonia, and may be a cause of death if the infant is fed a Vitamin D deficient diet.[110]

Vitamin D is synthesized by the skin on exposure to sunlight, and can be found in various foods such as oily fish and egg yolks. Living in conditions which had little sunlight, and/or a very smoky or foggy atmosphere, was bound to inhibit the formation of vitamin D, which is essential for the absorption of calcium.[111]

Figure 3:13 Child with Rickets

Science Museum, London. Wellcome Images images@wellcome.ac.uk http://wellcomeimages.org

[110] MAYO CLINIC, 'Rickets Symptoms', Mayo Clinic, 1 June 2013, http://www.mayoclinic.org/diseases-conditions/rickets/basics/symptoms/con-20027091; WIKIPEDIA, 'Rickets', Wikipedia, 8 April 2016, https://en.wikipedia.org/wiki/Rickets; MESTROVIC, Tomislav, 'Rickets Symptoms', AZoNetwork Site, News Medical, 28 June 2015, http://www.news-medical.net/health/Rickets-Symptoms.aspx.
[111] WALLER, Maureen, *1700: Scenes from London Life*, 100; MAYO CLINIC, 'Rickets Symptoms'.

Francis Place, referring in his autobiography to his childhood in the 1770s, remembered how: "…the number of children who had 'cheese cutters', i.e. with the shin bone bowed out (with rickets) was formerly so great that if an estimate were made now (1824) it would not be believed."[112]

Scarlet fever or Scarlatina

Scarlet fever is caused by group A Streptococcus bacteria, the usual time of infection being from September to April. The disease is spread by aerosols caused by coughing and sneezing, direct contact with infected people or handling utensils and other objects which are contaminated with the bacteria. The symptoms are a red sore throat, swollen tonsils, high fever, followed by a red rash that looks like sunburn and feels like sandpaper, "strawberry" tongue, and nausea. It was once a very serious childhood disease, its complications may include, pneumonia, rheumatic fever, and kidney disease.[113]

Scrofula or King's Evil

Scrofula is a painless swelling of the lymph nodes of the neck, caused by the bacteria*,* Mycobacterium tuberculosis. In rare cases there may be a fever.[114]At one time it was believed that it could be cured by a touch from Royalty. The practice began with King Edward the Confessor in England (1003/4-1066) and Philip I (1052-1108) in France, and continued up until the reign of Queen Anne in England (died 1714) and Charles X in France (abdicated 1830).[115]

[112] PICARD, Lisa, *Dr Johnson's London : Everyday Life in London 1740-1770* (London: Weidenfield and Nicolson, 2000), 159.
[113] PHE (Public Health England), 'Scarlet Fever FAQs', Gov.uk, March 2014, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/338368/Scarlet_fever_Q_and_A_factsheet.pdf; VORVICK, Linda J., 'Scarlet Fever', MedlinePlus, 5 May 2014, https://www.nlm.nih.gov/medlineplus/ency/article/000974.htm; SPRIGGS, Brenda B., 'Scarlet Fever', Healthline, 7 August 2012, http://www.healthline.com/health/scarlet-fever#Overview1.
[114] VYAS, Jatin M., 'Scrofula', MedlinePlus, 12 July 2014, https://www.nlm.nih.gov/medlineplus/ency/article/001354.htm.
[115] CRAWFURD, Raymond, *The King's Evil* (Oxford: Clarendon Press, 1911), https://ia802601.us.archive.org/17/items/b21463554/b21463554.pdf; SCIENCE MUSEUM, 'King's Evil and the Royal Touch', Exploring the History of Medicine, accessed 22 October 2015, http://www.sciencemuseum.org.uk/broughttolife/techniques/kingsevil.aspx; SIMPSON, Jacqueline and ROUD, Steve, *A Dictionary of English Folklore* (Oxford: O.U.P., 2003), http://www.oxfordreference.com/view/10.1093/acref/9780198607663.001.0001/acref-9780198607663-e-582?rskey=XmXydv&result=573.

The following more bizarre cures have also been noted: the touch of a seventh son or blacksmith, or a toad's leg in a silk bag round one's neck.[116] Reginald Scot, writing in *The Discoverie of Witchcraft*, in 1584, said:

> "Remedies to cure the Kings or Queenes evill, is first to touch the place with the hand of one that died an untimelie death.Otherwise : Let a virgine fasting laie hir hand on the sore, and saie ; Apollo denieth that the heate of the plague can increase,where a naked virgine quencheth it : and spet three times upon it."[117]

The person who died an untimely death was often a hanged man.[118]

Scurvy

This was a widespread disease during the 16th to 18th centuries caused by the lack of vitamin C. The symptoms include fatigue, malaise, pain in limbs, small blue spots under the skin, gum disease, loosening of teeth, poor wound healing, and emotional changes occur. If left untreated, the disease will ultimately lead to death due to hemopericardium or various kinds of haemorrhage.[119] Normally thought of as a scourge of the European navies during this period, it may seem surprising that it could occur in all sectors of the population, especially when one considers that the majority of people lived either in, or within easy reach of, the countryside.[120]

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[116] SIMPSON, Jacqueline and ROUD, Steve, *A Dictionary of English Folklore*.
[117] SCOT, Reginald, *The Discoverie of Witchcraft: Being a Reprint of the First Edition Published in 1584*, ed. NICHOLSON, Brinsley (London: Elliot Stock, 1886), 197, https://www.scribd.com/document/117063885/The-Discovery-of-Witchcraft-1584.
[118] SIMPSON, Jacqueline and ROUD, Steve, *A Dictionary of English Folklore*; DAVIES, Owen and MATTEONI, Francesca, '"A Virtue beyond All Medicine": The Hanged Man's Hand, Gallows Tradition and Healing in Eighteenth- and Nineteenth-Century England', *Social History of Medicine* 28, no. 2 (28 October 2015): 686–705, https://doi.org/10.1093/shm/hkv044; SCOT, Reginald, *The Discoverie of Witchcraft: Being a Reprint of the First Edition Published in 1584*, 197.
[119] National Health Service, 'Scurvy - Symptoms', NHS Choices, 14 January 2015, http://www.nhs.uk/conditions/Scurvy/Pages/Symptoms.aspx; GOEBEL, Lynne, 'Scurvy Clinical Presentation', Medscape, accessed 29 November 2015, http://emedicine.medscape.com/article/125350-clinical; PRINZO, Zita Weise, 'Scurvy and Its Prevention and Control in Major Emergencies', UNHCR (United Nations High Commissioner for Refugees), 1999, 4–5, http://www.unhcr.org/4cbef0599.pdf.
[120] HARVEY, Gideon, *The Disease of London, or, A New Discovery of the Scorvey : Comprizing the Nature, Manifold Differences, Various Causes, Signs, Prognostics, Chronology, and Several Methods of Curing the Said Disease by Remedies, Both Galenical, and Chymical, Together with Anatomical Observations, and Discourses on Convulsions, Palsies, Apoplexies, Rheumatisms, Gouts, Malignant Fevors, and Small Pox, with Their Methods of Cure and Remedies : Likewise Particular Observations on Most of the Fore-Mentioned Diseases* (London: W. Thackery, 1675), http://quod.lib.umich.edu/e/eebo/A43016.0001.001/1:4?rgn=div1;view=fulltext.Gideon Harvey, a 17th century doctor thinking that Scurvy was a new disease, called it "the disease of London.", in his book The disease of London, or, A new discovery of the scorvey. http://quod.lib.umich.edu/e/eebo/A43016.0001.001/1:4?rgn=div1;view=fulltext. LAMB, Jonathan, 'Captain Cook and the

People, did, of course, eat fruit and vegetables from pleasure or necessity, but there is overwhelming evidence that when possible, or when they could afford to, many people ate almost exclusively meat, fish, game, pies and sweetmeats, to the exclusion of vegetables, from their diet. This is one reason why well-off people came down with scurvy.

When people did eat vegetables or fruit, they weren't, unfortunately, guaranteed an adequate supply of vitamin C throughout the year. Owing to the poor dental health of the population, vegetables, which were tougher than they are today, had to be boiled for long enough to soften them, thus destroying most of their inherent goodness. And it must not be forgotten that fresh fruit and vegetables were seasonal commodities, only being available during the spring and summer months. This meant that the only produce available were things that could keep reasonably well, such as onions and apples. Potatoes, although rich in Vitamin C and well known in Europe as animal food, did not gain acceptance for humans until well on into the century.[121] We must also remember the vicissitudes of the weather and the problems caused by insect pests. These frequently produced crop failures and shortages of locally grown produce that could not easily be accommodated owing to the bad state of the roads and the slowness and high cost of transport from other regions or countries.[122]

It is interesting to note that the second edition of A New and Complete Dictionary of Arts and Sciences published in 1764, has this to say about the causes of the disease, and recommends mineral waters, a milk diet or whey impregnated with, amongst other things, the juices of antiscorbutic herbs such as scurvy-grass and water-cress.

> […] the scurvy chiefly affects the inhabitants of cold northern countries, especially those who live in marshy, low, fat, and moist soils, near

Scourge of Scurvy', BBC History, 17 February 2011, http://www.bbc.co.uk/history/british/empire_seapower/captaincook_scurvy_01.shtml For a vivid description of the disease see Jonathan Lamb, Captain Cook and the Scourge of Scurvy, where he quotes Richard Walter, the chaplain on Anson's voyage to the Pacific in the 1740s, http://www.bbc.co.uk/history/british/empire_seapower/captaincook_scurvy_01.shtml .

121 ALLEN, Andrew, *A Dictionary of Sussex Folk Medicine*, 131–32; CHAPMAN, Jeff, 'The Impact of the Potato', History Magazine, 1 August 2000, http://www.history-magazine.com/potato.html.

122 ALLEN, Andrew, *A Dictionary of Sussex Folk Medicine*, 132.

> stagnating waters, whether fresh or salt. Those who live idle sedentary lives are most subject, chiefly in the winter-time, to the attacks of this distemper; as also those feeding upon salted and smoke-dried flesh or fish, sea-biscuit, stinking water, unfermented farinaceous vegetables, peas, beans, sharp, salt, old cheese; likewise those who are subject to melancholic, maniacal hysteric or hypochondriacal disorders.[123]

The English naval surgeon, William Clowes, writing in 1596, gave a graphic description of the disease:

> Their gums were rotten even to the very roots of their teeth, and their cheeks hard and swollen, the teeth were very loose neere ready to fall out […] their breath a filthy savour. Their legs were feeble and so weak, that they were not scarce able to carrie their bodies. Moreover they were full of aches and paines, with many blewish and reddish staines or spots, some broad and some small like flea-biting.[124]

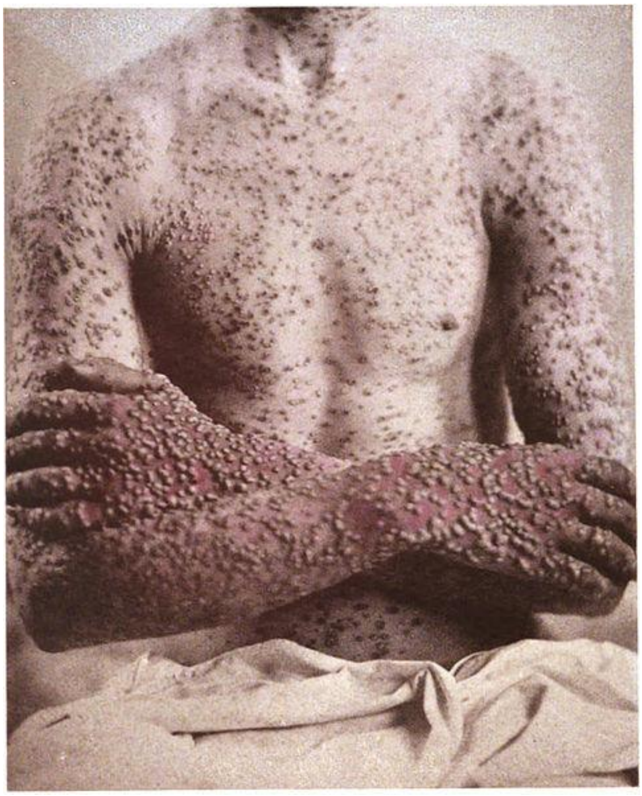
<u>Smallpox</u>

A highly infectious disease which was caused by one of two variants, Variola major and Variola minor, V. major being the most dangerous.[125] It has been estimated that smallpox was killing as many as 400,000 people per year in Europe by the end of the 18th century. Sadly, the majority of these deaths were children, as it was "*chiefly a disease of infancy and early childhood"*.[126] However, even if some of the population

[123] SOCIETY of GENTLEMEN, *A New and Complete Dictionary of Arts and Sciences : Comprehending All the Branches of Useful Knowledge, with Accurate Descriptions as Well of the Various Machines, Instruments, Tools, Figures, and Schemes Necessary for Illustrating Them, as of the Classes, Kinds, Preparations, and Uses of Natural Productions, Whether Animals, Vegetables, Minerals, Fossils, or Fluids : Together with the Kingdoms, Provinces, Cities, Towns, and Other Remarkable Places throughout the World : Illustrated with above Three Hundred Copper-Plates, Curiously Engraved by Mr. Jefferys, Geographer to His Majesty. The Whole Extracted from the Best Authors in All Languages*, 2nd ed., vol. 4 (London: W. Owen, 1764), 2895–96, https://books.google.fr/books?id=5Yw9AAAAYAAJ&pg=PA2895&lpg=PA2895&dq=This+distemper+chiefly+affects+the+inhabitants+of+cold+northern+countries,&source=bl&ots=4J7Oor3IRD&sig=0Xu7zy-nmDxOXFj_besgKwFb_Os&hl=en&sa=X&ved=0ahUKEwi77_SF8IvWAhXEChoKHTk7C6YQ6AEIJjAA#v=onepage&q=This%20distemper%20chiefly%20affects%20the%20inhabitants%20of%20cold%20northern%20countries%2C&f=false.
[124] DOBSON, Mary J., *Murderous Contagion : A Human History of Disease*, Revised and updated edition (London: Quercus Editions, 2015), 467.
[125] DIXON, Cyril William, *Smallpox* (London: J. & A. Churchill, 1962), 1, 203–4, https://www.nlm.nih.gov/nichsr/esmallpox/smallpox_dixon.pdf; WIKIPEDIA, 'Smallpox'; SMITH, J. R., *The Speckled Monster: Smallpox in England, 1670-1970, with Particular Reference to Essex* (Chelmsford: Essex Record Office, 1987), 179–82.
[126] WILLS, Simon, 'The Great Killer', *Your Family History*, January 2011, 38–41; CREIGHTON, Charles, *A History of Epidemics in Britain. Vol. 2 From the Extinction of Plague to the Present Time.*, 2:557.

survive the disease itself, they may well succumb to secondary infections such as bronchopneumonia and streptococcal septicaemia.[127]

Figure 3:14 Smallpox - Variola



By George Henry Fox [Public domain], via Wikimedia Commons

Syphilis and Gonorrhoea

It used to be thought that gonorrhoea which is caused by the bacterium, Neisseria gonorrhoeae and syphilis by the bacterium, Treponema pallidum, were manifestations of the same disease and it was not until 1838 that Philippe Ricord proved that they were separate diseases.[128] Syphilis was known as the Great or French Pox, the morbus gallicus, in England, whilst the French called it the Neapolitan disease, the Spanish disease, and later grande or grosse verole.[129] It first made its terrible appearance in

127 COX, Margaret, *Life and Death in Spitalfields, 1700-1850*, 21:74.

128 FRITH, John, 'Syphilis – Its Early History and Treatment until Penicillin and the Debate on Its Origins', *Journal of Military and Veterans' Health* 20, no. 4 (November 2012): 52, http://jmvh.org/article/syphilis-its-early-history-and-treatment-until-penicillin-and-the-debate-on-its-origins/; WIKIPEDIA, 'Syphilis', Wikipedia, 6 April 2016, https://en.wikipedia.org/wiki/Syphilis; NATIONAL HEALTH SERVICE, 'Gonorrhoea', NHS Choices, 28 July 2015, http://www.nhs.uk/Conditions/Gonorrhoea/Pages/Introduction.aspx.

129 WIKIPEDIA, 'Syphilis'; FRITH, John, 'Syphilis – Its Early History and Treatment until Penicillin and the Debate on Its Origins', 50.

Naples in 1493-94 during the war between Spain and France and by 1500 had spread throughout Europe like wildfire. The disease began with genital sores, progressed to a general rash, ulceration, and abscesses, eating into bones and destroying nose, lips and genitals, and often proved fatal.[130]

Venereal diseases are seldom mentioned as a direct cause of death; for example, in the London Bills of Mortality, French Pox only accounted for 49 deaths out of a total of 19,024, i.e. 0.257% in 1783, and in 1784 only 32 deaths out of a total of 17,828, i.e. 0.179%, were recorded. However, unpleasant as they were, they must have been extremely familiar to many as can be seen from the large number of adverts appearing in the newspapers of the time. The following, of which this is a typical example, appeared in the *Chester Chronicle, 1st October 1790:*

A MEDICINE
For the PREVENTION and infallible CURE of
ALL DEGREES of
VENEREAL INFECTION
THE Abbe Blondel's Grand Chymical Specific
(a preparation founded on true medical principles) is now
in the highest estimation throughout France, Spain, Portugal,
Germany, Italy, and other parts of the continent of Europe
For its peculiar efficacy in the PREVENTION of the VE-
NEREAL DISEASE, and effectual CURE of it when caught;
and what heightens its importance is, that it renders the com-
mon mercurial preparations unnecessary; by the profuse admi-
nistration of which (either through ignorance or unwarranta-
ble quackery) a far greater number of patients have been de-
stroyed than cured….[131]

130 LINDEMANN, Mary, *Medicine and Society in Early Modern Europe*, 1st ed., vol. 16, New Approaches to European History (Cambridge, New York: Cambridge University Press, 1999), 56–57.

131 CHESTER CHRONICLE, 'Advert for: A Medicine for the Prevention and Infallible Cure of All Degrees of Venereal Infection ...', *Chester Chronicle*, 1 October 1790, https://search.findmypast.co.uk/bna/viewarticle?id=bl%2f0000341%2f17901001%2f012&stringtohighlight=medicine.

As the medical profession relied on cures of doubtful efficacy using mercuric compounds, one cannot wonder that the general public proved an easy prey for the vendors of such nostrums.[132]

Enteric fever (Typhoid and Paratyphoid)

Typhoid

This is caused by the typhoid bacillus, Salmonella typhi. The symptoms include, high fever from 39°C to 40°C, lassitude, headache, muscle & abdominal pains, constipation, diarrhoea, loss of appetite, sweating, and chills. Usually, contamination is through the ingestion of food or water which has become contaminated by the faeces of an infected person. Flies which feed on faeces can also transfer the bacteria to food. In addition, a small number of persons, called carriers, recover from typhoid fever but continue to carry the bacteria which can be transmitted to others as mentioned above. Both ill persons and carriers shed Salmonella typhi in their faeces and urine. Without treatment, the death rate may be as high as 25%.[133]

Paratyphoid

Paratyphoid is a bacterial infection which is caused by any of three strains of Salmonella paratyphi: S. paratyphi A; S. schottmuelleri (also called S. paratyphi C); or S. hirschfeldii (also called S. paratyphi B). Like typhoid, infection is invariably from a human source, although it can be transmitted by animals or by animal products, the bacteria gaining access to the body through contaminated food or drink. Although not as deadly as typhoid, the death rate being between 10% and 15%, it is still a very dangerous disease.[134]

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[132] PORTER, Roy, *Quacks: Fakers and Charlatans in English Medicine*, Illustrated (Stroud & Charleston, SC: Tempus, 2000), 110–11, 133–40, 155; MACGREGOR, Helen, 'Eighteenth-Century V.D. Publicity', *British Journal of Venereal Diseases* 31, no. 2 (1955): 117–18, https://doi.org/10.1136/sti.31.2.117.
[133] ADAMS, E. B., 'Typhoid and Paratyphoid Fevers', in *Oxford Textbook of Medicine*, ed. WEATHERALL, D.J., and LEDINGHAM, J.G.G., 2nd ed., vol. 1 (Oxford: O.U.P., 1987), 223–25.
[134] ADAMS, E. B., 5.223-5.224; WIKIPEDIA, 'Paratyphoid Fever', Wikipedia, 22 September 2015, https://en.wikipedia.org/wiki/Paratyphoid_fever.

Typhus

In the restricted sense, this refers to the classical epidemic, or louse-borne disease caused by the bacteria, Rickettsia prowazekii. It is transmitted to man by the human body louse, Pediculus humanus (Fig. 3:15) which becomes infected by feeding on the blood of someone who is suffering from the disease. Infected lice excrete rickettsia onto the skin while feeding on a second host, who becomes infected by rubbing louse faecal matter or crushed lice into the bite wound.[135]Typhus can also be spread by infected dried faeces dust inhaled into the mucous membranes of the upper respiratory tract, a common cause in closed buildings during cold weather.[136] The onset is often sudden, with a high fever rising to 41.1°C. (106°F.) or so within 48 hours and continuing for up to two weeks. Various other symptoms include, cough, chills, delirium, joint pain, confusion, low blood pressure, severe headache, muscle pain, stupor, rash beginning on chest and spreading to rest of body, but not to face, palms of hands or soles of feet, eyes may be hurt by light. The disease runs a severe and often fatal course, with a death rate of between 40%-60% if left untreated.[137]

Figure 3:15 Human body louse - Pediculus humanus var. corporis

By Janice Harney Carr, Center for Disease Control [Public domain], via Wikimedia Commons

[135] WHO, ‘Typhus Fever (Epidemic Louse-Borne Typhus)’.
[136] DOBSON, Mary J., *Contours of Death and Disease in Early Modern England*, Cambridge Studies in Population, Economy and Society in Past Time (Cambridge University Press, 1997), 462.
[137] VYAS, Jatin M., ‘Typhus’, MedlinePlus, 12 July 2014, https://www.nlm.nih.gov/medlineplus/ency/article/001363.htm; WHO, ‘Typhus Fever (Epidemic Louse-Borne Typhus)’.

Whooping cough or pertussis

Whooping cough is a highly contagious disease caused by the bacteria, Bordetella pertussis. Before the introduction of a whooping cough vaccine, in 1950, it was a common cause of death among young children. The disease comes in two stages, the first, known as the catarrhal stage, lasts from a few days to a fortnight, and resembles a common cold, with sneezing, runny nose, watery eyes, and mild fever. In the second or paroxysmal stage, the cold symptoms disappear, but the cough gets worse, leading to intense bouts of coughing, followed by a characteristic whooping sound on the intake of breath, vomiting and sometimes fainting may follow. Coughing can also cause subconjunctival haemorrhages, hernias, fractured ribs, and pneumothorax or collapsed lung. Babies or young children can suffer from dehydration, low blood pressure, kidney failure, fits, brain damage and pneumonia, the latter two proving fatal without treatment.[138]

Worms

According to the *New and Complete Dictionary of Art and Sciences* at least three types of intestinal worm were recognised during the 18th century:

> There are three species of worms, most frequent in the human body; the lumbrici, the ascarides, and the taenia. The lumbricid […] are generally broad and long, and roll themselves up in a strange manner. The ascarides have their feet chiefly in the gross intestines, and are more plentiful in the rectum; they are round and small, and are thrown out in large quantities. The broad worm, called taenia, is like a swathe, commonly two ells (2.3m) long, but sometimes much longer, and divided with cross joints or knots.[139]

[138] WIKIPEDIA, 'Pertussis', Wikipedia, 25 November 2015, https://en.wikipedia.org/wiki/Pertussis; WebMD, 'The Dangers of Whooping Cough (Pertussis)', WebMD, accessed 3 December 2015, http://www.webmd.com/children/features/the-dangers-of-whooping-cough-pertussis?page=2; NATIONAL HEALTH SERVICE, 'Whooping Cough- Complications', NHS Choices, 1 July 2014, http://www.nhs.uk/Conditions/Whooping-cough/Pages/Complications.aspx.

[139] SOCIETY of GENTLEMEN, *A New and Complete Dictionary of Arts and Sciences : Comprehending All the Branches of Useful Knowledge, with Accurate Descriptions as Well of the Various Machines, Instruments, Tools, Figures, and Schemes Necessary for Illustrating Them, as of the Classes, Kinds, Preparations, and Uses of Natural Productions, Whether Animals, Vegetables, Minerals, Fossils, or Fluids : Together with the Kingdoms, Provinces, Cities, Towns, and Other Remarkable Places throughout the World : Illustrated with above Three Hundred Copper-Plates, Curiously Engraved by Mr. Jefferys, Geographer to His Majesty. The Whole Extracted from the Best Authors in All Languages*, 4:3474.

These worms which are now called roundworms (Fig. 3:16), thread or pinworms (Fig. 3:17), and tapeworms (Fig. 3:18), were clearly recognised as unpleasant nuisances. Infection from roundworms occurs through the ingestion of their eggs in food, for example in vegetables not properly cooked or prepared, or through contact with soil or water contaminated with faeces. Threadworm infections are spread from person to person by swallowing the worm eggs. They are transferred through direct human contact, or by touching a contaminated object. Tapeworm infections are usually spread by eating raw or undercooked beef, pork, or freshwater fish. They can also be caught by drinking water or food that has been in contact with faeces of an infected person, or by close contact with clothing, articles or food handled by such a person [140]

Intestinal worms, described as were a common occurrence amongst children, and although extremely unpleasant, would probably not have caused any deaths directly. However, it seems quite possible that they could lower the resistance of a child who repeatedly ingested the eggs through unwashed hands, thus prolonging the infection and increasing the likelihood that it would succumb to other more life-threatening diseases.[141]

[140] NATIONAL HEALTH SERVICE, 'Roundworm', NHS Choices, 26 August 2017, http://www.nhs.uk/conditions/Roundworm/Pages/Introduction.aspx; NATIONAL HEALTH SERVICE, 'Threadworms - Causes', NHS Choices, 24 August 2015, http://www.nhs.uk/Conditions/Threadworms/Pages/Causes.aspx; NATIONAL HEALTH SERVICE; HEXDOCTOR, 'Worm Infection - Treatment and Recovery', Hexdoctor.com, n/d, http://www.hexdoctor.com/human-worm-infection.aspx; WHO, 'What Are Intestinal Worms (Soil Transmitted Helminthiasis) ?', World Health Organisation Fact Sheet, 2017, http://www.who.int/intestinal_worms/en/.
[141] WALLER, Maureen, *1700: Scenes from London Life*, 98–99.

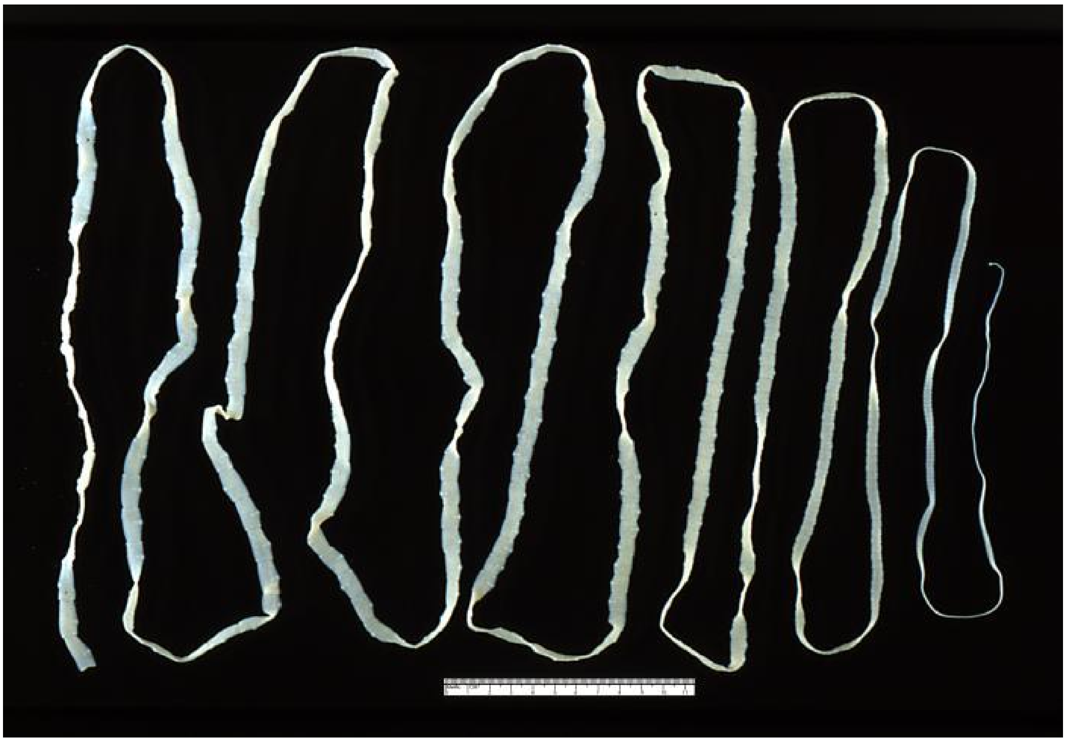
Figure 3:16 Human Roundworm - Ascaris lumbricoides

Public domain, via Wikimedia Commons

Figure 3:17 Human Threadworms - Enterobius vermicularis next to ruler: the markings are 1 mm apart

Public domain ,Erich gasboy via Wikimedia Commons

Figure 3:18 Human Tapeworm – Taenia saginata



Public domain, via Wikimedia Commons

John Pechey, writing at the end of the 17th century, had the following to say:

> "Oftentimes Children are extreamly troubled with Worms; they are generated of a viscous and flegmy humor; are sometimes round, and then Children are commonly troubled with a Feaver, and grow lean, their appetite fails them, they start in their sleep, they have a dry cough joyned with it, with a stinking breath, and an ill colour in their faces; the eyes hollow and dark with a kind of irregular Feaver, which comes three or four times a night, and they often rub their noses; if they be little worms, they have always a desire to go to stool, and their excrements are very purous".[142]

[142] PECHEY, John et al., *The Compleat Midwife's Practice Enlarged : In the Most Weighty and High Concernments of the Birth of Man. Containing a Perfect Directory, or Rules for Midwives and Nurses. As Also a Guide for Women in Their Conception, Bearing and Nursing of Children: From the Experience of Our English Authors. Viz. Sir Theodore Mayerne, Dr. Chamberlain, Mr. Nich. Culpeper. and Others of Forreign Nations. With Instructions of the Queen of France's Midwife to Her Daughter, a Little before Her Death, Touching the Practice of the Said Art. As Also a Farther Discovery of Those Secrets Kept Close in the Breast of Sir Theodore Mayern, Mr. Nicholas Culpeper, and Other English Writers, Not Made Publick 'till Now. The Fifth Edition Corrected, and Much Enlarged,* 5th ed. (London: H. Rhodes, J. Phillips, J. Taylor & K. Bentley, 1698), http://quod.lib.umich.edu/e/eebo/A53913.0001.001?view=toc See also Society of Gentlemen op. cit. pp. 3474-3475.

3:3:3 Occupational Diseases

An occupational disease is any chronic disability that occurs as a result of work or occupational activity. Although these afflictions were unlikely to kill in the short term, they might so weaken the constitution of the victim that he died from one or other of the diseases which were prevalent at the time, especially when an epidemic such as smallpox was raging. Many of the diseases mentioned below affected the lungs and would, therefore, have been exacerbated by a sulphurous fog such as Laki's.

A Mr. J. Howlett, writing in the Gentleman's Magazine of 1782, was under no misapprehension as to the severity of these diseases and their devastating effects:

> The collier, the clothier, the painter, the gilder, the miner, the makers of glass, the workers in iron, tin, lead, copper, while they minister to our necessities, or please our tastes and fancies, are impairing their health and shortening their days…*Arts* and *Manufactures* can present as long a catalogue of our fellow creatures suffocated in mines and pits, or gradually poisoned by the noxious effluvia of metals, oils, powders, spirits, &c. used in their work and can exhibit as mournful a scene of blind and lame, of enfeebled, decrepit, asthmatic, consumptive wretches, panting for breath, and crawling half alive upon the surface of the earth.[143]

Although Howlett was writing some 20 years after the start of the Industrial Revolution, he failed to mention the rise of the factory system with all its attendant ills. Workers in cotton mills had to endure working in a hot, damp atmosphere for some twelve or more hours per day, six days a week.[144] In a report to the House of Lords Committee regarding the health of workers in cotton factories, Dr Michael Ward, had this to say about the horrendous conditions in which they worked:

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[143] HOWLETT, J., *The Gentleman's Magazine; and Historical Chronicle*, ed. URBAN, Sylvanus John, vol. 52 (London: J. Nichols, 1782), 526, https://babel.hathitrust.org/cgi/pt?id=mdp.39015013465862;view=1up;seq=552.
[144] PORTER, Roy, *English Society in the 18th Century*, 335.

> "I have had frequent opportunities of seeing people coming out from the factories and occasionally attending as patients. Last summer I visited three cotton factories with Dr Clough of Preston and Mr. Barker of Manchester and we could not remain ten minutes in the factory without gasping for breath. How it is possible for those who are doomed to remain there twelve or fifteen hours to endure it? If we take into account the heated temperature of the air, and the contamination of the air, it is a matter of astonishment to my mind, how the work people can bear the confinement for so great a length of time."[145]

Working conditions such as these led to an appalling rise in tuberculosis, bronchitis, asthma, and byssinosis (brown lung disease), whilst forcing children to crawl into unguarded machinery to pick up threads made injuries commonplace. Grinders' lung or Sheffield grinders' disease caused by dry-grinding cutlery, lead poisoning from paint manufacture and lead glazes used in the potteries were often lethal.[146]

Breathing in fumes from poisonous chemicals was highly dangerous; for example, inhaling vapour from mercury used in the manufacture of felt hats, caused Mad hatter disease. Close contact with soot, a carcinogenic substance, caused Chimney sweeps' carcinoma, a form of skin cancer affecting the scrotum of young men or boys who had worked as sweeps for most of their lives, and which, if left untreated, proved fatal.[147]

People living in rural environments were not immune from the effects of work-related diseases. For example, "farmers lung", a potentially fatal disease, was liable to be caught by those working with damp mouldy hay or other cereal crops and inhaling the

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[145] COMMITTEE on COTTON FACTORIES, 'Committee Evidence on Cotton Factories' (House of Lords, 25 March 1819), Main Papers, Parliamentary Archives, HL/PO/JO/10/8/410 Volume 10 pp. 2 & 3 paraphrased in SIMKIN; SIMKIN, John, 'Michael Ward', Spartacus Educational, September 1997, http://spartacus-educational.com/IRward.htm.
[146] PORTER, Roy, *English Society in the 18th Century*, 335.
[147] KIPLING, M. D. and WALDRON, H. A., 'Percival Pott and Cancer Scroti', *British Journal of Industrial Medicine* 32, no. 3 (1 August 1975): 244–46, http://oem.bmj.com/content/oemed/32/3/244.full.pdf.

dust and spores so produced, which, in turn, could cause an allergic reaction in the lungs of susceptible individuals.[148]

3:3:4 Human Illnesses associated with volcanic eruptions

Having looked at the diseases that were common during this period, we shall now turn our attention to those that could have been caused or at least exacerbated by the Laki eruption. In Table 3:2 we can see a summary of human illnesses which have been collected from contemporary records and were believed to have been caused by the Laki dry fog, and in Table 3:3 the potential ill-health effects caused by volcanic ash and gas emissions. These afflictions fall into three main categories, namely: those connected with the respiratory system, those connected with the head, and miscellaneous. Maps 1:3 - 1:5, listed in Chapter 1, show that a great part of Northern Europe was affected by the dry fog, and that its effects ranged from the benevolent in parts of eastern and southern Europe, to the distinctly unpleasant in France and the Netherlands. It is these effects which will now be discussed relative to their impact on human health.

Given the extent of medical knowledge at the time, it is not surprising that a whole host of symptoms, ranging from difficulty in breathing, tingling hands, and loss of appetite, to diarrhoea and dysentery, were blamed on the fog, whether or not it was the actual cause.

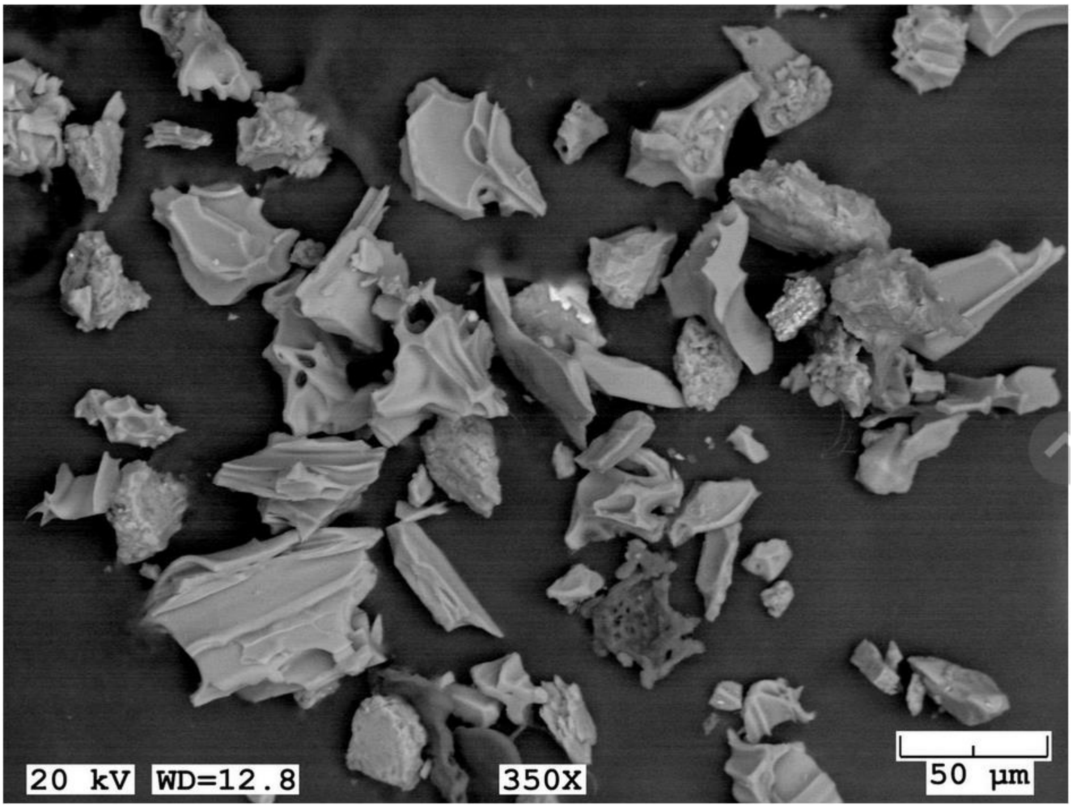
Volcanic Ash

As can be seen from the accompanying electron micrographs of more recent volcanic events, Figs.3:20 – 22, volcanic ash is composed of irregularly-shaped particles with sharp, jagged edges. Whereas volcanic ash is defined as pyroclasts having a diameter of 2mm or less (those having a greater diameter are known as lapilli),[149] the very fine

[148] WILD, Laurianne G., 'Farmer's Lung', Medscape, 21 December 2015, https://emedicine.medscape.com/article/298811-overview; M. J. DOBSON, *A Chronology of Epidemic Disease and Mortality in Southeast England, 1601-1800* (London: Historical Geography Research Group, 1987), 476.
[149] ROSE, W. I. and DURANT, A. J., 'Fine Ash Content of Explosive Eruptions', *Journal of Volcanology and Geothermal Research* 186, no. 1 (September 2009): 32–39, https://doi.org/10.1016/j.jvolgeores.2009.01.010.

ash which is of concern to us has a diameter of < 15 μm or smaller. The importance of the grain size of ash particles and their ability to be inhaled into the lungs is graphically illustrated in Fig.3:23. This shows that particles of < 15 μm are likely to effect the upper respiratory tract, particles of < 10 μm may be inhaled as far as the lungs, whilst particles of < 4 μm and smaller have the potential of penetrating as far as the alveolar region:[150] limited human studies indicate that ultrafine particles, of < 0.1 μm, are the most toxic.[151]

Figure 3:19 Scanning Electron Microscope image of volcanic ash from the 1912 Novarupta-Katmai deposits in the Katmai region, Alaska

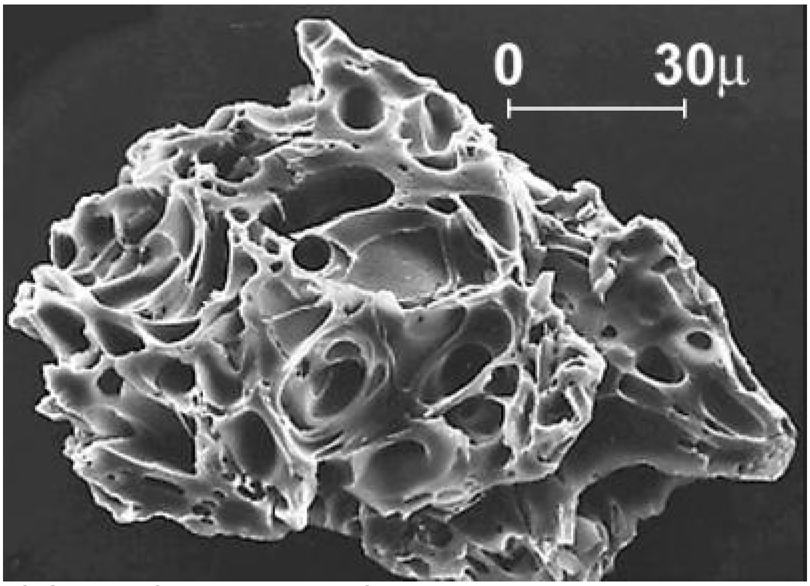


Alaska Volcano Observatory, U.S. Geological Survey. Photo by Kristi Wallace.

[150] GUDMUNDSSON, Gunar, 'Respiratory Health Effects of Volcanic Ash with Special Reference to Iceland. A Review', *The Clinical Respiratory Journal* 5, no. 1 (29 November 2010): 2–9, https://doi.org/10.1111/j.1752-699X.2010.00231; HORWELL, Claire J. and BAXTER, Peter J., 'The Respiratory Health Hazards of Volcanic Ash: A Review for Volcanic Risk Mitigation', *Bulletin of Volcanology* 69, no. 1 (July 2006): 3, https://doi.org/10.1007/s00445-006-0052-y.

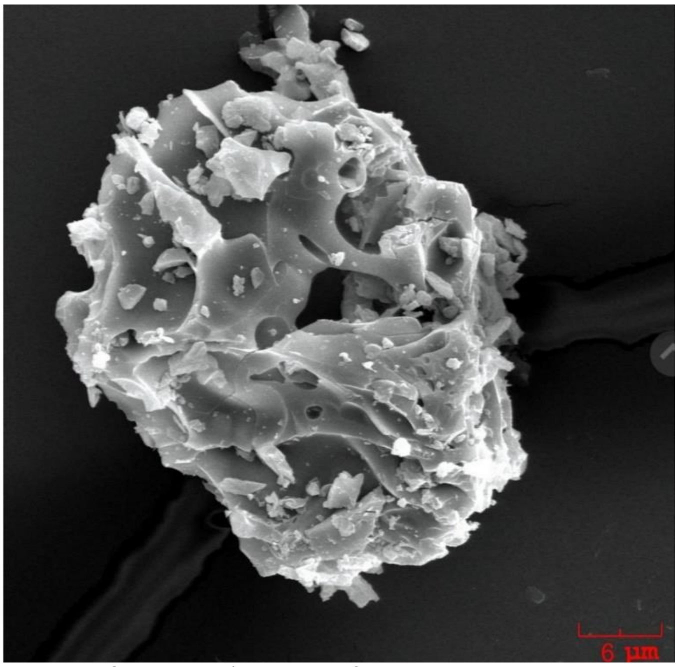
[151] HORWELL, Claire J. and BAXTER, Peter J., 'The Respiratory Health Hazards of Volcanic Ash: A Review for Volcanic Risk Mitigation', 3; EXPERT PANEL ON AIR QUALITY STANDARDS, 'Airborne Particles: What Is the Appropriate Measurement on Which to Base a Standard? A Discussion Document. Department for Environment, Food & Rural Affairs', National Archives, 17 May 2001, http://webarchive.nationalarchives.gov.uk/20060215181825/http://www.defra.gov.uk/environment/airquality/aqs/air_measure/06.htm#04.

Figure 3:20 Volcanic Ash particle, 1980 Mount St. Helens eruption, x 200



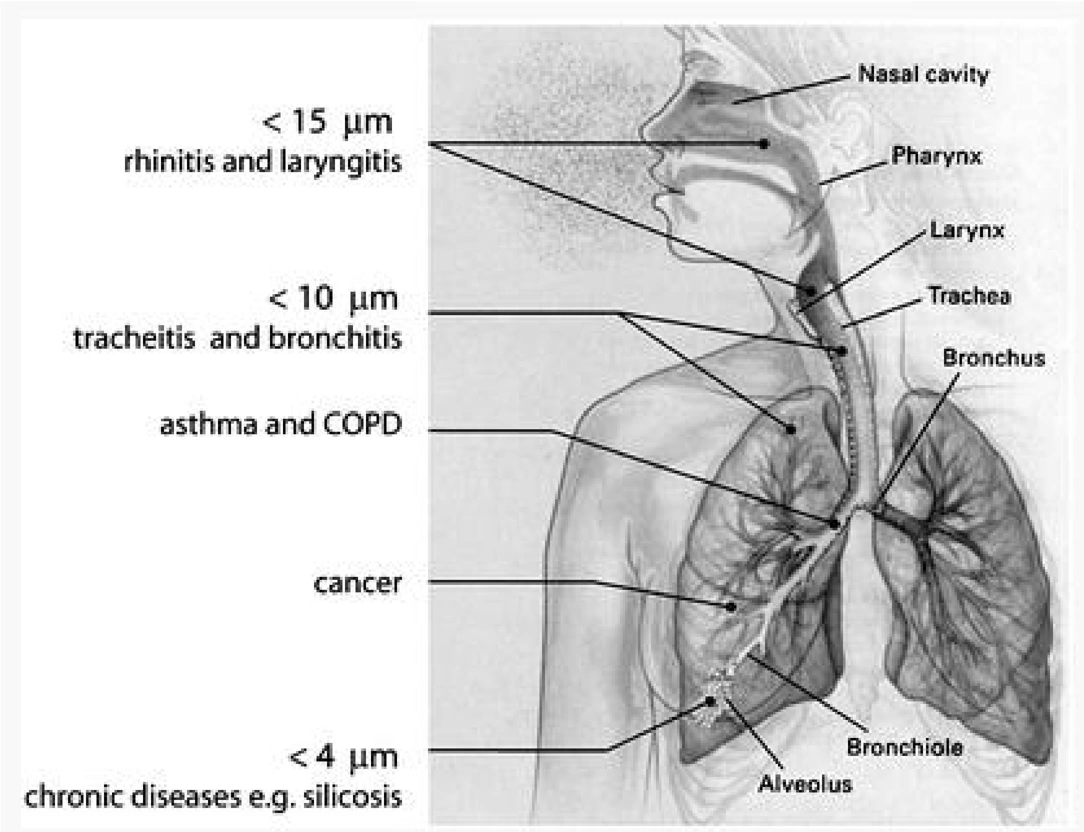
U.S. Geological Survey photo by A.M. Sarna-Wojcick

Figure 3:21 Vesicular ash particle erupted by Augustine volcano on January 13, 2006



Alaska Volcano Observatory / University of Alaska Fairbanks.
Photo by peizbekov@alaska.edu

Figure 3:22 Diagram of the lung showing the anatomy of the lung and airways, and the penetration of ash and gas particles of different sizes associated with their potential health effects



From Horwell and Baxter, 2006

Respiratory effects of volcanic ash

Surface properties and mineral composition are thought to influence the health effects of ash particles. Freshly erupted ash particles have had no time to weather, they are still rough and have not been leached or oxidised, thus making it easy for them to adsorb sulphuric or other acids from gasses in the volcanic plume. This in turn may cause added irritability when inhaled.[152] Should Fe^{2+} be present in the ash, it could result in the generation of free radicals through interaction with hydrogen peroxide already present in the lungs, and this in turn, could provoke a toxic reaction akin to that produced by crystalline silica.[153]

[152] HORWELL, Claire J. and BAXTER, Peter J., 'The Respiratory Health Hazards of Volcanic Ash: A Review for Volcanic Risk Mitigation', 3 COPD: Chronic Obstructive Pulmonary Disease.
[153] HORWELL, Claire J. and BAXTER, Peter J., 5; GUDMUNDSSON, Gunar, 'Respiratory Health Effects of Volcanic Ash with Special Reference to Iceland. A Review'.

The morphology of particles may also have a health impact. For example, fibrous particles having a diameter < 3 µm and a length > 5 µm may have an effect similar to asbestos, although in a recent study, Damby et al state that few "*fiber-like particles were observed, but those present comprised glass or sodium oxides, and are not related to pathogenic natural fibres, like asbestos or fibrous zeolites, thereby limiting concern of associated respiratory diseases.*"[154]

Volcanic Gases

Kizer, has described the various gaseous products produced by volcanic activity as follows:

> Gases and vapours: The gaseous state of an element which normally exists in a liquid or solid form and can be readily reverted to this form by decreases in temperature or increases in pressure, for example, mercury.
>
> Aerosols: Droplets or particles suspended in a gaseous medium. Aerosols composed of tiny droplets of sulfuric acid are commonly formed during explosive volcanic eruptions.
>
> Fumes: Aerosols of solid particles, usually less than < 0.1 µm in size, usually formed by the escape of volatiles from molten materials.
>
> Smoke: Volatile gases or particles, usually less than < 0.5 µm in size, produced by combustion.[155]

[154] DAMBY, David E. et al., 'Assessment of the Potential Respiratory Hazard of Volcanic Ash from Future Icelandic Eruptions: A Study of Archived Basaltic to Rhyolitic Ash Samples', *Environmental Health* 16, no. 98 (11 September 2017): 1, https://doi.org/10.1186/s12940-017-0302-9.
[155] KIZER, K. W., 'Toxic Inhalations', *Emergency Medicine Clinics of North America* 2, no. 3 (August 1984): 649–66 Cited in Weinstein and Cook (2005).

Table 3:2 Summary of human illnesses reported in conjunction with the dry fog in Europe in 1783

Type	Symptom	Location	Reporter
Respiratory	Disagreeable symptoms (in those with weak chest)	France	de Lamanon[156]
	Pestilence of the throat	France	Dreux[157], Curé d'Umpeau[158]
	Similar to that when exposed to SO_2 (in those with weak chest)	Netherlands	van Swinden[159]
	Difficulty breathing, like when exposed to SO_2 (worse in asthmatics)	Netherlands	Brugmans[160]
	Tingling throat	France	Harreaux[161]
Head	Headaches	France	Anon[162]
	Headaches	Netherlands	Brugmans[163], van Swinden[164]
	Violent pains in head	France	de Lamanon[165]

[156] de LAMANON, 'Observations on the Nature of the Fog of 1783', in *The Philosophical Magazine: Comprehending the Various Branches of Science, the Liberal Arts, Agriculture, Manufactures and Commerce by Alexander Tilloch*, vol. 5 (London: J. Davis, 1799), 89, http://babel.hathitrust.org/cgi/pt?id=hvd.hxh3j3;view=1up;seq=92.
[157] M. DREUX (1783) cited in RABARTIN, Roland and ROCHER, P, *Les Volcans, Le Climat et La Révolution Française*, Mémoire de l'Association Volcanologique Européenne (L.A.V.E.) 1 (Paris: L'Association Volcanologique Européen (L.A.V.E.), 1993).
[158] CURE d'UMPEAU cited in RABARTIN, Roland and ROCHER, P.
[159] VAN SWINDEN, S.P., 'Observations on the Cloud (Dry Fog) Which Appeared in June 1783', ed. THORDARSON, Thorvaldur, trans. LINTLEMAN, Susan, *Jokull* 50 (January 2001): 73–80, https://www.researchgate.net/publication/280527027_Lintleman_and_Thordarson_2001._van_Swinden_contemporary_description.
[160] BRUGMANS, Sebald Justinus, *Natuurkundige Verhandeling over Een Zwavelagtigen Nevel Den 24 Juni 1783 in de Provintie van Stad En Lande En Naburige Landen Waargenomen* (Groningen: Petrus Doekema, 1783) cited in DURAND and GRATTAN (1999).
[161] M. HARREAUX cited in DURAND, Michael and GRATTAN, John, 'Extensive Respiratory Health Effects of Volcanogenic Dry Fog in 1783 Inferred from European Documentary Sources', *Environmental Geochemistry and Health* 21 (1999): 371–76.
[162] ANON cited in DURAND, Michael and GRATTAN, John.
[163] BRUGMANS, Sebald Justinus, *Natuurkundige Verhandeling over Een Zwavelagtigen Nevel Den 24 Juni 1783 in de Provintie van Stad En Lande En Naburige Landen Waargenomen* cited in DURAND and GRATTAN (1999).
[164] VAN SWINDEN, S.P., 'Observations on the Cloud (Dry Fog) Which Appeared in June 1783'.
[165] de LAMANON, 'Observations on the Nature of the Fog of 1783', 89.

Type	Symptom	Location	Reporter
Miscellaneous	Loss of appetite	France	Anon[166]
	Uncomfortable pressure	Netherlands	Brugmans[167]
	Diseases and deaths	Italy	Gennari[168]
	Tingling hands, eyes, lips	France	Harreaux[169]
	Hurtful to the eyes	France	de Lamanon[170]
	Stinging eyes	France	Cotte[171]
	Putrid illnesses, dysentery	France	de Bazinghen[172]
	Tired eyes	France	Anon[173]
	Sickness	France	Curé de Broué[174], Curé de Landelles[175]
	Sickness	Norway	Brun[176]
	Diarrhoea and putrid fever	Belgium	Blomme[177]
	Dysentery	Netherlands	Van Geuns[178]
	Malignant fevers	Spain	Maldà[179]
	Fevers	England	Cowper[180]
	Heat stroke	England	White[181]

166 ANON cited in DURAND, Michael and GRATTAN, John, 'Extensive Respiratory Health Effects of Volcanogenic Dry Fog in 1783 Inferred from European Documentary Sources'.
167 BRUGMANS, Sebald Justinus, *Natuurkundige Verhandeling over Een Zwavelagtigen Nevel Den 24 Juni 1783 in de Provintie van Stad En Lande En Naburige Landen Waargenomen* cited in DURAND and GRATTAN (1999).
168 GENNARI cited in DURAND, Michael and GRATTAN, John, 'Extensive Respiratory Health Effects of Volcanogenic Dry Fog in 1783 Inferred from European Documentary Sources'.
169 M. HARREAUX cited in DURAND, Michael and GRATTAN, John.
170 de LAMANON, 'Observations on the Nature of the Fog of 1783', 89.
171 COTTE, L, 'Memoire Sur Les Bruillards Extraordinaire de Mios de Juin et Juillet 1783', *Journal de Physique* 23 (1788): 201–6.
172 de BAZINGHEN, Gabriel, Abot de Bazinghen, 'Journal d'Abot de Bazinghen' (Pas-de-Calais, 1783), coll. partic., Archives Départementales Pas-de-Calais cited in ; DEMAREE, G. R. and OGILVIE, A. E. J., 'Bon Baisers d'Islande: Climatic, Environmental and Human Dimensions, Impacts of the Lakagigar Eruption (1783-1784) in Iceland.', in *History and Climate: Memories of the Future?* (New York: Kluwer, 2001), 312, https://books.google.fr/books?id=-cgnFsLkIAYC&pg=PA219&dq=demaree,+ogilvie+bon+baisers+d%27islande&hl=en&sa=X&ei=IBh2VdT3MMvkUczsgIAF&ved=0CCkQ6AEwAA#v=onepage&q=demaree%2C%20ogilvie%20bon%20baisers%20d%27islande&f=false.
173 ANON cited in DURAND, Michael and GRATTAN, John, 'Extensive Respiratory Health Effects of Volcanogenic Dry Fog in 1783 Inferred from European Documentary Sources'.
174 CURE de BROUE cited in RABARTIN, Roland and ROCHER, P, *Les Volcans, Le Climat et La Révolution Française*.
175 CURE de LANDELLES cited in RABARTIN, Roland and ROCHER, P.
176 J.N. BRUN cited in DEMAREE, G. R. and OGILVIE, A. E. J., 'Bon Baisers d'Islande: Climatic, Environmental and Human Dimensions, Impacts of the Lakagigar Eruption (1783-1784) in Iceland.'
177 A. BLOMME cited in DEMAREE, Gaston R. and OGILVIE, Astrid E. J., 'L'éruption Du Lakagigar En Islande Ou "Annus Mirabilis 1783". Chronique d'une Année Extraordinaire En Belgique et Ailleurs', in *Etudes et Bibliographies d'histoire Environnementale*, Collections Autres Futurs 5 (Namur: Presses universitaires de Namur, 2016), 297.
178 van GEUNS, Matthias, 'De Heerschende Persloop, &c. Recherches sur la Dysenterie Epidémique qui a regné pendant trois ans & surtout en 1783 dans la Province de Gueldre, Particulierement dans le Quertier de Veluwe, publiées pour le bien général par M. Matthias van Geuns, premier Médecin de la Province de Gueldre, & Professeur à son Académie, & avec un Supplément & des Pièces, gr. in 8). 302 22. Harderwyk & Amsterdam chez Mooyen & Holtrop, 1784. Pf1.160', in *Nouvelle Bibliotheque Belgique*, vol. 6 2nd part (La Haye, The Hague, Netherlands: Chez C. Plaat, 1784), 380–90, https://books.google.fr/books?id=yUsVAAAAQAAJ&pg=PA380&lpg=PA380&dq=van+geuns+recherches+sur+la+dysenterie&source=bl&ots=mjMWxlRpa_&sig=STCbT4cbV5UgCrlQFk8HAFTxgg8&hl=en&sa=X&ved=0ahUKEwixnIj3m_DSAhXkDsAKHQWXCb0Q6AEIHTAA#v=onepage&q=van%20geuns%20recherches%20sur%20la%20dysenterie&f=false.
179 MALDA cited in DEMAREE, G. R. and OGILVIE, A. E. J., 'Bon Baisers d'Islande: Climatic, Environmental and Human Dimensions, Impacts of the Lakagigar Eruption (1783-1784) in Iceland.'
180 COWPER, William, *The Letters of the Late William Cowper, Esq. to His Friends. Revised by His Kinsman, J. Johnson, LL.D. Rector of Yaxham with Welborne, in Norfolk.*, ed. JOHNSON, J. LLD, New Edition (London: Baldwin, Craddock & Joy, 1820), 187–88.
181 WHITE, Gilbert, *The Journals of Gilbert White1774-1783*, ed. GREENOAK, Francesca, vol. 2 (London: Century Hutchinson, 1988), 468.

Table 3:3 Major Toxic Compounds of Volcanic Gas and Ash Emissions and their Potential Effects on Health – IDLH (Immediately Dangerous to Life or Health)

Values in bold

Compound	Action of Toxin	Acute Effects	Chronic Effects
Volcanic Ash	Irritant	Irritation of eyes, chest, nose and throat. Exacerbation of asthma & bronchitis, increased cough, chest tightness, breathlessness. Can also exacerbate COPD & chronic heart problems.	Possibly silicosis over long period if ash has significant silica content.
Ammonia NH_3 **300 ppm**	Irritant	Irritation of eyes, chest, nose and throat.	
Carbon dioxide CO_2 **40,000 ppm**	Inert asphyxiant	Asphyxiation	
Carbon monoxide CO **1,200 ppm**	Binds to haemoglobin to form carboxyhaemoglobin thus preventing the haemoglobin from carrying oxygen to the tissues.	Confusion, headache, toxicity of central nervous system, coma and death.	Depression, confusion, memory loss
Sulphur dioxide SO_2 **100 ppm**	Acidic irritant	Skin and eye irritation, sore throat, bronchoconstriction, Increase in asthma symptoms.	Exacerbation of respiratory disease, e.g. bronchitis, asthma
Hydrogen sulphide H_2S **100 ppm**	Irritant, asphyxiant	Irritation of throat & eyes, dyspnoea, vertigo, confusion, nausea and vomiting, possible loss of consciousness, diarrhoea, haemoptysis, and with very high concentrations: nausea and vomiting, myocardial infarction, sudden loss of consciousness, seizure, cardiopulmonary arrest.	
Hydrogen fluoride HF **30 ppm**	Highly corrosive and toxic acidic irritant on inhalation or skin contact	Low serum magnesium, low serum calcium (hypocalcaemia) Irritation and burns to eyes, skin, nose and throat, bronchitis, coughing, pulmonary oedema, acute ARDS.	Permanent injury to lungs, dental or skeletal fluorosis via fluoride contaminated drinking water.
Hydrogen chloride HCl **50 ppm**	Acidic irritant	Eye and throat irritation. Coughing, choking, severe breathing difficulties, haemoptysis, skin inflammation or burns, pulmonary oedema, acute ARDS	Permanent lung injury.
Mercury vapour Hg **.0017 ppm**	Neurotoxin, irritant	Tremors, emotional changes, insomnia, headaches, pulmonary oedema,	Damage to brain, kidneys & lungs
Radon Rn	Carcinogen		Lung cancer

After Weinstein and Cook 2005 and NIOSH Table of LDLH Values

The detrimental effects that volcanic gases have on the population can be classified into three groups, namely, those which are: irritant, noxious, or inert.[182] Of these, SO_2 appears to have been, judging by contemporary accounts, the main constituent of the Laki fog. One can see from the above table, that only 100 ppm of the gas are needed to be immediately dangerous to health, whilst 0.5 - 1ppm may be distressing to asthmatics and exacerbate asthma attacks.[183] Owing to the fact that Sulphur dioxide is very soluble, it mainly effects the mucous membranes of the upper respiratory tract, i.e. nose, throat, trachea and bronchi, where it reacts with the ambient moisture to form Sulphurous acid (H_2SO_3), a severe irritant. In healthy adults breathing difficulties may be experienced at 5 ppm, sneezing and coughing at 10 ppm, and bronchospasm and eye irritation at 20 ppm. Above 20 ppm, pneumonitis, ARDS or pulmonary oedema may be experienced, and although exposures of 50 to 100 ppm may be tolerated for more than 30 to 60 minutes, higher or longer exposures can cause death from airway obstruction.[184]

Although SO_2 would appear to have been the main constituent of the dry fog, other irritants were also present, but in much smaller quantities. HCl and HF, can both cause eye and throat irritation at low levels of exposure, but as they are very soluble, tend to be removed by the mucus linings of the upper respiratory tract before they can reach the alveoli. Notwithstanding this, the effects can be particularly severe for asthma and bronchitis sufferers. Ammonia, which was another irritant discharged by the eruption, is especially sensitive to the eyes and other delicate membranes.[185]

H_2S or Hydrogen sulphide, is a powerful, malodorous, noxious asphyxiant, which also acts as an irritant. It can act as a skin and eye irritant at a concentration of only 0.000125 ppm, whilst higher concentrations can lead to loss of smell, headaches, loss

[182] WEINSTEIN, Philip and COOK, Angus, 'Volcanic Emissions and Health', in *Essentials of Medical Geology, 1st Edition*, 1st ed. (Waltham, Massachusetts: Academic Press, 2005), 826, https://www.wou.edu/las/physci/taylor/g473/med_geo/weinstein_2005.pdf.
[183] WEINSTEIN, Philip and COOK, Angus.
[184] ATSDR-Agency for Toxic Substances & Disease Registry, 'Toxic Substances Portal - Sulfur Dioxide', ATSDR, 3 March 2011, https://www.atsdr.cdc.gov/mmg/mmg.asp?id=249&tid=46; WEINSTEIN, Philip and COOK, Angus, 'Volcanic Emissions and Health'.
[185] WEINSTEIN, Philip and COOK, Angus, 'Volcanic Emissions and Health'; DURAND, Michael and GRATTAN, John, 'Extensive Respiratory Health Effects of Volcanogenic Dry Fog in 1783 Inferred from European Documentary Sources'; ATSDR-Agency for Toxic Substances & Disease Registry, 'Toxic Substances Portal - Ammonia. Relevance to Public Health', ATSDR, September 2004, https://www.atsdr.cdc.gov/ToxProfiles/tp126-c2.pdf.

of appetite and irritation to the respiratory tract. Concentrations of between 500 to 1000 ppm will lead to fainting and ultimately death.[186]

Although CO_2, an inert asphyxiant, is emitted in huge quantities in volcanic eruptions, it quickly becomes diluted and is not a danger to life.[187] However, when cold it is heavier than air, and in certain circumstances can flow along the ground becoming sufficiently concentrated and thus life threatening through asphyxiation. Concentrations exceeding 3% can quickly lead to headaches, dizziness, increased heart rate and difficulty breathing, whilst those in the region between 7-10% will rapidly cause unconsciousness, and above 15%, death.[188] Fortunately however, Carbon dioxide, even if it had been transported in the Laki haze, would have been so diluted by the time it reached Europe as to have had no effect on the health of the population.

To summarise Table 3:2, the respiratory symptoms as reported by Brugmans (1787), de Lamanon (1783) and van Swinden (1783), certainly seem to point to SO_2 exposure, as do the sore throats described by Harreaux (1858) and Dreux (1783). The pestilence of the throat described by Dreux (1783), is unusual because it affected the inhabitants of Champersu for some 10 months, the latter six of which were after the fog had left Europe. It has been suggested that as he described the illness as an affliction, a large number of people may have been affected, and the long-term nature of the sickness could have been a period of chronic bronchitis during the winter of 1783/84, brought about by the protracted exposure to pollution during the previous summer.[189]

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186 DURAND, Michael and GRATTAN, John, 'Extensive Respiratory Health Effects of Volcanogenic Dry Fog in 1783 Inferred from European Documentary Sources'; WEINSTEIN, Philip and COOK, Angus, 'Volcanic Emissions and Health'; NIOSH The National Institute for Occupational Safety and Health, 'Hydrogen Sulfide', PubChem, accessed 13 October 2017, https://pubchem.ncbi.nlm.nih.gov/compound/hydrogen_sulfide#section=Top; ATSDR-Agency for Toxic Substances & Disease Registry, 'Toxic Substances Portal - Hydrogen Sulfide Carbonyl Sulfide', ATSDR, 21 January 2015, https://www.atsdr.cdc.gov/toxprofiles/tp.asp?id=389&tid=67; USGS, 'Volcanic Gases Can Be Harmful to Health, Vegetation and Infrastructure.', USGS Volcanic Hazards Program, accessed 13 May 2016, https://volcanoes.usgs.gov/vhp/gas.html.

187 USGS, 'Volcanic Gases Can Be Harmful to Health, Vegetation and Infrastructure.'

188 USGS; WEINSTEIN, Philip and COOK, Angus, 'Volcanic Emissions and Health'.

189 DURAND, Michael and GRATTAN, John, 'Extensive Respiratory Health Effects of Volcanogenic Dry Fog in 1783 Inferred from European Documentary Sources'; WELLBURN, Alan, *Air Pollution and Climate Change : The Biological Impact*, 2nd ed. (Harlow, Essex: Longman Scientific, 1994).

The severe headaches noted by Brugmans and de Lamanon, and the loss of appetite noted by Anon (1784), are symptoms of exposure to H_2S.[190] Headaches may also be caused by exposure to particulate fluorine.[191]

Several commentators, de Lamanon (1783), Harreaux (1858), Cote (1788), and Anon (1784), remarked that the fog had an unpleasant effect on the eyes, hurtful, stinging, tingling and tiring being the adjectives used. It is a characteristic of both SO_2 and H_2S that they cause ocular irritation in small concentrations.[192]

We are now left with reports of sickness by de Broué and de Landelles in France and Brun (1786) in Norway. The term is so vague that it could be taken to mean nearly anything, however, Blomme (1892), gives us a clue when he mentions that a lot of people had suffered from a putrid fever and diarrhoea in Termonde, Belgium. The account by Blomme suggests that the sickness was gastroenteritis, the main symptoms being: diarrhoea (sometimes accompanied blood or mucus), sickness and stomach cramps. Sometimes these can be accompanied by a high fever, headache and aching limbs.[193] Van Guens' (1783) account of dysentery may also refer to gastroenteritis, which is a very common disease today (about 1 in 5 people in the UK develop a bout of gastroenteritis in a year), and due to a general lack of cleanliness, would have been much more prevalent in the 18th century than now.[194]

The Malignant fevers in Spain as documented by Malda (1791), and Cowper's (1783) report from England cannot, I think, be blamed on the Laki fog, neither can the heat stroke which incapacitated farm workers in Selborne, Hampshire, in the summer heatwave of 1783 (White 1783). According to the Mayo Clinic:

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[190] WELLBURN, Alan, *Air Pollution and Climate Change : The Biological Impact*; ATSDR-Agency for Toxic Substances & Disease Registry, 'Toxic Substances Portal - Hydrogen Sulfide Carbonyl Sulfide'; DURAND, Michael and GRATTAN, John, 'Extensive Respiratory Health Effects of Volcanogenic Dry Fog in 1783 Inferred from European Documentary Sources'.
[191] WELLBURN, Alan, *Air Pollution and Climate Change : The Biological Impact*; DURAND, Michael and GRATTAN, John, 'Extensive Respiratory Health Effects of Volcanogenic Dry Fog in 1783 Inferred from European Documentary Sources'.
[192] WELLBURN, Alan, *Air Pollution and Climate Change : The Biological Impact*; DURAND, Michael and GRATTAN, John, 'Extensive Respiratory Health Effects of Volcanogenic Dry Fog in 1783 Inferred from European Documentary Sources'; ATSDR-Agency for Toxic Substances & Disease Registry, 'Toxic Substances Portal - Hydrogen Sulfide Carbonyl Sulfide'; ATSDR-Agency for Toxic Substances & Disease Registry, 'Toxic Substances Portal - Sulfur Dioxide'.
[193] KNOTT, Laurence, 'Gastroenteritis in Adults', Patient: Making lives better, 20 September 2017, https://patient.info/health/gastroenteritis-in-adults.
[194] KNOTT, Laurence.

> Heatstroke is a condition caused by your body overheating, usually as a result of prolonged exposure to or physical exertion in high temperatures. This most serious form of heat injury, heatstroke, can occur if your body temperature rises to 104 F (40 C) or higher…Untreated heatstroke can quickly damage your brain, heart, kidneys and muscles. The damage worsens the longer treatment is delayed, increasing your risk of serious complications or death.[195]

3:3:5 Perceived causes of death within the Bills of Mortality

Although the London Bills of Mortality are perhaps the best known and most complete set of records relating to death and disease we have from the 18th century, they were also compiled in many other towns, for example, Chester, Warrington, Dublin. They were initially begun in 1592 in order to document outbreaks of plague and other diseases in each parish, were compiled by the parish clerks and published on a weekly basis. Eventually, these were collected together and published as annual volumes.

The information in these Bills was obtained by searchers, elderly female pensioners with no medical training, who would look at the bodies and then decide either by their appearance, or the information they had been given by doctors or relatives of the deceased.[196]A correspondent, writing to the *Gentlemen's Magazine* in 1799 deplored the fact that: "*In two parishes, which I could point out, the searchers cannot write; the mistakes they make are numberless, in the spelling Christian and surnames, for, they trust to memory till they get home; then, child or neighbour writes what they suppose it to be.*"[197]

[195] MAYO CLINIC, 'Heatstroke', Mayo Clinic, 15 August 2017, https://www.mayoclinic.org/diseases-conditions/heat-stroke/symptoms-causes/syc-20353581.
[196] FITZHARRIS, Lindsey, 'Silent Voices in History: The Searchers of the Dead: The Chirurgeon's Apprentice', The Chirurgeon's Apprentice, accessed 11 July 2015, http://thechirurgeonsapprentice.com/2013/02/11/silent-voices-in-history-the-searchers-of-the-dead/.
[197] URBAN, Sylvanus John, ed., *The Gentleman's Magazine; and Historical Chronicle*, vol. 69 (London: John Nichols, 1799), 657–58, https://babel.hathitrust.org/cgi/pt?id=osu.32435054260948;view=1up;seq=130.

John Graunt, one of the first British demographers, made scathing criticisms concerning the veracity of the searchers in his magnum opus, published in 1662. He suspected that the reason so few deaths appeared to be caused by venereal disease was because the searchers had been bribed, or of course, they may have just been particularly reticent about mentioning the subject. From the table below, we can see that there were only 81 recorded deaths from the French Pox, or syphilis.

> Forasmuch as by the ordinary discourse of the world it seems a great part of men have, at one time, or other, had some *species* of this disease, I wondering why so few died of it […]
>
> […] that the Old-women *Searchers* after the mist of a Cup of *Ale,* and the bribe of a two-groat fee, instead of one, given them, cannot tell whether this emaciation, or leanness were from a *Phthisis*, or from a *Hectick Fever*, *Atrophy*, &c. or from an Infection of the *Spermatick parts* […][198]

Despite Graunt's misgivings, the Bills of Mortality remain an important contribution to our knowledge concerning the death and disease of this period.

Although many of these forms of death such as, horshoehead, headmouldshot and purples look strange to us, they obviously had meaning for contemporaries, whilst others, for example, convulsions, consumption, teeth and worms could cover a multitude of different ailments. Graunt, of course, was under no misapprehension that many of the diagnoses made by the searchers were wrong, but it is highly likely that the medical profession would have been no more accurate.[199] Even today it is thought that some 25% of death certificates are inaccurate.[200] However, outside London, the cause of death was recorded in a small number of parish registers, for example, Leeds and Selby in the West Riding of Yorkshire.

[198] GRAUNT, John, *Natural and Political Observations Made upon the Bills of Mortality*, ed. WILLCOX, Walter F (Baltimore: John Hopkins Press, 1939), 37, https://babel.hathitrust.org/cgi/pt?id=uc1.$b430633;view=1up;seq=9.
[199] FITZHARRIS, Lindsey, 'Silent Voices in History: The Searchers of the Dead: The Chirurgeon's Apprentice'.
[200] COX, Margaret, *Life and Death in Spitalfields, 1700-1850*, 21:73–74.

Table 3:4 London Bills of Mortality – Diseases and Casualties for the years 1783 and 1784

	1783	1784		1783	1784
Abortive and Stillborn	636	528	Mortification	211	136
Abscess	0	1	Palsy	73	66
Aged	1239	1240	Plurisy	17	15
Ague	11	8	Quinsy	7	4
Apoplexy and Suddenly	219	207	Rash	0	0
Asthma and Phthisic	199	377	Rheumatism	3	8
Bedridden	19	12	Rickets	0	0
Bleeding	3	4	Rising of the Lights	0	0
Bloody Flux	5	1	Scald Head	0	0
Bursten and Rupture	5	17	Scurvy	5	4
Cancer	67	43	Small Pox	1550	1759
Canker		2	Sore Throat	22	6
Chicken Pox	1	3	Sores and Ulcers	8	13
Childbed	144	133	St Anthony's Fire	1	0
Cholick, Gripes and Twisting of the Guts	37	8	Stoppage in the Stomach	6	10
Cold	3	3	Surfeit	3	1
Consumption	4575	4540	Swelling	1	1
Convulsions	4770	4219	Teeth	532	369
Cough, and Hooping Cough	268	467	Thrush	85	65
Diabetes	1	0	Tympany	0	1
Dropsy	864	830	Vomiting and Looseness	14	2
Evil	7	13	Worms	18	11
Fever, Malignant Fever, Spotted Fever, and Purples	2313	1973	Bit by a mad Dog	0	2
Fistula	0	4	Broken Limbs	1	3
Flux	23	9	Bruised	0	2
French Pox	49	32	Burnt	13	14
Gout	47	63	Choaked	0	1
Gravel, Stone, and Strangury	43	35	Drowned	110	97
Grief	4	3	Excessive Drinking	4	8
Head-Ach	1	1	Executed	15	11
Headmouldshop, Horshoehead, and Water in the Head	19	15	Found Dead	4	5
Imposthume	6	4	Frighted	0	0
Inflammation	308	198	Killed by Falls and several other Accidents	75	39
Itch	0	0	Killed themselves	26	23
Jaundies	75	62	Murdered	4	4
Leprosy	1	0	Overlaid	3	0
Lethargy	2	0	Poisoned	0	2
Livergrown	1	4	Scalded	3	5
Lunatick	53	46	Smothered	1	0
Measles	185	29	Starved	2	1
Miscarriage	1	3	Suffocated	8	3
			Total Buried	**19029**	**17828**

We must remember that for people living in the18th century death was never far away. A simple cut or broken bone could lead to blood poisoning, sepsis, and ultimately, without the benefit of modern antibiotics, death.

3:3:6 Infantile deaths – natural or infanticide?

The number of infant deaths as recorded in the London Bills of Mortality during this period was absolutely staggering. The total number of all deaths in 1783, was 19,029 and of this, 6,632 were infants under the age of two, i.e. 34.85%, whilst the figures for 1784 were hardly any better, 5,729 infant deaths out of a total of 17,828, i.e. 32.13%. What was the reason for these deaths? Apart from the diseases mentioned above, a far more sinister cause could have been infanticide.

> The discovery of the dead body of a new-born child aroused suspicions that a single woman in the neighbourhood had committed murder. Bodies were usually discovered in privies or in fields or rivers, or hidden indoors under mattresses, in cupboards, or in locked boxes.[201]

As well as straightforward murder or abandonment, there is good reason to believe that the wet nursing profession was responsible for many infant deaths in both this and the following century.

The wet nurses and foster mothers, the "angel makers", who were responsible for looking after babies in their charge, deliberately neglected them, especially if illegitimate, and if they were not, often at the behest of their natural mother, thereby causing an early death.[202] According to Malcolmson there were very few indictments for infanticide during the second half of the eighteenth century in Britain.[203] However,

[201] JACKSON, Mark, *New-Born Child Murder : Women, Illegitimacy and the Courts in Eighteenth-Century England* (Manchester, & New York, NY, USA: Manchester University Press, 1996), 84, https://books.google.fr/books?id=4AzoAAAAIAAJ&pg=PA24&lpg=PA24&dq=malcolmson+infanticide+eighteenth+century&source=bl&ots=1Ok-wL_ORu&sig=6M6JFAbluGB3SZ-E4M-UI6QfrAY&hl=en&sa=X&ved=0ahUKEwjFopiC8a7MAhXC8RQKHfrmAwsQ6AEIKDAD#v=onepage&q=malcolmson%20infanticide%20eighteenth%20century&f=false.

[202] EVANS, Richard J., *Death in Hamburg : Society and Politics in the Cholera Years, 1830-1910* (London and New York: Penguin Books, 1987), 215.

[203] MALCOLMSON, R. W., 'Infanticide in the Eighteenth Century', in *Crime in England 1550-1800*, ed. COCKBURN, J. S. (London: Methuen, 1977), 191; MACFARLANE, Alan, 'A History of Infanticide in England', 2002, 3, http://www.alanmacfarlane.com/savage/A-INFANT.PDF.

that is not to say that there was a failure to investigate cases of sudden death. As Jackson says:

> […] medical opinion as to the cause of death was by no means disregarded, during the eighteenth century. This is well illustrated by the large number of investigations held into the deaths of new-born children thought to have been murdered by their mothers.[204]

Perhaps we should not be surprised at these low figures, and with so many children dying at birth it would be difficult to prove that death was intentional. Even today, it can be notoriously difficult to distinguish between infanticide and genuine cot deaths. It was well known that the smothering of babies by their mothers was a common occurrence, and contemporary commentators were damning in their criticism, as can be seen from a pamphlet published in 1757 by George Burrington:

> […] (people) sent their Bastards to the Foundling Hospital; if they are not admitted, there are Men and Women, that for a certain Sum of Money will take them, and the Fathers never hear what becomes of the Children afterwards…in and about London a prodigious Number of Infants are cruelly murdered unchristened, by those Infernals, called Nurses; these detestable Monsters throw a Spoonful of Gin, Spirits of Wine, or Hungary-Water down a Child's Throat, which instantly strangles the Babe; when the Searchers come to inspect the Body, and enquire what Distemper caused the Death, it is answered, Convulsions, this occasions the Article of Convulsions in the Bills of Mortality so much to exceed all others. The price of destroying and interring a Child is but Two Guineas; and these are the Causes that near a Third die under the Age of Two Years, and not unlikely under two Months.[205]

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[204] JACKSON, Mark, *New-Born Child Murder : Women, Illegitimacy and the Courts in Eighteenth-Century England*, 86.
[205] George BURRINGTON cited in MACFARLANE, Alan, 'A History of Infanticide in England', 5–6 Hungary Water: is an alcohol-based perfume, claimed to date to about the late 14th century. Spirits of wine: Ethanol obtained from distilling wine.

It is interesting to note that nearly all those accused of infanticide were unmarried women. The stigma attached to having an illegitimate child must have been more than some women could bear, especially as this could mean instant dismissal from their jobs, and if the infant lived, not only would they lose their employment, and endure public shame, but would most probably be unable to support themselves and the child.

Hoffer concludes that: "*married women were not accused of murdering their newborn babies.*"[206] Malcolmson also agrees that documented cases of married women being accused are exceptional.[207] Perhaps the reason for this was that "child-murder or murderous neglect by married people was surprisingly widely condoned, virtually impossible to police, and rarely punished." It would appear from the evidence throughout Europe that infanticide was viewed by a good proportion of the population as one of the means that parents used to save their other children from starvation.[208]

It was to try and stop this situation that various individuals and philanthropic organisations set up foundling hospitals where unwanted children could be looked after and cared for. The 18th century saw an explosion of such hospitals, but tragically, the death rate was staggering. Nearly 80% of children into the Rouen hospital during the mid-eighteenth century died, and by the end of the century this had risen to the astounding figure of 95%. Between the years 1700-1800, the Madrid foundling hospital had a mortality rate of 75%, the Dublin hospital, one of 89%, and by the end of the century very few hospitals had a rate of under 60%.[209]

It would seem that the main reason for this was the gross overcrowding these institutions had to contend with. In the 18th century, overcrowding on a huge scale was invariably accompanied by high rates of infectious disease. Many of the babies had

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206 HOFFER, Peter C. and HULL, N. E. H., *Murdering Mothers: Infanticide in England and New England 1558-1803*, New York University School of Law Series in Legal History (New York: New York University Press, 1981), 101.
207 MALCOLMSON, R. W., 'Infanticide in the Eighteenth Century', 192.
208 HUNT, Margaret R., *Women in Eighteenth-Century Europe*, The Longman History of European Women (London and Abingdon: Routledge, 2014), 105–6, https://books.google.fr/books?id=E2XJAwAAQBAJ&pg=PA112&lpg=PA112&dq=foundling+hospital+europe&source=bl&ots=lWbAMJ5viP&sig=ISVjQBHcSzEcTQEO-kXp1v_np-8&hl=en&sa=X&ved=0ahUKEwjp6PW96rXMAhXMuBQKHdQODKY4ChDoAQhLMAg#v=onepage&q=foundling%20hospital%20europe&f=false.
209 HUNT, Margaret R., 111–13.

come from the countryside and therefore had little or no resistance to urban diseases. Sanitation was, at the best, basic in the extreme, and this encouraged diseases such as infantile diarrhoea, and smallpox was always waiting in the wings, ready to strike. Finding enough wet-nurses to cope with all the infants must have posed an insoluble problem, and the children were farmed out to rural wet-nurses. When none could be found, babies were fed on pap or cow's milk, and in the days before sterilization, this was a virtual death sentence.[210]

Table 3:5 Causes of death listed in the Bills of Mortality which are particularly relevant to infants

	1783	1784
Abortive and Stillborn	636	528
Convulsions	4770	4219
Cough and Hooping Cough	268	467
Headmouldshot, Horshoead and Water in the Head	19	15
Livergrown	1	4
Measles	185	29
Rickets	0	0
Teeth	532	369
Worms	18	11
Overlaid	3	0
Smothered	1	0
Suffocated	8	3
	6441	5645

3:4 The Medical Profession

In general, the European medical profession was divided into four main sections, physicians, surgeons, apothecaries, and midwives. As can be expected, these divisions were not clear-cut, and general practices were becoming more and more

[210] HUNT, Margaret R., 113.

common. Even in London where specialization could be expected, the apothecaries and surgeons began to resemble one another, whilst the demarcation between surgeons and physicians was becoming less clear.[211] Surgeons were also encroaching on the midwives' domain, and taking over difficult cases, as well as normal births if requested. Much to the midwives' chagrin, in some Protestant countries such as England, south Germany and the Netherlands, man-midwives had started to muscle in on their preserve since the early 1700s, but in the Catholic countries of France, Italy and Spain the church insisted on the use of female midwives to protect female modesty.[212]

In addition, the official medical hierarchy was supported by a whole host of unofficial figures, from straightforward charlatans or quacks, to folk healers and cunningmen, and people of other professions who practiced medicine as a sideline.[213] Ramsey quotes the following examples from 1786 and 1800:[214]

> "Deschamp, a butcher at 'Chevigné' (Chavagne?) in Brittany, practices medicine, attracting patients from far away; his wife is an unauthorised midwife. Saint-Lau or Saint-Laurent, formerly town crier at Guingamp, practices medicine in the *subdélégation* of Lannion (Brittany)."
>
> "A chair bottomer of Montargis (Loiret) who cannot live from his regular trade has practised as a surgeon for two or three years."

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[211] DIGBY, Anne, *Making a Medical Living : Doctors and Patients in the Market for Medicine, 1720-1911.*, Cambridge Studies in Population, Economy and Society in Past Time 24 (Cambridge: Cambridge University Press, 1994), 29; RAMSEY, Matthew, *Professional and Popular Medicine in France, 1770-1830: The Social World of Medical Practice*, Reprint, Cambridge History of Medicine (Cambridge, New York, New Rochelle, Melbourne, Sydney: Cambridge University Press, 2002), 29–31, https://books.google.fr/books?id=f_Qap3_F8x8C&pg=PA247&lpg=PA247&dq=charles+x+scrofula&source=bl&ots=Ju54OOhLnr&sig=vYVBP_btJm86ccr2a50u3SmDknI&hl=en&sa=X&ved=0ahUKEwjD3tzy6cLJAhVErRoKHWXlCBU4ChDoAQgqMAQ#v=onepage&q=charles%20x%20scrofula&f=false.

[212] KONTOYANNIS, Maria and KATSETOS, Christos, 'Midwives in Early Modern Europe (1400-1800)', *Health Service Journal* 5, no. 1 (2011): 31–36, http://www.hsj.gr/medicine/midwives-in-early-modern-europe-14001800.pdf; SCIENCE MUSEUM, 'Man-Midwives', Science Museum brought to Life Exploring the History of Medicine, accessed 1 May 2016, http://www.sciencemuseum.org.uk/broughttolife/people/manmidwives; For the arguments for and against man-midwives see: Samuel Gregory, Man-midwifery exposed and corrected (Boston & New York, 1828), and Do History,The Controversy: http://dohistory.org/man-midwife/controversy/index.html (accessed, 1/05/2016). Adrian Wilson Making of man-midwifery: childbirth in England, 1660-1770 (Harvard University Press, Cambridge, 1995), p.192, convincingly argues that only ladies could afford the 10 guineas that William Hunter, the famous surgeon, charged. "The artisan's wife might not be able to afford a carriage, but every couple of years she could afford a man-midwife. .Man-midwifery thus became an area of conspicuous consumption;" 'King's Evil and the Royal Touch'.

[213] PORTER, Roy, *Quacks: Fakers and Charlatans in English Medicine*; WESTON, Robert, *Medical Consulting by Letter in France, 1665-1789*, The History of Medicine in Context (Farnham & Burlington: Ashgate, 2013), 49; RAMSEY, Matthew, *Professional and Popular Medicine in France, 1770-1830: The Social World of Medical Practice*, 27–28.

[214] RAMSEY, Matthew, *Professional and Popular Medicine in France, 1770-1830: The Social World of Medical Practice*, 381, 386.

Unfortunately, the medical profession was ill-equipped to deal with any of these diseases, especially as the "germ theory of disease" had not yet been accepted. This theory states that many diseases are caused by the presence and actions of specific micro-organisms within the body and was scientifically proved by, Louis Pasteur in the 1860s and Robert Koch in the following decades. It eventually superseded the existing miasma and contagion theories of disease and in so doing radically changed the practice of medicine.[215] See Appendix 3.

Given the poor state of medical knowledge, it's no wonder that the population, and in particular, country people and those who were unable to afford medical treatment, resorted to some very strange remedies. The following recipe *"to cure a great flux or looseness of the belly"* comes from *The Queen's Closet Open'd* which was published in 1696.[216]

> Take a hard egg and peel off the shell, and put the smaller end of it to the fundament or arsehole, and when it is cold take another such hot, fresh, hard and peeled egg, and apply it as aforesaid.

The following cures as practised by country folk give one an idea of the multitude of different things that were used by those who could not afford a physician, or preferred to put their trust in tried and trusted remedies.

A well-known cure for ague involved swallowing a live spider, wrapped in its own web on an empty stomach; another involved transferring the disease to an aspen tree as follows. *"Take the clippings from the sufferer's finger and toe nails while he is asleep, without him knowing, cut some hair from the nape of his neck, wrap them in paper, and*

[215] SCIENCE MUSEUM, 'Germ Theory', Exploring the History of Medicine, accessed 27 October 2015, http://www.sciencemuseum.org.uk/broughttolife/techniques/germtheory.aspx; WIKIPEDIA, 'Germ Theory of Disease', Wikipedia, 25 October 2015, https://en.wikipedia.org/wiki/Germ_theory_of_disease.
[216] WALLER, Maureen, *1700: Scenes from London Life*, 98.

put them in a hole in an aspen tree". This is clearly an example of transference magic.[217]

Even today such folk cures are alive and well. For example, one cure for shingles involves cutting the comb of a cockerel, squeezing the blood onto a plate, and then dabbing the blood in a wide band onto the back of the sufferer.[218]

As Porter *says "'medicine without doctors' was a necessity for many but a preference for some."*[219] Perhaps the following quote attributed to Voltaire was very apt. *"The art of medicine consists in amusing the patient while nature cures the disease."*

It was not only the poor who believed in the efficacy of alternative medicine. Religion and magic still underlaid a great deal of vernacular healing. The author and lexicographer, Samuel Johnson, when an infant, was one of the last to be touched by Queen Anne for scrofula; whilst in France, Charles X revived the custom in 1825.[220] John Aubrey, the antiquary, recorded numerous magic formulae, supposedly with curative powers. Family recipe books record healing salves, prophylactics and various remedial practices, some of which had their origins in the occult.[221] Again, quoting from Porter: "*Everyone had a cure for everything, and some may have worked, if only as placebos."*[222]

Affluent patients could "take the waters" at the many spa towns that were established in England and Europe. These had been known since Roman times, but it was only in the middle of the seventeenth century that their popularity really took off, so much so

[217] SIMPSON, Jacqueline, *The Folklore of Sussex* (London: Batsford, 1973), 84; POWYS, Caroline, 'Eighteenth-Century Recipes', 1 November 2011, https://18thcenturyrecipes.wordpress.com/category/18th-century-medical-recipes/ This is an interesting collection of 18th century medical recipes.
[218] CAMUS, Dominique, *L'univers des guérisseurs traditionnels* (Rennes: Ouest France, 2010), 76–79.
[219] PORTER, Roy, *The Greatest Benefit to Mankind : A Medical History of Humanity from Antiquity to the Present*, 1st ed. (London: HarperCollins, 1997), 281.
[220] ROGERS, Pat, 'Samuel Johnson', Oxford Dictionary of National Biography, 21 May 2009, http://www.oxforddnb.com/view/article/14918?docPos=4; RAMSEY, Matthew, *Professional and Popular Medicine in France, 1770-1830: The Social World of Medical Practice*, 247.
[221] AUBREY, John, *Remaines of Gentilisme and Judaisme*, ed. BRITTEN, James, Folklore Society 4 (London: W. Satchell, 1881), 49 et seq, https://archive.org/stream/remainesofgentil00aubruoft/remainesofgentil00aubruoft_djvu.txt.
[222] PORTER, Roy, *The Greatest Benefit to Mankind : A Medical History of Humanity from Antiquity to the Present*, 281–82.

in fact, that between the years 1660-1800, over four hundred medical publications in Britain alone were written concerning this subject.[223] At about the same time seawater bathing was being promoted as being very beneficial to health, and some medical practitioners even recommended that seawater be drunk on its own or in conjunction with a weird collection of ingredients such as coral, cuttle-fish bones, viper's flesh, burnt sponge, snails, crab's eyes, wood lice and tar, whilst other doctors recommended the efficacy of sea air.[224] It is, perhaps, not surprising that sea water could affect almost miraculous cures. In an era of "the great unwashed" and the overindulgence of the rich, its disinfecting and cleansing qualities when used externally, and purging qualities when drunk, must have proved extremely beneficial.

Allied to these cures was the trade in patent medicines. Many, if not most, were of little or no value and were produced with little or no scientific basis. The trade in patent medicines was not to be ignored and huge fortunes were to be made by those catering to a gullible public.[225] The following advert (Fig. 3:23), which appeared in the Kentish Gazette on 23rd of August 1783, is a typical example.

Lady Mary Montagu, writing from Italy declared: "The English are easier than any other nation infatuated by the prospect of universal medicines; nor is there any country in the world where doctors raise such immense fortunes."[226] By the end of the century there were more than 450 patent medicines listed in Schedule B of the 1804 Medical Stamp Act. [227]

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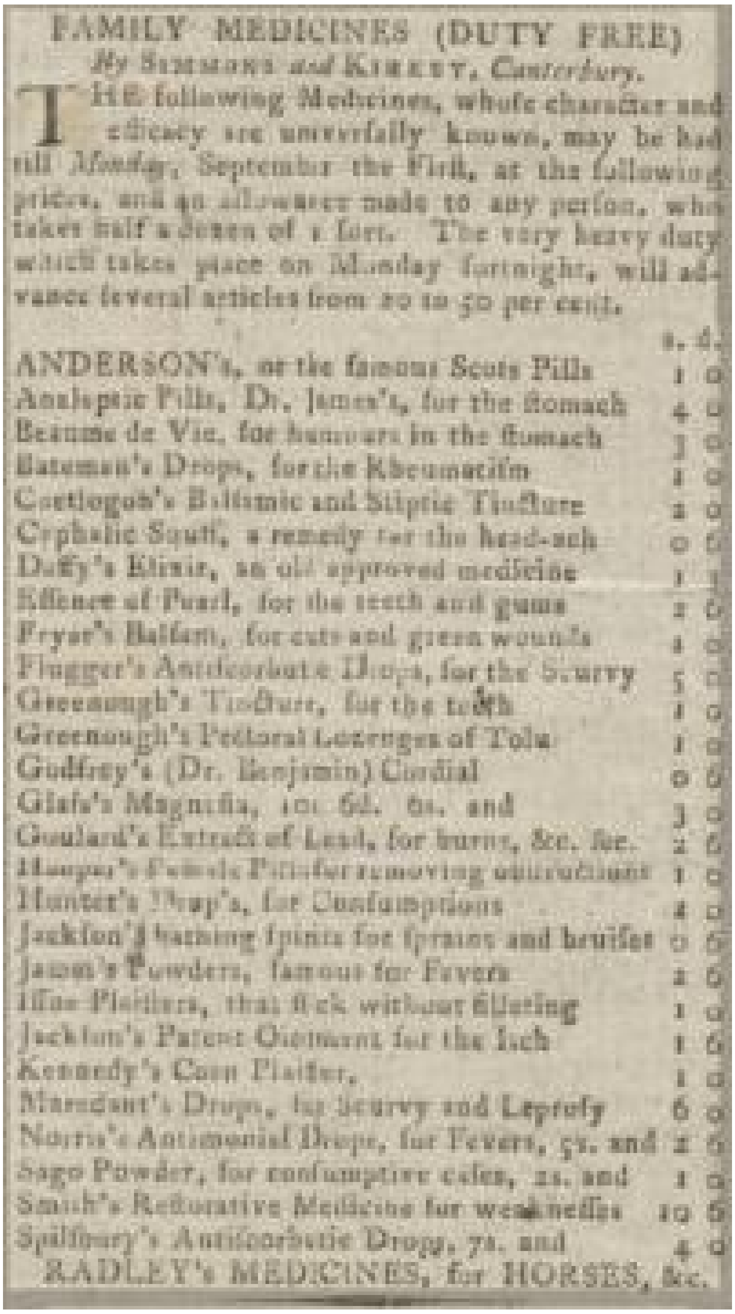
[223] DIGBY, Anne, *Making a Medical Living : Doctors and Patients in the Market for Medicine, 1720-1911.*, 213.
[224] MUSGRAVE, Clifford, *Life in Brighton: From the Earliest Times to the Present*, 1st ed. (London: Faber and Faber, 1970), 52; RUSSELL, Richard, *A Dissertation on the Use of Sea-Water in the Diseases of the Glands Etc: To Which Is Added an Epistolary Dedication to R. Frewin.*, 2nd ed. (Oxford: James Fletcher, 1753), 1 et seq; RELHAN, Anthony, *A Short History of Brighthelmston : With Remarks on Its Air, and an Analysis of Its Waters, Particularly of an Uncommon Mineral One Long Discovered, Though but Lately Used.*, 1st ed. (London: W. Johnston, 1761), 48–53.
[225] MONTAGU, Lady Mary Wortley, *The Letters and Works of Lady Mary Wortley Montagu*, ed. WHARNCLIFFE, Lord, 2nd ed., vol. 2 (London: Richard Bentley, 1837), 397, https://books.google.fr/books?id=UUwGAAAAQAAJ&pg=PA397&lpg=PA397&dq=the+english+are+easier+than+any+other+nationinfatuated&source=bl&ots=_ws85zD8O6&sig=S28-o03v2D9E5yvLvEMsTcClpVI&hl=en&sa=X&ved=0ahUKEwid7O--88fJAhXDOBQKHR3kDBcQ6AEIKjAE#v=onepage&q=the%20english%20are%20easier%20than%20any%20other%20nationinfatuated&f=false.
[226] MONTAGU, Lady Mary Wortley, 2:397.
[227] HOUSE of COMMONS, 'Schedule of Drugs, Herbs, Pills, Waters, Essences, Tinctures, Powders, Preparations and Compositions and ALL Foreign Medicines except Drugs That Were to Be Taxed under the Medicine Stamp Duty Act 44 George III. Cap. 98 Schedule B', 1804, 917–24, Parliamentary Archives.

Figure 3:23 Advert for patent medicines, Kentish Gazette, 23rd of August 1783



FAMILY MEDICINES (DUTY FREE)

By SIMMONS *and* KIRKBY, *Canterbury.*

THE following Medicines, whofe character and efficacy are univerfally known, may be had till *Monday*, September the Firft, at the following prices, and an allowance made to any perfon, who takes half a dozen of a fort. The very heavy duty which takes place on Monday fortnight, will advance feveral articles from 20 to 50 per cent.

	s.	d.
ANDERSON's, or the famous Scots Pills	1	0
Analeptic Pills, Dr. James's, for the ftomach	4	0
Beaume de Vie, for humours in the ftomach	3	0
Bateman's Drops, for the Rheumatifm	1	0
Cortlogon's Balfamic and Stiptic Tincture	2	0
Cephalic Snuff, a remedy for the head-ach	0	6
Daffy's Elixir, an old approved medicine	1	3
Effence of Pearl, for the teeth and gums	2	6
Fryar's Balfam, for cuts and green wounds	1	0
Flugger's Antifcorbutic Drops, for the Scurvy	5	0
Greenough's Tincture, for the teeth	1	0
Greenough's Pectoral Lozenges of Tolu	1	0
Godfrey's (Dr. Benjamin) Cordial	0	6
Glafs's Magnefia, 10s. 6d. 6s. and	3	0
Goulard's Extract of Lead, for burns, &c. &c.	2	6
Hooper's Female Pills for removing obftructions	1	0
Hunter's Drop's, for Confumptions	4	0
Jackfon's Warming fpirits for fprains and bruifes	0	6
James's Powders, famous for Fevers	2	6
Iffue Plaifters, that ftick without fileting	1	0
Jackfon's Patent Ointment for the Itch	1	6
Kennedy's Corn Plaifter,	1	0
Marcdant's Drops, for Scurvy and Leprofy	6	0
Norris's Antimonial Drops, for Fevers, 5s. and	2	6
Sago Powder, for confumptive cafes, 2s. and	1	0
Smith's Reftorative Medicine for weaknefles	10	6
Spilfbury's Antifcorbutic Drops, 7s. and	4	0

RADLEY's MEDICINES, for HORSES, &c.

The following rhyme was said about the notorious quack, Joshua Ward, who made a fortune in the 1700s selling patent medicines, claiming that his preparations would cure everything, including gout, scurvy, syphilis, and cancer. Whilst living in exile in France, he invented his famous Ward's Pill and Ward's Drop, which must have captured the public's imagination, as a contemporary wit made up the following doggerel about them:

> Before you take his Drop or Pill,
> Take leave of friends and make your will.[228]

3:5 Conclusion

By today's standards, 18th century towns and villages were very insalubrious places. Living conditions were often primitive in the extreme, with only a few houses having proper sanitation or fresh, clean running water. Rubbish and sewage would often be left to rot in piles, thrown in the nearest river, or carted away by night-soil men who dumped it outside the town without disposing of it properly. The following quote from Dobson admirably sums up the situation.

> Intolerable smells of all sorts wafted through the contours of the early modern world… We are confronted with places of 'a thousand stinks', airs of overpowering nastiness, waters of stagnant stinking mud, hovels of putrefying decay, cities of foul and filthy fumes, effluvia of rotten human and animal flesh, streams of sickly stenches, alleys of corruption, and noisome corners of festering filth. We are offended by the smells of stinking breaths, the descriptions of foul spittle and black vomit, the scenes of unwashed bodies crawling with nauseous and venomous vermin, the sight of human and animal excrement in every corner, the exhalations of lousy men, women and children.[229]

[228] SCIENCE MUSEUM, 'Germ Theory'; CAMPBELL, William Alec, *The Chemical Industry*, Industrial Archaeology (London: Longman, 1971), 116; CAMPBELL, William Alec, 'General and Fine Inorganic Chemicals', in *Chemistry, Society and Environment: A New History of the British Chemical Industry* (Cambridge: Royal Society of Chemistry, 2000), 158, https://books.google.fr/books?id=WMWEYFfLBlMC&pg=PA158&lpg=PA158&dq=w+a+campbell+portrait+of+a+quack&source=bl&ots=EcwPrVVgwX&sig=mAdg-s_J3WDbvvHauvt2NSYc3Hk&hl=en&sa=X&ved=0ahUKEwj-_pLijsjJAhVF2xoKHdwaAYIQ6AEIHTAA#v=onepage&q=w%20a%20campbell%20portrait%20of%20a%20quack&f=false.
[229] DOBSON, Mary J., *Contours of Death and Disease in Early Modern England*, 10–11.

Overcrowding in graveyards was a perennial problem, particularly in towns and cities, perhaps the most notorious example being the cemetery of Les Innocents in Paris. Another problem that city residents had to endure was the choking, smoky atmosphere from thousands of domestic and industrial coal fires and the harmful effects it must have had on the inhabitants' lungs, and this fact was commented on by John Evelyn writing in the mid-seventeenth century.

There were many different diseases which plagued the population living in the 18th century, and we have seen how they could be transmitted by mechanical means, either by air, contaminated food, or water; examples of these being influenza, E-coli and typhoid; by human to human contact, smallpox and tuberculosis are but two examples of this type; and last but by no means least, animal and insect vectors which transmit diseases such as typhus, brucellosis and malaria. The lack of sanitation which resulted in unclean water seeping into wells or other means of water supply caused periodic outbreaks of intestinal disease, with typhoid – mentioned above – and infantile diarrhoea being just two of them.

Whilst smallpox was, perhaps, the most feared disease, often causing severe epidemics with many fatalities, others, such as typhus, could be just as deadly. Tuberculosis another devastating infection was, more usually, endemic rather than epidemic, and was particularly rife in the squalid housing conditions of the rapidly growing industrial towns. It could also be classed as an occupational disease caused by the horrific working conditions in, for instance, the Manchester cotton mills. Occupational diseases, which were many and varied, killed over a period of time, mainly through the ingestion of minute particles into the lungs – one only has to think of silicosis, a disease of miners and stone workers – or by the absorption of noxious substances through the skin or mucous membranes of the nose and lungs, for example, the inhalation of mercury vapour which caused mad hatter disease.

Although they have many deficiencies, the London Bills of Mortality give us the best snapshot of 18th century disease, albeit many of the terms used would not be recognisable today. The number of infant deaths during this period was horrifying, as can be seen by the figures recorded in the London Bills; approximately 33% of all fatalities in the years 1783 and 1784. Not all of these were by natural means, and several authors have commented on the fact that infanticide was a common occurrence. To attempt to combat this, many foundling hospitals were set up where unwanted infants could be looked after and cared for. Although well intended, these institutions had an exceedingly high death rate, in one case up to 95% by the end of the century, caused in part by the spread of highly infectious diseases due to massive overcrowding, and lack of adequate feeding arrangements.

Illnesses caused by volcanic eruptions can be placed in three categories, irritant, noxious, or inert. The Laki dry fog was an irritant consisting mainly of SO_2 and much smaller amounts of HCl, HF and NH_3, and these may have been deleterious to the health of asthmatics and people suffering from bronchitis or other respiratory ailments.

The medical profession was only just emerging from the dark ages as far as the treatment of disease was concerned and was unable to cope effectively with most infections. Epidemic diseases such as smallpox, influenza, and fevers of various kinds, were rife and it is no wonder that a large part of the population, especially the poorer sort who were unable to afford doctors, were fitting targets for the quacks and charlatans that travelled the countryside. In an era when death was just around the corner, it is hardly surprising that many people relied instead on old wife's tales or tried and tested home remedies. It was into this climate of uncertainty that the patent medicine industry started to take off and was positively booming towards the end of the century.

To add to these woes, the food eaten by most of the population was, by today's standards, extremely unhealthy, both for the rich and poor. The rich probably suffered from vitamin deficiency through eating a high protein diet of meat with little fruit and vegetables, whilst the poor subsisted on little meat, brown bread, and fruit and vegetables when in season. However, according to Misson, the middling sort could eat very well, even if not very healthily.

CHAPTER 4 – Consequences of the Laki Eruption in Britain and Europe

In this chapter, we shall look at the consequences of the Laki eruption in order to test the hypothesis that it caused an untold increase in the average number of annual burials in Europe during the years 1783 to 1785. The received opinion is that in England alone, there were between 8,000 to 30,000 fatalities above what could normally have been expected, and the proposition that these were due to effects caused by the eruption, will be tested by a close examination of the burial registers of some 1461 parishes in England and Wales. Records from Scottish parishes were not used as there were too few with complete sequences from 1770 to 1799. In addition, the registers of 30 parishes from the Isle of Man and Jersey have been examined together with 43 from the Netherlands, Norway and Sweden. See Appendix 4

In the main, previous studies of the eruption's effects in Britain have been based on figures relating to the 404 English parishes used by Wrigley and Schofield in "*The Population History of England 1541-1871*",[230] a notable exception being the 65 parishes used in the study by Michnowicz.[231] The present paper uses data from 1448 parishes in England and Wales, 18 on the Isle of Man, and 12 from Jersey.[232] As far as is known, this is the first time that data relating to parishes in Wales, the Isle of Man and Jersey has been used to calculate whether their burial rates were affected by the Laki eruption.

Britain was chosen for an in-depth analysis of the parish registers because:

1. There was large amount of indexed searchable material that was available on the internet.
2. The countrywide coverage of this material – Map 4:1 – should make it possible to establish whether the hypothesised increase in the mortality rate caused by

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[230] WITHAM, C. S. and OPPENHEIMER, C., 'Mortality in England during the 1783–4 Laki Craters Eruption', *Bulletin of Volcanology* 67 (November 2004): 15–26, https://doi.org/10.1007/s00445-004-0357-7.

[231] MICHNOWICZ, Sabina A. K., 'The Laki Fissure Eruption and UK Mortality Crises of 1783-1784' (MPhil, Aberystwyth, Aberystwyth, 2011), http://cadair.aber.ac.uk/dspace/bitstream/handle/2160/7793/Michnowicz_MPhil_July2011.pdf?sequence=1.

[232] WRIGLEY, E. A. and SCHOFIELD, R. S., *The Population History of England 1541-1871*, New, Cambridge Studies in Population, Economy and Society in Past Time (Cambridge: Cambridge University Press, 2010), 485–89.

the eruption, was widespread over the whole country, or limited to specific areas, or was non-existent.

4:1 Methodology

Through the auspices of the FreeREG Genealogy website, many thousands of burial statistics transcribed from British parish registers, representing small to large parishes – arranged by county and listed on Excel spreadsheets – were downloaded for the years, 1780-1799 and 1800-1821. Wherever possible, and providing the figures were complete for the whole of the first period, data for the preceding 10 years was retrieved via the internet – by utilising several different Genealogy websites – in order to give a continuous overall picture for the period, 1770-1799. The main sites used were: "*Ancestry.co.uk, Findmypast UK, and FamilySearch*"; in addition to which, extensive use was made of the CD, "*National Burial Index for England and Wales, 3rd edition*", and over 60 parish registers published by learned archaeological and parish register societies; details of all of these are to be found in the bibliography. The number of burials for both periods was then checked, either by counting them from copies of the original entries, or by comparing the number of transcriptions from two different sources; the published registers were not checked. The verified figures were entered on the appropriate Excel spreadsheets and annual totals for each county obtained; graphics were produced using the Excel graphing facility. If possible, parishes that had been listed by Wrigley and Schofield, and Michnowicz, but not by FreeREG, were also utilised.[233]

The figures for 1783 and 1784 were tabulated on a monthly basis, which potentially allowed for a very detailed analysis of the seasonality as well as the overall severity and cause of any mortality crisis. In addition, a decadal analysis was undertaken to discover whether there were any crisis years between 1770 and 1799.

[233] WRIGLEY, E. A. and SCHOFIELD, R. S., 485–89; MICHNOWICZ, Sabina A. K., 'The Laki Fissure Eruption and UK Mortality Crises of 1783-1784', 129–32.

Map 4:1 Map of Great Britain showing counties, coloured green, that have been used in this study

The definition of a mortality crisis is that devised by Schofield, namely, where an annual number of burials is more than twice the average number of burials for that year.[234] In order to identify those crises which fall short of this figure, we have followed Turner's example and called a figure of between one and a half times to twice the average, a minor crisis, whilst one of twice or more, a major crisis.[235] The method used to calculate an average, was to count the number of deaths in 20 consecutive years beginning with the year 1770, and then divide the total by 20. This method resulted in two sets of figures, namely: 1770-1789, and 1780-1799. A third average was also taken over the full 30-year period, i.e. 1770-1799. Apart from its simplicity and ease of use, there was the added advantage of having three parameters with which to test the 1780's figures. It was felt that using an average based upon 12 consecutive years and deducting the highest and lowest figures, or a moving average of 11 or 25 years, were somewhat cumbersome and unwieldly methods.[236] In any event the average taken is an entirely arbitrary conception, and the nature of the crisis "*will depend far more on our choice of the factor by which the annual number of burials must exceed the average annual number.*"[237]

A slightly different system was used for the years 1783 and 1784 as these were analysed on a monthly basis, but using the same criteria as before, for major and minor epidemics.

4:2 Parish Registers and other Vital Records

Parish registers, together with bishop's transcripts, are the church records of baptisms, marriages and burials and are the cornerstone of any research into population statistics. They can, however, suffer from a number of deficiencies and errors of interpretation. According to Razzell, research into the reliability of parish registers in England, has shown that between a fifth and a third of all baptisms and burials went

[234] SCHOFIELD, R. S., 'Crisis Mortality', *Local Population Studies*, no. 9 (1971): 13, http://www.localpopulationstudies.org.uk/PDF/LPS9/LPS9_1972_10-22.pdf.
[235] TURNER, Derek, 'Crisis Mortality in Nine Sussex Parishes', *Local Population Studies*, no. 11 (1973): 40.
[236] OSWALD, N.C., 'Epidemics in Devon, 1538-1837', *Report and Transactions of the Devon Association for the Advancement of Science* 109, no. 469 (1977): 74; SCHOFIELD, R. S., 'Crisis Mortality', 11.
[237] SCHOFIELD, R. S., 'Crisis Mortality', 11–12.

unregistered between 1538 -1850.[238]This unreliability may be due to several reasons, the most important perhaps, being:

1. Clerical negligence. The following extract comes from Burn's history of parish registers, and many more examples are to be found there.

> The custody of Parish Registers having been frequently committed to ignorant parish clerks, who had no idea of their utility beyond their being occasionally the means of putting a shilling into their pockets for furnishing Extracts, and at other times being under the superintendence of an incumbent, either forgetful, careless, or negligent, the result has necessarily been, that many Registers are miserably defective, some having the appearance of being kept regularly from month to month, and year to year, yet being deficient of a great many entries; some having a break of several years together, while others are written with a carelessness amounting to little better than a total omission of registry;[239]

The following examples will suffice to exemplify Burn's comments. The first from the *Bibliotheca Topographica Britannica* concerning the parish of Plungar, in Leicestershire: "*The late clerk was the village grocer; and having no reverence for antiquity, nor probably any other idea of the use of paper than that it served to wrap tea and snuff in, he made it answer that purpose*…"[240]

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[238] Razzell, Peter, *Population and Disease: Transforming English Society, 1550-1850* (London: Caliban, 2007), 3–39.
[239] BURN, John Southerden, *Registrum Ecclesiae Parochialis : The History of Parish Registers in England : Also of the Registers of Scotland, Ireland, the East and West Indies, the Dissenters, and the Episcopal Chapels in and about London, with Observations on Bishops' Transcripts, and the Provisions of the Act of the 52nd George III Cap.146*, 2nd ed. (London: John Russell Smith, 1862), 40 et sec, https://archive.org/details/registrumecclesi00burnrich.
[240] NICHOLS, John, *Bibliotheca Topographica Britannica: Antiquities in Leicestershire*, vol. 8 (London: J. Nichols, 1780), 1169, https://www.myheritage.com/research/record-90100-33335568/bibliotheca-topographica-britannica-antiquities-in-leicestershire-vol-8#fullscreen.

To quote from Burn again: "*In Northamptonshire… the Register being in the custody of a parish clerk, his daughters, who were lace makers, were allowed to cut it up for a supply of parchment to be used in their manufacture*".[241]

An unnamed correspondent to the Gentleman's Magazine wrote:

> Our Parish Registers, particularly in the Country, have frequently been kept in the most slovenly manner, without order or regularity. The Clergyman has entered the names at his leisure, whenever he had nothing better to do, and has perhaps has never entered them at all. Misnomers, which for the individual may have had the most serious consequences, have occurred in every page…[242]

2. Accidental damage or loss There could be many reasons for the accidental damage or loss to registers. For example, keeping them in damp conditions which would encourage mould growth and could cause the ink to run, thus making them illegible, destruction in time of war, direct water damage, insects, and vermin. See Figures 4:1 and 4:2.

3. Non-Protestant Cemeteries Many congregations of dissenters had their own burial grounds, as had Jews and Roman Catholics.

4. No burial service Some persons, from motives of convenience or economy, interred their dead without any ceremony.

5. Un-baptised children Children who died before baptism may not have been registered or had no ceremony.

6. Negligence in small benefices where the minister was not resident.[243]

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[241] BURN, John Southerden, *Registrum Ecclesiae Parochialis : The History of Parish Registers in England : Also of the Registers of Scotland, Ireland, the East and West Indies, the Dissenters, and the Episcopal Chapels in and about London, with Observations on Bishops' Transcripts, and the Provisions of the Act of the 52nd George III Cap.146*, 43.

[242] URBAN, Sylvanus (John Nichols), *The Gentleman's Magazine: And Historical Chronicle*, vol. 81 (fourth of a new series), New (London: J. Nichols and Son, 1811), 6, https://books.google.fr/books?redir_esc=y&id=yvcRAAAAYAAJ&q=clergyman#v=snippet&q=clergyman&f=false.

[243] COX, J. Charles, *The Parish Registers of England*, The Antiquary's Books (London: Methuen, 1910), 96, https://archive.org/details/b21352422.

7. Errors in transcription These often occurred when registers were transcribed for one reason or another, for example, when making an annual copy of the registers to send to the local bishop, known as Bishops' Transcripts, or because the original copies had become damaged. Unfortunately, many modern transcriptions by commercial genealogy websites contain a multitude of errors regarding the copying of names, males entered as females and vice versa, entries recorded in the wrong year, and duplication of entries, to name but a few. The last two mentioned being the most serious for our purposes.

Before embarking on an analysis of the available statistics, it would be well to bear in mind the following caveat by Loughlin et al.:

> Unfortunately, historical records relating to 1783-4 cannot be critically analysed using the standard epidemiological methods used in modern air pollution research. It is not possible to reliably infer the short-term exposure levels of people to individual air pollutants from the reports of odour, haze or vegetation damage. The available historical data are also inadequate for calculating age-specific death rates, or doing time-series analyses from the parish numbers of deaths, which are also known to be highly unstable in many parishes due to the high prevalence of endemic infectious diseases no longer seen in Britain today, and the much lower life expectancy in 1783.[244]

[244] LOUGHLIN, S. C., et al., 'Large-Magnitude Fissure Eruptions in Iceland: Source Characterisation', British Geological Survey Open File Report (London: British Geological Survey, 15 May 2012), xii, https://www.bgs.ac.uk/downloads/start.cfm?id=2881.

Figure 4:1 Parish Register from the church of St Margaret of Antioch, Toppesfield, Essex Ref. D/P 163/1/2 severely damaged by damp

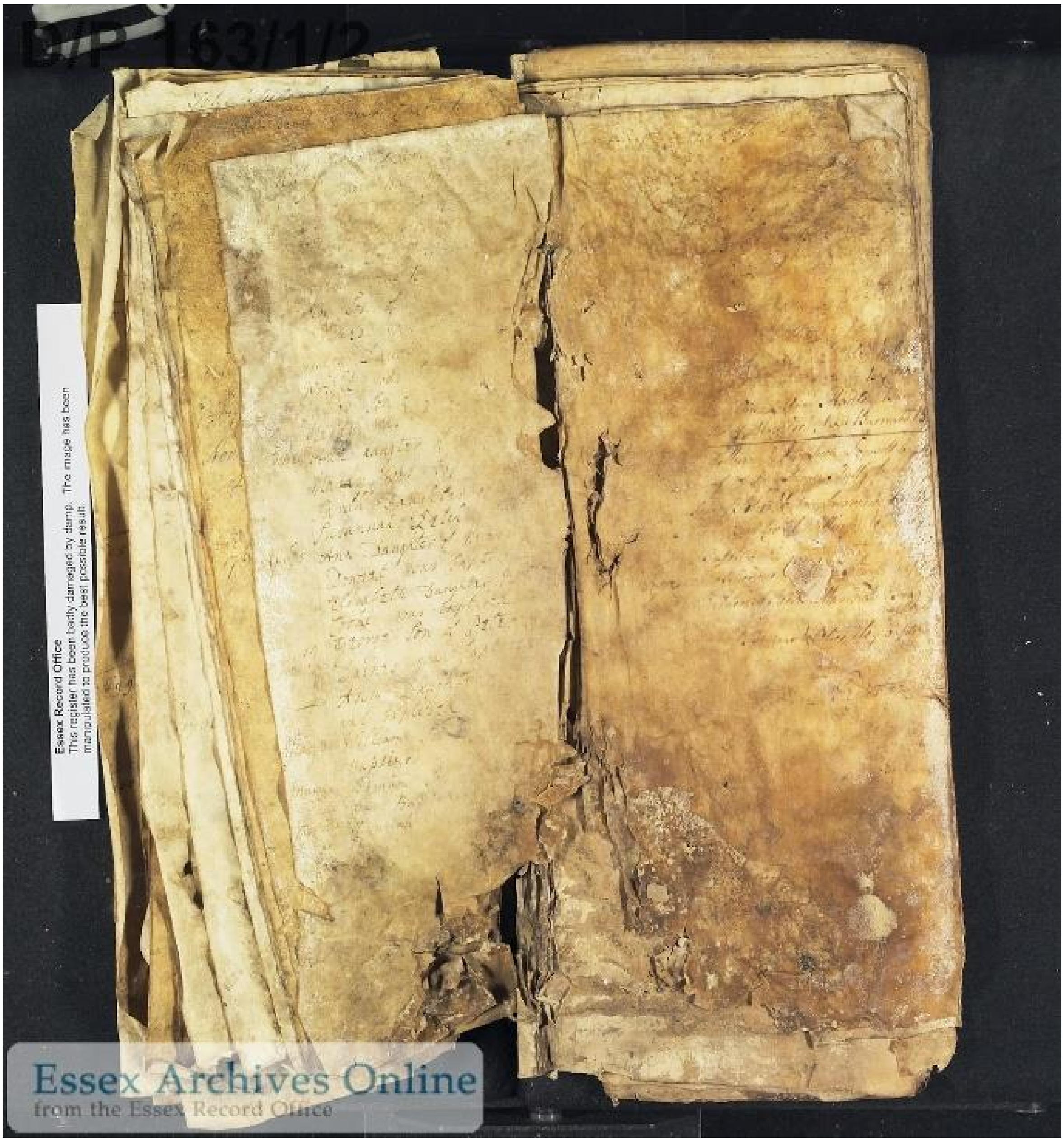


Photo Essex Record Office

Figure 4:2 Parish Register from St Nicholas Church, Salthouse, Norfolk. Ref. PD 23/1 which has been severely damaged through being kept in damp conditions

Photo Norfolk Record Office

The damage to the Salthouse register was caused by a well-intentioned but misguided effort to keep the oldest parish registers safe during the war. Salthouse is situated on the North Norfolk coast, and was just over the sea from German occupied Europe. The Rector of Salthouse, the Revd. Charles Swainson, and the local churchwarden, hid the two oldest volumes underground in Salthouse churchyard. The volumes were wrapped in newspaper and blue cloth – possibly oilcloth – to protect them whilst they were underground. By the time they were recovered after the war they were in a lamentable state. The books were dirty, covered in mould, some pages were fused together by the damp, and some had completely disintegrated.[245]

It seems reasonable to surmise that the problems encountered with British parish registers apply in equal measure, or possibly more so, to those on the Continent of

[245] NORFOLK RECORD OFFICE, 'Exhibition Guide: The Salthouse Parish Register, 1538-1713', 27 June 2007, http://www.archives.norfolk.gov.uk/view/NCC110418.

Europe, especially when one considers the upheaval caused by the number of wars which have taken place during the past 250 years.

Having seen the number of deficiencies that parish registers can suffer, it is reasonable to ask the question, “Why do we use them?”. The answer lies in the fact that they are the best and often the only means at our disposal. However, an exception must be made for the London Bills of Mortality which were published on a weekly basis, and excerpts of which were published at the end of each month in the “*The Gentleman’s Magazine*”. Newspaper reports do not show annual numbers of deaths, and where a number of fatalities is given, after a catastrophe for example, it cannot, in all probability, be relied upon. The same caveat applies to orally transmitted information. Official reports may fail – purposely in some cases – to give accurate information. See Chapter 5 regarding the differing figures of reported deaths caused by the Great Lindon Smog of 1952 and the Chernobyl disaster in 1986.

4:3 Analysis of Parish Register Statistics

The following tables and graphs have been produced to show the number of deceased for the years 1770-1799, and in particular to investigate whether Laki was, in fact, responsible for a vastly increased rate of mortality between the years 1783 -1785. See tables 4:1 to 4:18, and figures 4:1 to 4:11.

4:3:1 England

The figures show that there was a steady increase in the rate of mortality during the last three decades of the century; 3.32% between the decade ending in 1779 and the one ending in 1789; and by 2.9% between those ending in 1789 and 1799, with an increase of 6.51% over the whole 30-year period. This is clearly indicated by the totals shown in Figure 4:1.

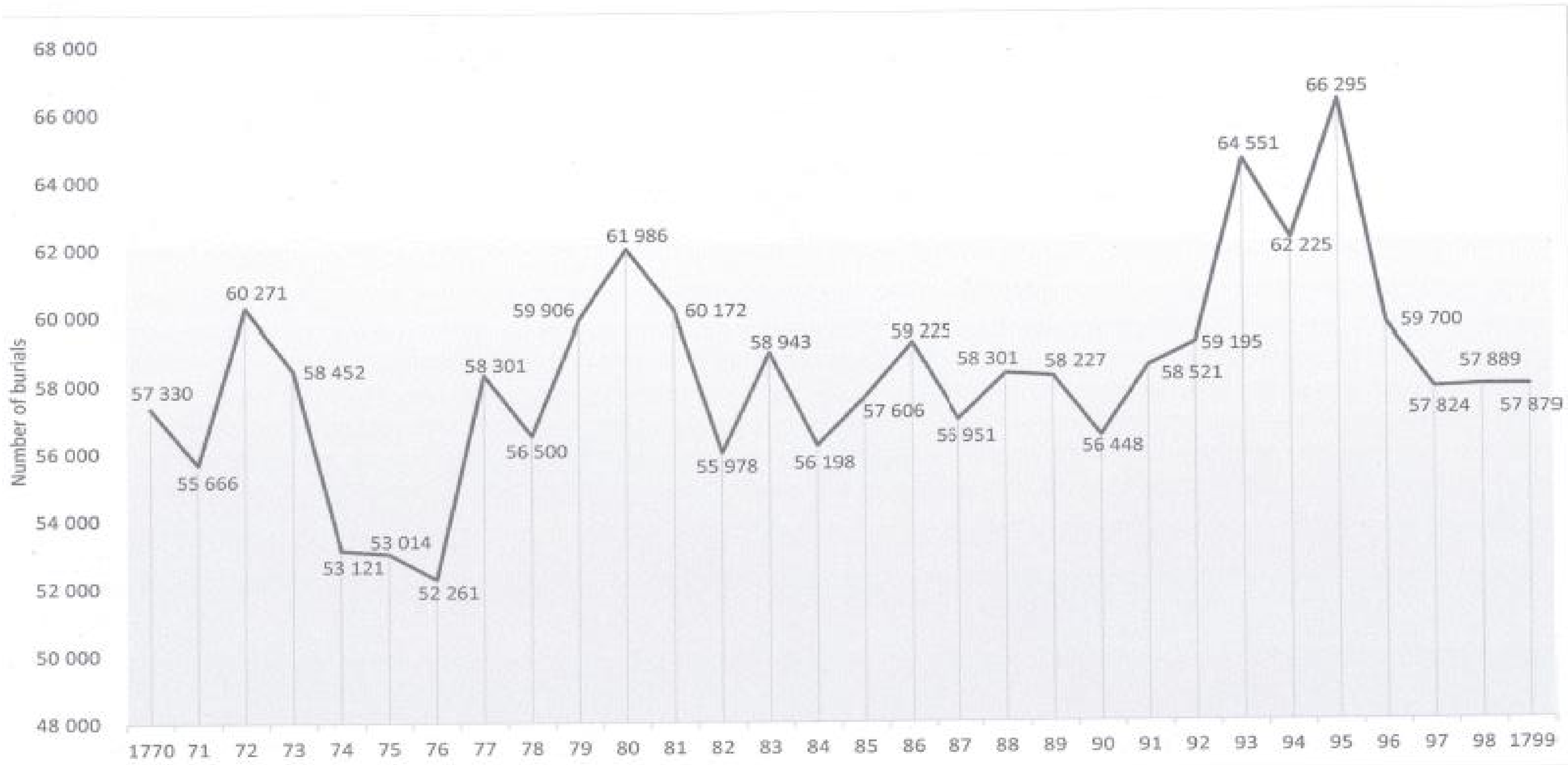
Table 4:1 Number of burials in England for 1324 parishes 1770-1799

1770	57 330	***1780***	***61 986***	1790	56 448
1771	55 666	***1781***	***60 172***	1791	58 521
1772	***60 271***	1782	55 978	1792	59 195
1773	58 452	1783	58 943	***1793***	***64 551***
1774	53 121	1784	56 198	1794	62 225
1775	53 014	1785	57 606	***1795***	***66 295***
1776	52 261	1786	59 225	1796	59 700
1777	58 301	1787	56 951	1797	57 824
1778	56 500	1788	58 301	1798	57 889
1779	***59 906***	1789	58 227	1799	57 879
Total	**564 822**	**Total**	**583 587**	**Total**	**600 527**

The two years with the greatest number of burials in each decade are marked in bold italics.

One can see from the counties coloured green on Map 4:1, that the figures listed above cover the entire country. The number of deaths recorded for the whole of 1783, was only the fourth highest in the decade, and those for 1784 and 1785, considerably less. This is more clearly indicated by the above table and the graph shown in Figure 4:3, which emphasises the fact that although the year 1783 peaks between those of 1782 and 1784, it has by no means the highest rate of mortality in any of the three decades analysed, the two highest years in each decade being marked in bold italics. As received opinion states that Laki caused the death, either directly or indirectly, of many thousands of people, one would think that the number of burials for the years, 1783-1785, would have been far in excess of those for the three preceding years, whilst in reality it was considerably fewer. The graph clearly indicates the highest rates of mortality for the 30-year period from 1770 to 1799, were 1772, 1780, 1793, and 1795, and of these, only two were crisis years; 1780 was a major crisis year in Kent, and a minor one in Hampshire, whilst 1795 was a minor crisis in Devonshire and Lancashire.

Figure 4:3 Number of burials in England 1770 to 1799



A careful analysis of the number of burials from each county shows that there was only one that had a major crisis year during the whole 30-year period, and five having six minor crises. It will be noted that none of these crises fell in the years 1783 or 1784. See Table 4:2 below.

Table 4:2 Number of crises by county using averages of 2 x 20 & 1 x 30 years

	County	1770-1789	1780-1799	1770-1799
Major crisis	Kent	1780	1780	1780
Minor crisis	Cumberland	1773		
	Westmorland	1773		1773
	Hampshire		1780, 1781	
	Devonshire		1795	1795
	Lancashire			1795

It has to be borne in mind that signs of the eruption first appeared in Caithness in the north of Scotland between the 10th and 16th June, and at an unspecified location in the north of Great Britain on the 16th June – was this also Caithness? – thus, only the second half of June should be taken into consideration when analysing the total mortality for 1783.[246]

An analysis of the figures for 1783 and 1784 on a monthly as opposed to an annual basis – Table 4:3 – shows that in 1783, two (20.00%) of the crises occurred in January and May, before the Laki eruption started, whilst the remaining 8 crises (80.00%) took place during August and September. However, in 1784, 77.77% of crises occurred during the first four months of the year; four in January, one each in February, March and April, and the remaining two in December.

[246] GEIKIE, Archibald, *Text-Book of Geology*, 2nd ed. (London: Macmillan, 1885), 202, https://archive.org/details/textbookofgeolog00geikuoft; THORDARSON, Thorvaldur, 'Volatile Release and Atmospheric Effects of Basaltic Fissure Eruptions' (PhD, Honolulu, University of Hawaii, 1995), 83.

Table 4:3 Number of minor crises in 1783 and 1784 by month

County	**Crisis months 1783**	Total no of burials in year	Average no of burials per month in year	Minimum no of burials in crisis month
Westmorland	Jan	121	10.08	15.13
Wiltshire	May	468	39.00	58.50
Surrey	Aug	632	52.67	79.00
Bedfordshire	Aug, Sep	903	75.25	112.88
Hampshire	Aug, Sep	1 652	137.67	206.50
Rutland	Aug, Sep	268	22.33	33.50
Cambridgeshire	Sep	1 019	84.92	127.38
	1784			
Bedfordshire	Jan	810	67.50	101.25
Hampshire	Jan	941	78.42	117.63
London Bills	Jan	17 828	1 485.67	2 228.50
London Non. Conf.	Jan	745	62.08	93.13
Shropshire	Feb	439	36.58	54.88
Rutland	Mar	247	20.58	30.88
Sussex	Apr	418	34.83	52.25
Cumberland	Dec	178	14.83	22.25
Westmorland	Dec	116	9.67	14.50

This can be seen more clearly in Figure 4:4, which shows that there is a rapid rise in the burial rate from the end of June until the peak is reached in September, from whence it falls until rising again in November to reach a new high point at the end of January 1784.

Witham and Oppenheimer state that after the second peak of mortality had occurred in January and February 1784, there was a heightened rate of mortality in the ensuing March and April. This is not borne out by the data shown in Figure 4:4. They also conjecture that "*if the parish data are assumed to be representative of England as a whole, then the peaks represent ~19,700 extra deaths in the country during this* *period"* [247]. That this assumption is clearly incorrect, can be shown by reference to Figure 4:3.

The question naturally arises as to what caused these crises. Unfortunately, there are only a relatively few instances in the parishes studied, where the cause of death and the age of the deceased were recorded. It is quite possible that the dry fog produced by Laki had a deleterious effect on people already suffering from asthma or other respiratory diseases, but its effect during the hot summer of 1783 is impossible to quantify. However, a hot summer was the ideal time for infantile diarrhoea, as well as other gastric infections such as dysentery and typhoid to take hold, and it's quite likely that they were the cause of many infant deaths.[248] As we saw in Chapter 1, Gilbert White wrote, "[…] *that the heat was so intense that butchers' meat could hardly be eaten on the day after it was killed; and the flies swarmed so in the lanes and hedges* […]"[249] Due to the speed that flies breed in hot weather – the common housefly may take only six days from egg to fly – it is not surprising that there is an increased likelihood of spreading infection from contaminated food.[250]

Creighton reports that there was an epidemic of fevers and agues between 1780-1785 throughout the country, being particularly noticeable in London, "*not least so during the very severe cold of the winter and spring of 1783-84.*"[251] Confirmation of a fever epidemic during late summer comes from the Memoirs of the Rev. Charles Simeon who returned to his parish – Holy Trinity, Cambridge – on 19th September after journeying through central England in August and September. In a letter dated 22nd September 1783 to his friend, the Rev. John Venn, he writes, "*many whom I left in my parish well are dead, and many dying; this fever rages wherever I have been.*"[252] On

[247] WITHAM, C. S. and OPPENHEIMER, C., 'Mortality in England during the 1783–4 Laki Craters Eruption', 25.
[248] CREIGHTON, Charles, *A History of Epidemics in Britain. Vol. 2 From the Extinction of Plague to the Present Time.*, 2:763.
[249] WHITE, Gilbert, *The Natural History and Antiquities of Selborne in the County of Southampton: With Engravings and an Appendix* (London: T. Bensley, 1789), 301–2, https://ia800504.us.archive.org/12/items/naturalhistorya04whitgoog/naturalhistorya04whitgoog.pdf.
[250] WITHAM, C. S. and OPPENHEIMER, C., 'Mortality in England during the 1783–4 Laki Craters Eruption', 22; WHO, 'Houseflies', WHO, 302–3, accessed 12 November 2016, http://www.who.int/water_sanitation_health/resources/vector302to323.pdf.
[251] CREIGHTON, Charles, *A History of Epidemics in Britain. Vol. 2 From the Extinction of Plague to the Present Time.*, 2:366–70.
[252] SIMEON, Rev. Charles, *Memoirs of the Life of the Rev. Charles Simeon, M.A., Late Senior Fellow of Kong's College, and Minister of Trinity Church, Cambridge*, ed. CARUS, Rev. William, 1st ed. (London: Hatchard and Son, 1847), 58, http://books.google.com.my/books/about/Memoirs_of_the_Life_of_the_Rev_Charles_S.html?id=XO0oG2caEFMC.

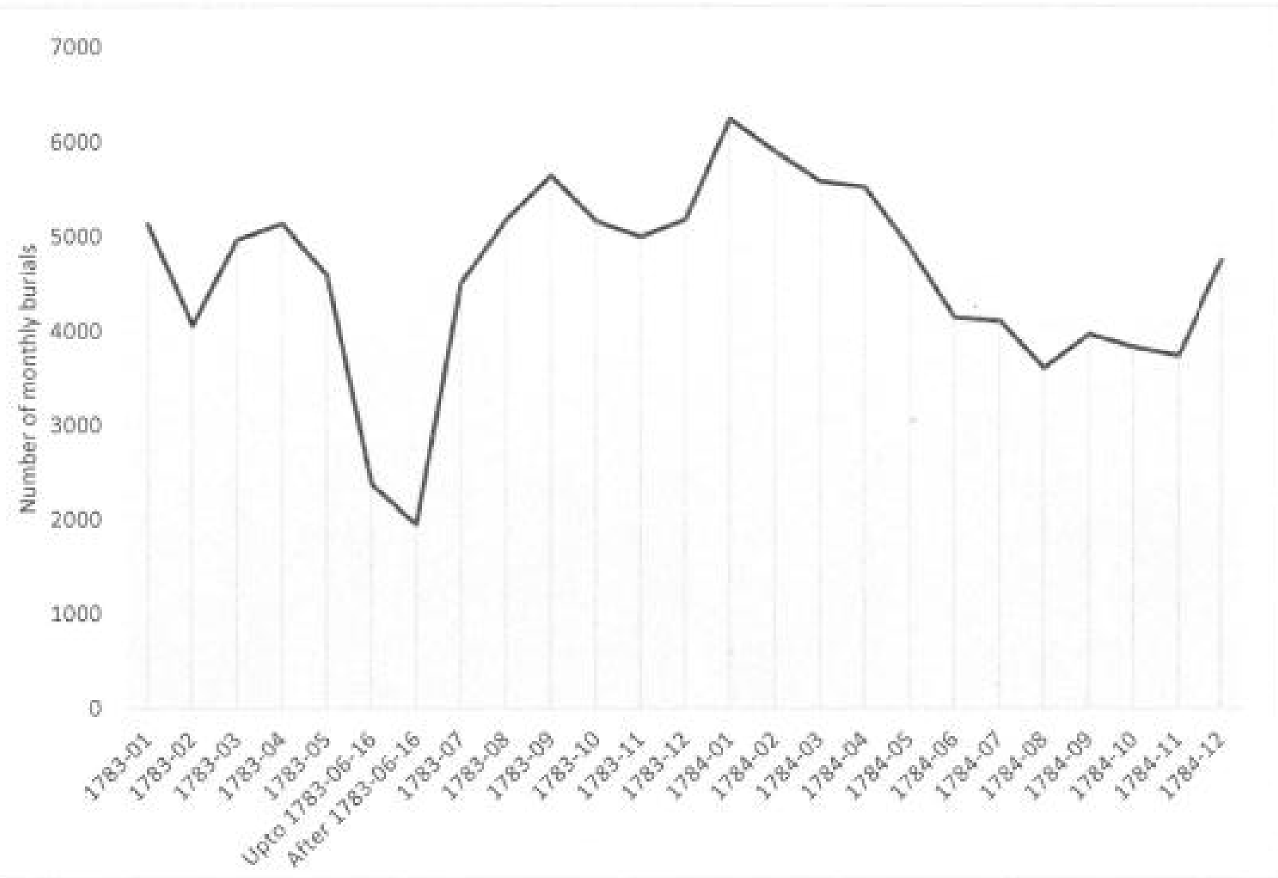
8th September, the poet, William Cowper, said in a letter to the Rev. John Newton, "*The epidemic begins to be more mortal as the autumn comes on, and in Bedfordshire it is reported, how truly I cannot say, to be nearly as fatal as the plague*", and the Rev. James Woodforde writing in his diary from Weston Longville in Norfolk on the 2nd September, reported that three of his servants were sick. "*Almost all the House is ill in the present Disorder… It is in almost in every House in every Village.*"[253]

Summary

During the extremely hot summer there was an increase in the number of deaths which was probably due one of the many gastric infections circulating at the time. It is generally accepted that the severe winter of 1783-1784 – one of the coldest for 500 years – impacted directly on the mortality of the population. There are accounts of people and cattle freezing to death, of great quantities of snow and hard frosts over much of Britain and Europe. Chap. 1:3:7.[254] It seems reasonable to assume that the cold weather lessened peoples' disease resistance, especially amongst the old or infirm, to respiratory diseases such as the common cold; influenza; bronchitis and pneumonia.[255] Typhus, a louse-borne disease, would have spread rapidly from person to person amongst those huddled together trying to keep warm. This applied particularly to people living in the slum areas of large towns, especially newly-arrived country folk who would have been unused to such conditions.[256]

[253] COWPER, William, *The Letters of the Late William Cowper, Esq. to His Friends. Revised by His Kinsman, J. Johnson, LL.D. Rector of Yaxham with Welborne, in Norfolk.*, 187–88; WOODFORDE, James, *A Countyr Parson: James Woodforde's Diary 1759-1802*, 84.
[254] WITHAM, C. S. and OPPENHEIMER, C., 'Mortality in England during the 1783–4 Laki Craters Eruption', 22; URBAN, Sylvanus John, *The Gentleman's Magazine; and Historical Chronicle*, vol. 54, 1784, 67–68; 142–43, https://babel.hathitrust.org/cgi/pt?id=mdp.39015013465896&view=1up&seq=536.
[255] WITHAM, C. S. and OPPENHEIMER, C., 'Mortality in England during the 1783–4 Laki Craters Eruption', 22; ALBERT, Michael, DY, Norman, and FEESER, Scott, 'Winter Illness Guide', John Hopkins Medicine, accessed 27 February 2020, https://www.hopkinsmedicine.org/health/conditions-and-diseases/winter-illness-guide.
[256] CREIGHTON, Charles, *A History of Epidemics in Britain. Vol. 2 From the Extinction of Plague to the Present Time.*, 2:100–101.

Figure 4:4 Analysis of monthly burials in England 1783 and 1784



1783	
Jan	5 134
Feb	4 057
Mar	4 970
Apr	5 143
May	4 593
Up to 16 Jun	2 374
Total	26 271
After 16 Jun	1 948
Jul	4 511
Aug	5 179
Sep	5 648
Oct	5 167
Nov	5 001
Dec	5 183
Total	32 637
Total for Year	58 908
1784	
Jan	6 246
Feb	5 902
Mar	5 586
Apr	5 526
May	4 884
Jun	4 145
Jul	4 106
Aug	3 612
Sep	3 969
Oct	3 833
Nov	3 742
Dec	4 756
Total	56 307

4:3:2 Wales

Between 1770 to 1778, the number of annual burials in Wales is very erratic, but after having reached the 1778 low point, there is a steady climb to the maximum number in

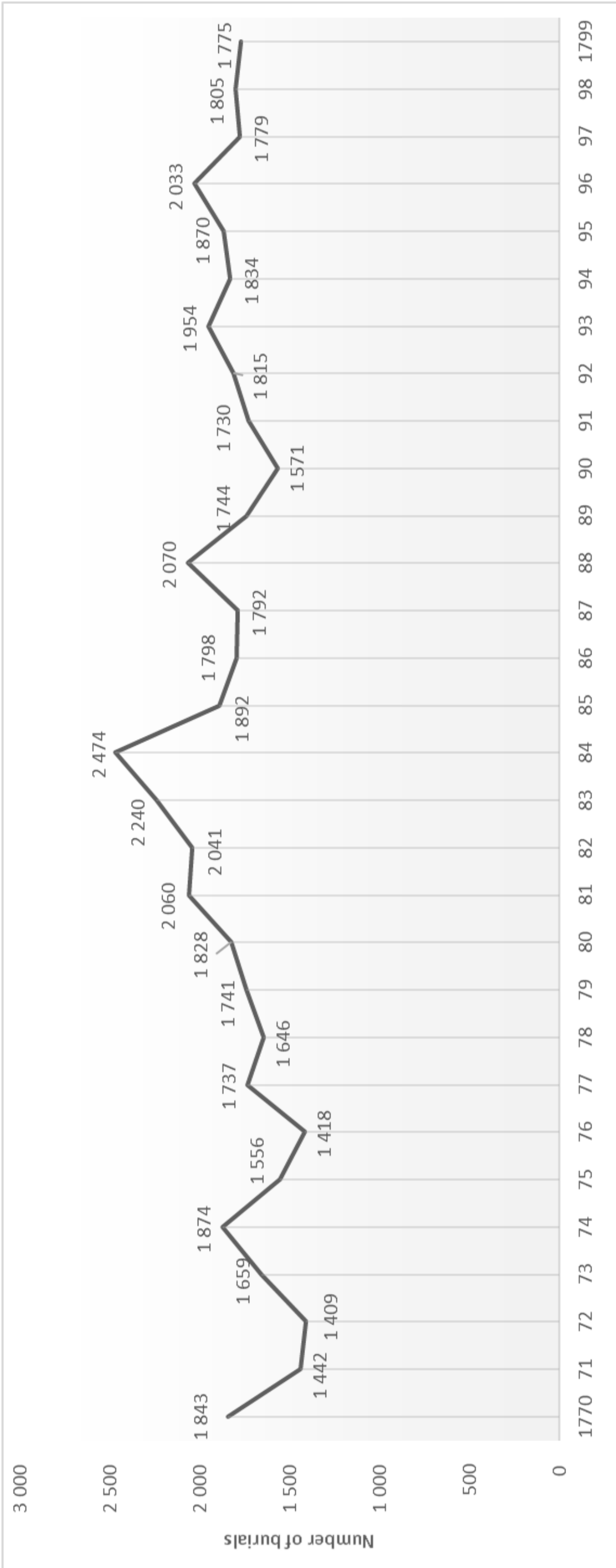


Figure 4:5 Number of burials in Wales 1770 to 1799

1784, from whence it falls sharply in 1785 and then tends to level out until the end of the century. See table 4:4 and Figure 4:5. Even though 1783 and 1784 had the highest number of burials in the decade, we see that by using 20 and 30-year averages, there were no major crisis years during the final three decades of the century and only one minor crisis, that being Cardiganshire in 1784.

Table 4:4 Number of burials in Wales for 124 parishes 1770 to 1799

1770	1 843	1780	1 828	1790	1 571
1771	1 442	1781	2 060	1791	1 730
1772	1 409	1782	2 041	1792	1 815
1773	1 659	1783	2 240	1793	1 954
1774	***1 874***	***1784***	***2 474***	1794	1 834
1775	1 556	1785	1 892	1795	1 870
1776	1 418	1786	1 798	***1796***	***2 033***
1777	1 737	1787	1 792	1797	1 779
1778	1 646	1788	2 070	1798	1 805
1779	1 741	1789	1 744	1799	1 775
Total	**16 325**	**Total**	**19 939**	**Total**	**18 166**

The year with the greatest number of burials in each decade has been marked in bold italics.

Table 4:5 Number of crises by county using averages of 2 x 20 & 1 x 30 years

	County	1770-1789	1780-1799	1770-1799
Major crisis	None	None	None	None
Minor crisis	Cardiganshire		1784	1784

There were, however, a number of minor monthly crises during 1783 and 1784, and It can be seen from table 4:6 that in 1783, only one crisis occurred after the Laki eruption, and in 1784, all three crises happened in February. As in England, these were probably caused by a spate of respiratory infections attacking the very young or the old and infirm, due no doubt to the extremely harsh winter that year.

Table 4:6 Number of minor crises in 1783 and 1784

County	**Crisis months 1783**	Total no of burials in year	Average n° of burials per month	Minimum n° of burials in crisis month	Number of burials in crisis month
Flintshire	Jan	425	35.42	53.13	54
Breconshire	May	253	21.08	31.63	33
Caernarfonshire	Sep	135	11.25	16.88	17
	1784				
Caernarfonshire	Feb	160	13.33	20.00	21
Cardiganshire	Feb	513	42.75	64.13	65
Glamorganshire	Feb	705	58.75	88.13	91

Summary

It can be seen from table 4:6 that in 1783, only one crisis occurred after the Laki eruption, and in 1784, all three crises occurred in February. As in England, these were probably caused by a spate of respiratory infections attacking the very young or the old and infirm, due no doubt to the extremely harsh winter that year. Thus, from the above figures, it would seem highly contentious to state that these crises resulted from the Laki eruption.

4:3:3: Isle of Man

The Isle of Man, Map 4:2, is situated in the Irish Sea about 91 miles from the English coast and was, in the 18th century, somewhat isolated from the mainland. It should, therefore have stood a reasonable chance of escaping any epidemics that were prevalent elsewhere; but unfortunately, it didn't. The first recorded death on the island due to smallpox, was that of Jane Cluage, whose burial is recorded in the Kirk Braddan parish register on 17th January 1684/5.[257] Her death was the precursor of a series of epidemics that were virtually eradicated towards the end of the 19th century. This was due to the widespread adoption of vaccination as opposed to the much more dangerous method of inoculation.[258]

Map 4:2 The Isle of Man

After Wikimedia Commons

[257] MANX NOTEBOOK, 'Manx Notebook: Disease', Manx notebook, 2001, http://www.isle-of-man.com/manxnotebook/famhist/genealgy/diseases.htm.
[258] MANX NOTEBOOK.

The following graph Figure 4:6, together with Table 4:7, chart the rise and fall of the I.O.M. burials over the last three decades of the 18th century, and clearly show the large spike relating to a smallpox epidemic in 1772-1773. To give but two examples of the severity of this epidemic, there were a total of 1,163 burials, of which 70, all children, took place in Kirk German between 14th September 1772 and 29th March 1773; and in the neighbouring parish of Kirk Braddan, 77 children died between 25th June and 8th October 1772. There were sporadic outbreaks of smallpox until nearly the end of the following century, but unfortunately, there is nothing in the registers that explains the large number of burials in 1784, even though there were several monthly crises. See Table 4:8.

Table 4:7 Number of burials in the I.O.M. for 18 parishes 1770 to 1799

1770	256	1 780	339	1 790	446
1771	293	1781	431	1791	378
1772	***656***	1782	394	1792	411
1773	507	1783	311	1793	377
1774	432	***1784***	***599***	***1794***	***596***
1775	292	1785	492	1795	439
1776	323	1786	519	1796	447
1777	439	1787	367	1797	557
1778	335	1788	362	1798	496
1779	414	1789	486	1799	589
Total	**3 947**	**Total**	**4 300**	**Total**	**4 736**

The year with the greatest number of burials in each decade has been marked in bold italics.

Were these crises caused by influenza, pneumonia or even smallpox, which although not named, seems to have made its appearance in January before considerably abating by June, or was the manner of deaths considered unremarkable and therefore not recorded? Several months later another bout of Smallpox is clearly indicated by the large number of child burials (94) in the parish of Kirk Braddan from 30th September 1785 to 30th March 1786, and also in an outbreak in Kirk Malew between 2 May and 23 October 1785. We should also point out that the peak of burials in 1794 was due to a major outbreak of smallpox, some of which, according to the parish register, were caused by deliberate inoculation.

Figure 4:6 Number of burials in I.O.M. 1770 to 1799

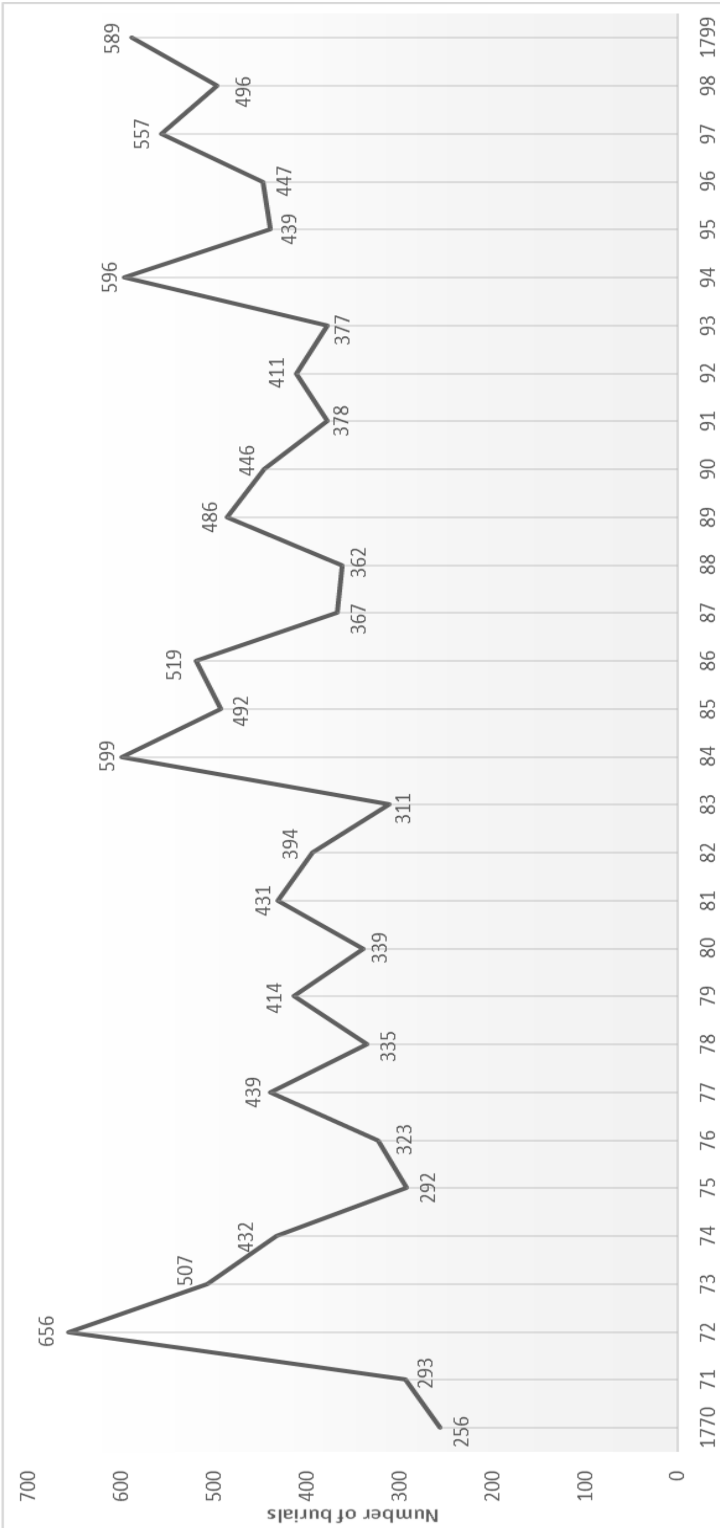


Table 4:8 Annual parish crises in the I.O.M. using averages of 2 x 20 & 1 x 30 years

	Parish	1770-1789	1780-1799	1770-1799
Major crisis	German	1772		1772
	Maughold	1772		1772
	Santon	1772		1772
	Patrick	1773		1773
	Andreas	1773		
	Rushen	1781		
	Arbory	1782	1797	1797
	Lonan	**1784**	**1784**	
	Michael	**1784**		
	Marown		1790, 94	1790, 94
	Bride		1798	1798
	Ballaugh		1799	1799
	Jurby		1799	1799
Minor crisis	Braddan	1772, 85, 86	1794	1794
	Lezayre	1772, 74, **84**		1772, 74
	Malew	1772, **84**, 85	**1784**, 92, 97	1792, 97
	Marown	1772, 73, **84**, 89	1795	1772, 95
	Onchan	1772, 77		1777, 99
	Andreas	**1784**	**1784**, 90, 98, 99	1773, 90, 98, 99
	Arbory		1782, 92, 94	1792, 94
	Ballaugh	1773, 81	1781, 90	1773, 90
	Jurby	1773, 82	1782	1773
	Michael	1773, 86	**1784**	1773
	Bride	1774, 81		1774
	German	1777		1777
	Patrick	1789	1797	1797
	Santon	1789	1789	
	Rushen		1781, 97	1797
	Lonan		1794, 98	1794, 98

The above table, 4:8, shows the number of crises that occurred during the final three decades of the 18th century. Of the 15 major crises, none occurred in 1783 and only two in 1784, whilst out of the 42 minor crises, there were none in 1783 and only five in 1784.

Crises which occurred in 1784 have been marked in bold.

It is interesting to note the differing outcomes obtained by using three contrasting sets of average figures. If we look at the major crises, we see that four out of five relating to the 1772-73 epidemic are revealed in both the 1770-1789 and the 1770-1799 averages, and there is only one instance when a 1780's crisis – 1784 – appears in more than one set of averages; all of the 1790 crises occur in both the 1780-1799 and 1770-1799 averages. The same can be said for the minor crises, where not one appears in all three sets of averages; this begs the question as to which is the optimal set of average figures to use?

We will now examine the parishes individually on a month by month basis. In view of the fact that in the majority of cases, the number of burials was very small, only the major crises have been taken into account. See Tables 4:9 and 4:10. Individually, there were eight major crises in 1783 and 24 in 1784, but when taken collectively, there were no crisis months in 1783. This is not at all surprising considering the low number of burials that year. As can be seen from Table 4:10, the first five months in 1784 had considerably elevated burial rates, but only three were crisis months; April being major with 101 burials and February and March being minor, having 77 and 86 burials respectively.

Perhaps the large increase in April burials, was caused by bodies already weakened by the rigors of a harsh winter, succumbing to the normal range of winter diseases, such as influenza, pneumonia, and possibly smallpox.

Table 4:9 Number of major monthly parish crises in the I.O.M. during 1783 and 1784

County	**Crisis months 1783**	Total no of burials in year	Average no of burials per month	Minimum no of burials in major crisis month	No of burials in crisis month
Andreas	Mar, May, Jun	24	2.00	4.00	4,4,5
German	May, Nov	24	2.00	4.00	7,4
Maughold	Feb	34	2.83	5.66	7
Patrick	Mar, Aug	19	1.58	3.16	4,4
	1784				
Andreas	Jan, Feb, Mar	40	3.33	6.66	8,10,8
Arbory	Jan	14	1.17	2.34	4
Ballaugh	Jan, Feb	24	2.00	4.00	5,4
Braddan	***Apr***	106	8.92	17.84	***30***
Bride	Feb	18	1.50	3.00	5
German	Jan	48	4.00	8.00	8
Jurby	Mar, ***Apr***	15	1.25	2.50	6,***4***
Lezayre	Feb, ***Apr***	45	3.75	7.50	16,***8***
Lonan	Mar, ***Apr***, May	37	3.08	6.16	9,***10***,7
Marown	May	16	1.33	2.66	7
Maughold	Jan, ***Apr***	44	3.67	7.34	8,***10***
Michael	Mar	37	3.08	6.16	12
Onchan	***Apr***, May	23	1.92	3.84	***5***,5
Patrick	***Apr***	29	2.42	4.84	***6***
Rushen	Jan	20	1.67	3.34	4

Crises which occurred in April 1784 have been marked in bold italics.

Table 4:10 Total Number of monthly burials in 1784

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Average	Minor Crisis
67	77	86	**101**	68	33	33	16	29	24	21	43	598	49.83	74.75

Summary

After the first recorded death from smallpox in 1684/5, the disease became endemic in the I.O.M. surfacing every few years to cause serious epidemics among the population.[259]

The year of the Laki eruption was one of the healthier periods for the island during the final three decades of the 18th century, with 311 burials. A detailed examination of the records failed to suggest a reason for the sudden increase in the burial rate the following year. This was in all likelihood due to respiratory diseases such as bronchopneumonia, asthma, influenza or typhus, resulting from the very harsh 1783/84 winter. It is possible that smallpox made a brief appearance, although this is not born out by the register entries.

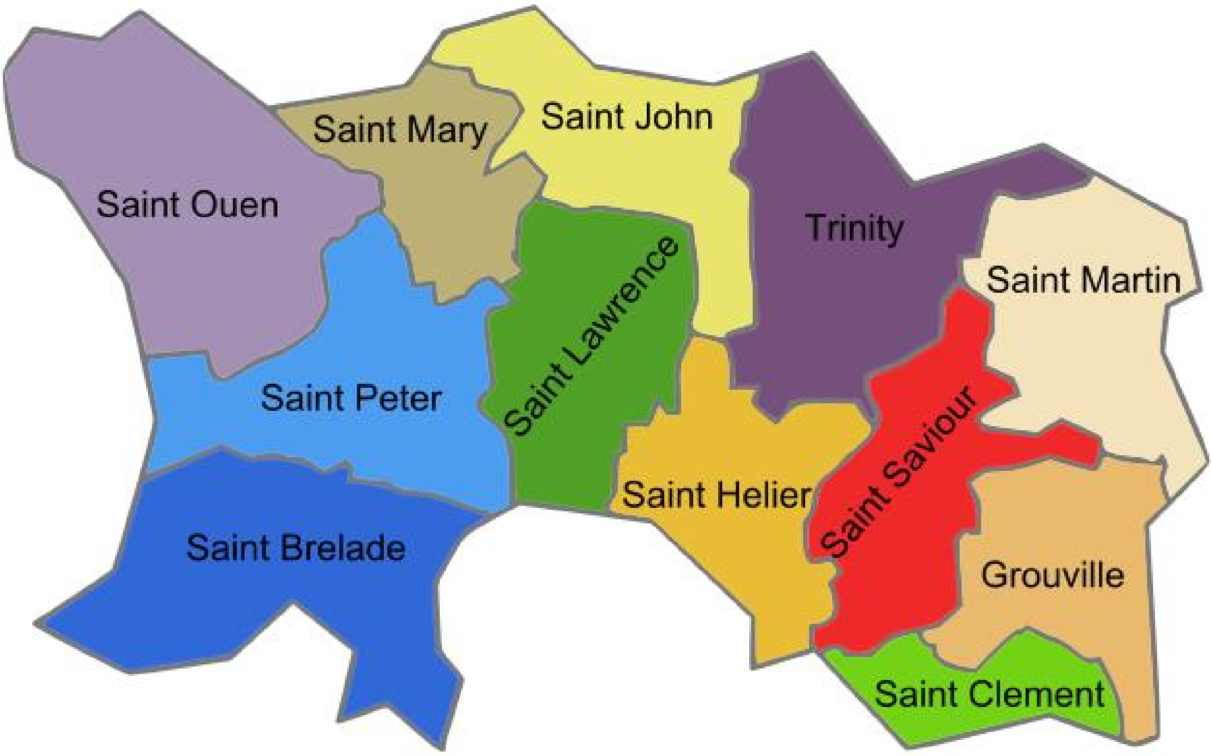
It is an interesting question, but why in 1783 – the year of Laki's eruption –were there the lowest number of burials in the decade? Surely, the answer lies in the fact that the eruption had either no, or minimal effect at all.

4:3:4 Jersey

Jersey is the largest of the Channel Islands and lies about 14 miles from the Cherbourg Peninsula in Normandy. At the time of writing, it is the only Channel Island for which detailed burial statistics are available over the internet, and owing to its proximity to the French coast, could reasonably be expected to have suffered from the blanket of Laki's dry fog, which covered a large part of northern Europe.

[259] MANX NOTEBOOK.

Map 4:3 Jersey parishes



Wikimedia Commons

During the last three decades of the 18th century, there were two spikes in the number of burials that stand out from the others: 638 in 1780 and 1015 in 1794. These are shown in Table 4:11 and Figure 4:7.

Although the parish registers are silent regarding the reason for the unusual number of burials in 1780 – St Helier having a total of 201 – this may have been due to either dysentery or malaria. Some 65 years later, in 1845, *"Constable Pierre Le Sueur ordered the construction of a network of sewers to prevent sewage being discharged into the brooks running through St Helier. This was to help bring under control epidemics of malaria, dysentery and cholera".*[260]

[260] THE ISLAND WIKI, 'The Island Changes', theislandwiki, 22 March 2015, https://www.theislandwiki.org/index.php/The_island_changes.

Table 4:11 Number of burials in Jersey for 12 parishes 1770 to 1799

1770	313	***1780***	***638***	1790	320
1771	***452***	1781	460	1791	432
1772	336	1782	438	1792	456
1773	283	1783	481	1793	557
1774	298	1784	400	***1794***	***1 015***
1775	366	1785	487	1795	663
1776	432	1786	384	1796	599
1777	354	1787	471	1797	531
1778	348	1788	480	1798	439
1779	435	1789	393	1799	519
Total	**3 617**	**Total**	**4 632**	**Total**	**5 531**

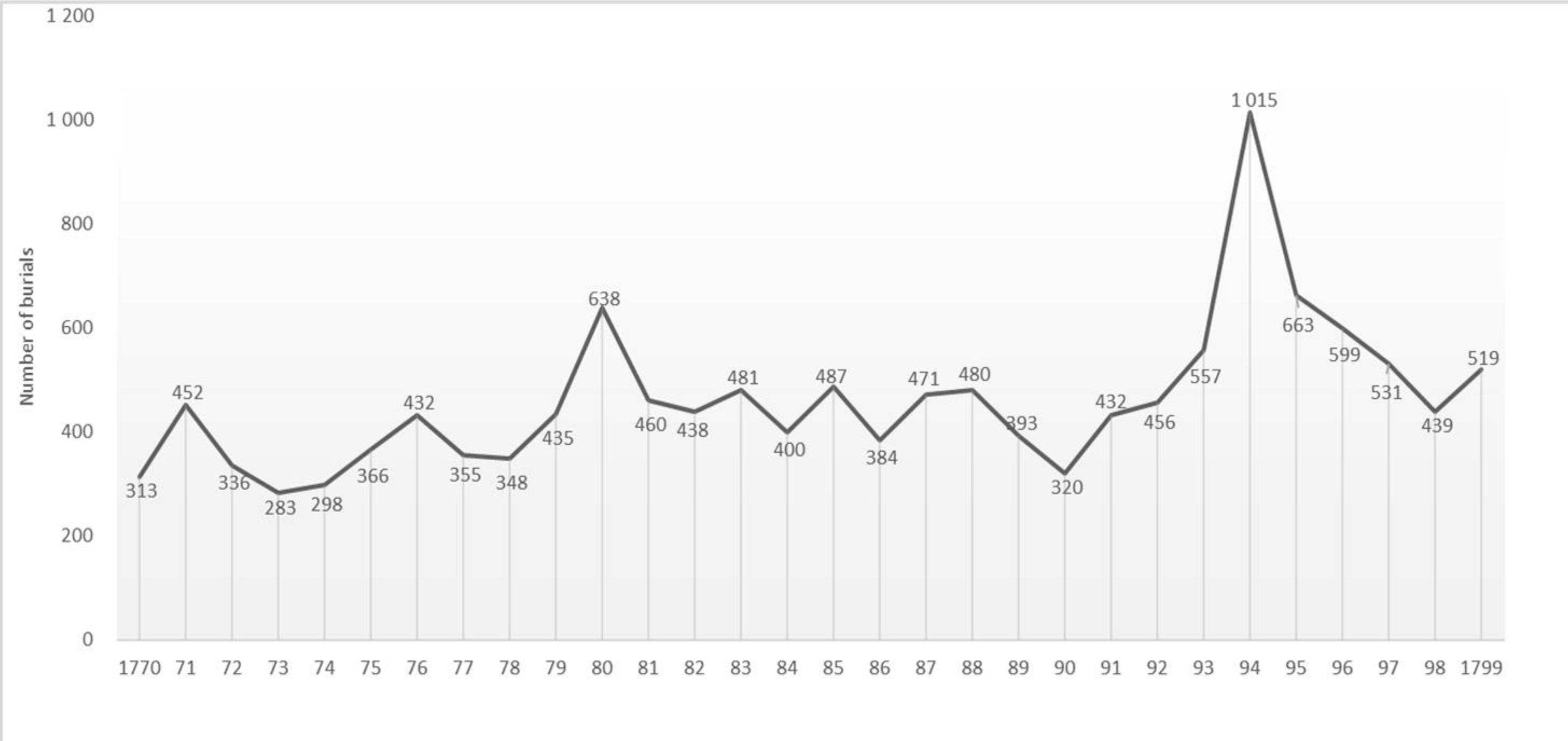
The year with the greatest number of burials in each decade has been marked in bold italics.

It seems reasonable to assume that the problems the parish experienced in 1845 were no different than those that occurred in 1780, with the exception of cholera, which first made its appearance in Jersey in early August 1832.[261]

The year 1794 was particularly unhealthy, with all the parishes showing elevated burial levels especially during the latter part of the year.

[261] BLENCH, Brian J. R., ‘The Jersey Cholera Epidemic of 1832’, *Société Jersiaise 91st Annual Bulletin* 19, no. 2 (1966): 146–49, societe-jersiaise.org/digital-publications/bulletin?file=../bulletin-pdfs/ABSJ1966-web.pdf.

Figure 4:7 Number of burials in Jersey 1770 to 1799



The printed proceedings of the States show that, on 15 October 1794, the authorities were informed that a fatal and contagious disease existed among the garrison soldiers stationed on the Island. Measures were therefore put in place to prevent the disease from spreading to the inhabitants. The soldiers from the 82nd Regiment of Foot were quarantined in St Aubin's Fort, and unsurprisingly, many died through being confined in such a small area. Their deaths are recorded in the St Ouen and St Brelade registers. Although the epidemic was not identified at the time, it has since been attributed to the plague. The Regiment, which had only been formed in Lancashire on 12th March 1794 had visited no foreign parts beforehand and thus there was no opportunity for them to have brought the disease from abroad.[262] If the attribution were correct it would mean that plague had been raging on the British mainland. As the last outbreak of this disease in Britain occurred in 1665-1666, the attribution is clearly incorrect. The contagion was unlikely to have been smallpox as it was no stranger to the island, but could well have been typhus. From what we know of its aetiology, typhus appears to be the most likely candidate for this disease, often having a sudden onset and death rate of between 40%-60% if left untreated.[263]

Notwithstanding the fact that there had been an increase in burials during 1783, see Figure 4:7, there was only one annual crisis, and none in 1784; this is shown in Table 4:12. If we now look at Table 4:13, we see there were five major monthly crises during 1783, with only one occurring after the Laki eruption. The harsh winter of 1783/84 also took its toll, eight out of the nine major crises in 1784 falling in the first four months of the year. Owing to the small number of burials in a crisis month, only the major crises have been shown in this table.

[262] THE ISLAND WIKI, 'Plague Outbreaks', theislandwiki, 1 August 2014, https://www.theislandwiki.org/index.php/Plague_outbreaks.
[263] VYAS, Jatin M., 'Typhus'.

Table 4:12 Annual parish crises in Jersey using averages of 2 x 20 & 1 x 30 years

	Parish	1770-1789	1780-1799	1770-1799
Major Crisis	St Clement	1785		1785
	St Brelade		1794, 95	1794, 95
	St Helier		1794	1794
	Grouville		1794	1794
	St Martin			1794
Minor Crisis	St Mary	1770, 71, 72, 73, 74, 99		1770, 71, 72, 73, 74, 75, 99
	St John	1777, 80, 81	1794, 97	1780, 94, 97
	St Ouen	1779, 80	1780, 94, 95	1780, 94, 95
	St Clement	1780, 88	1796	1780, 88, 96
	St Helier	1780		1780, 94
	St Martin	1780	1794	1780
	Grouville	1780	1795	1795
	St Brelade	1781	1796	1796
	St Peter		1794	1781, 94
	Trinity	**1783**	1794	**1783**, 94
	St Saviour	1785	1793, 94	1793, 94

Table 4:13 Number of major monthly parish crises in 1783 and 1784

Parish	**Crisis months 1783**	Total n° of burials in year	Average n° of burials per month	Minimum n° of burials in crisis month	N° of burials in crisis month
St Ouen	Jan	36	3.00	6.00	6
St Saviour	Jan	40	3.33	6.66	7
St Brelade	Feb	35	2.92	5.84	9
St Peter	Apr	34	2.83	5.66	6
St Lawrence	Sept	41	3.42	6.84	7
	1784				
St Ouen	Jan	32	2.67	5.34	6
St Saviour	Jan, Jun	30	2.50	5.00	5, 5
Trinity	Jan, Feb, Mar	36	3.00	6.00	6, 6, 7
St John	Feb	30	2.50	5.00	8
St Martin	Apr	28	2.33	4.66	5
St Peter	Apr	29	2.42	4.84	5

Summary

Jersey did not suffer from the dry fog that shrouded much of Europe for several months from mid-June 1783. Although the annual number of burials was greater than those for either 1782 or 1784, the majority took place in the first half of the year before Laki erupted. At a monthly level, there were four major crises before June and one in September. The harsh winter, not unexpectedly, caused a few major crises during the first months of 1784, but these were not enough to prevent the year from having the second lowest burial rate in the decade.

The years 1780 and 1794 had the two highest death rates in the final three decades of the century. There is no information regarding the deaths in 1780, but these could have been caused by dysentery and malaria, as this specific problem was only alleviated, at least in St Helier, by the construction of a sewerage system in 1845.

The fatal epidemic that took place in 1794, was initially reported to the authorities in October, as being rife among the regiments of soldiers stationed on the island. In order not to infect the general population, the soldiers were quarantined which, unfortunately, only served to exacerbate the situation. The contagion overlapped into the following year and was not identified at the time. Later, the incorrect assumption was made that plague was to blame. Smallpox can be discounted as the islanders were familiar with the disease, but typhus, also known as gaol or ship fever, was very likely the culprit as it flourished in crowded, insalubrious conditions.

4:3:5 Continental Europe – France

The French mortality data as shown in a series of papers by Grattan et al., Garnier, and Balkanski et al. has been interpreted most convincingly, to show that the dry fog generated by the Laki eruption, in association with the extreme summer heat, had a dire effect on the health of the population.[264] This especially affected those who suffered from asthma and other respiratory infections. Contemporary accounts such as the following, written by the curés of three parishes in Eure-et-Loir, northern France, would seem to bear this out:

Curé de Broué	Pendant cette obscurité du soleil, on n'entendait que maladie et morts très innombrables.
Curé de Landelles	Les brouillards ont été suivis de grands orages et de maladies qui ont mis au tombeau le tiers des hommes dans plusieurs paroisses.
Curé d'Umpeau	Au commencement de ce dégel, la paroisse de Champseru a été affligée d'une maladie pestilentielle ; les malades se sentaient pris a la gorge, quelques ignorants de chirurgiens ont commencé par la saignée et l'émétique ; depuis dix-sept jours, en voilà quatorze mors sur dix-huit. On prétend que les brouillards de mai, juin, juillet

264 GRATTAN, John et al., 'Volcanic Air Pollution and Mortality in France 1783-1784', *C. R. Geoscience*, no. 337 (2005), http://www.google.fr/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&ved=0CC8QFjAB&url=http%3A%2F%2Fwww.researchgate.net%2Fprofile%2FThorvaldur_Thordarson%2Fpublication%2F37145366_Volcanic_air_pollution_and_mortality_in_France_17831784%2Flinks%2F0c96052ab09ddb2314000000.pdf&ei=XAMxVb71IofSaN6tgbgC&usg=AFQjCNEu4GPSOz-wZdzpmC2hcI5PiG9umQ&bvm=bv.91071109,d.d2s; GARNIER Emmanuel, *Les dérangements du temps : 500 ans de chaud et de froid en Europe* (Paris: Plon, 2010); BALKANSKI, Y., et al., 'Mortality Induced by PM2.5 Exposure Following the 1783 Laki Eruption Using Reconstructed Meteorological Fields', *Scientific Reports*, 26 October 2018, 11, https://doi.org/10.1038/s41598-018-34228-7.

> et août, qui offusquèrent le soleil qui paraissait rouge comme du sang, nous pronostiquaient ce fléau. Dieu en préserve ma paroisse![265]

Whereas mortality data regarding many British parishes is relatively easy to obtain, burial figures relating to Continental parishes are not. We have, therefore, relied upon data from published research, but as Grattan notes, "*This limited data set does need to be interpreted with caution*".[266]

In order to attempt to make a comparison between the French and English mortality rates, we have taken the figures used by Grattan which compared French burial data from 53 parishes; four from Loiret, 44 from Seine-Maritime and five from Eure-et-Loir, with 13 parishes in Bedfordshire. The results were then contrasted with the data from the 43 Bedfordshire parishes used in this thesis, and the whole of England, Wales, the Isle of Man and Jersey.

Table 4:14 Comparison of number of burials of 53 French parishes with Bedfordshire, England, Wales, I.O.M. and Jersey 1783-1784

	N° of parishes	Av. monthly mortality 1782-1784	N° of burials Aug-Oct 1783	N° & % above or below average	N° of burials Aug 1783 – May 1784	N° & % above average
France[267]	53	232	1 128	432 = 38%	3104	784 = 25%
Bedford	43	69	338	131 = 39%	942	252 = 27%
England	1323	4 753.30	15 994	1 734 = 11%	54 322	6 789 = 13%
Wales	124	187.64	485	**-78 = -16%**	2 081	205 = 10%
I.O.M.	18	36	57	**-51 = -89%**	510	148 = 29%
Jersey	12	36	101	**-7 = -7%**	378	18 = 5%

[265] RABARTIN, Roland and ROCHER, P, *Les Volcans, Le Climat et La Révolution Française* quoted in Grattan et al. 2005, p.647.
[266] GRATTAN, John et al., 'Volcanic Air Pollution and Mortality in France 1783-1784', 647.
[267] GRATTAN, John et al., 648.

All percentage averages in the above table have been rounded up to two significant figures. It is interesting to see that the percentage increase in the number of burials is slightly more for Bedford than for the French parishes, and that for the whole of England, somewhat less. Furthermore, Wales, the Isle of Man and Jersey show a negative or decrease in the number of burials compared to the average burial rate for August to October 1783. However, all the British figures for August 1783 to May 1784 show percentage increases. It appears, therefore, that the overall figures for Britain, the Isle of Man and Jersey have not been influenced by Laki, but are due to normal fluctuations in the annual burial rate.

That these substantial increases in the rate of mortality applied to other areas of France, is demonstrated by the parish of Saint-Nizier de Lyon in the Auvergne-Rhône-Alpes region, which experienced a 75% increase in the number of burials among those under the age of 20. The average number between 1780 and 1789 was 365, but in 1783 this reached 640. The rate for adults rose from 354 to 431, an increase of 22%.[268]

If the above percentage figures from these admittedly very small samples were extrapolated throughout France, the resulting number of deaths would have been catastrophic. As it is, the figures produced by INED, see Table 4:15 and Fig.4:8, show that this was not necessarily the case. Although the number of deaths in 1783 was the fourth highest between 1770 and 1799, it was 18,500 fewer than those in 1782. The total number in 1784 was the fourth lowest in that decade and 61,100 less than in 1783. If an average of the burial figures is taken using the same 20 and 30-year criteria as before, it indicates that there were no crisis years during this period.

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[268] GARNIER Emmanuel, *Les dérangements du temps : 500 ans de chaud et de froid en Europe*, 1051; GARNIER, Emmanuel, 'The Laki fog of 1783. Volcanic activity and health crises in Europe', *Bulletin de l'Académie nationale de médecine* 195, no. 4–5 (10 May 2011): 1043–55, https://www.researchgate.net/publication/221871315_The_Laki_fog_of_1783_Volcanic_activity_and_health_crises_in_Europe.

Figure 4 :8 Number of deaths in France in thousands 1770 to 1799

Estimation by INED (Institut national d'études démographiques)

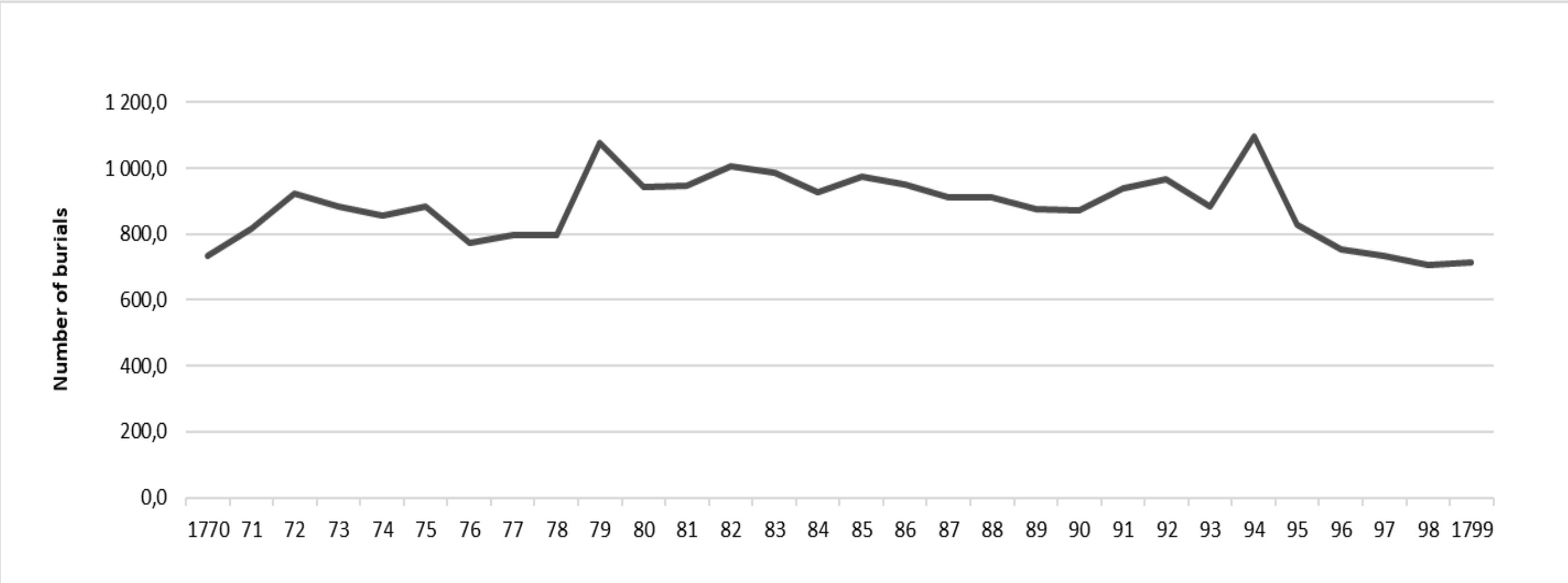


Table 4:15 Number of deaths in France in thousands 1770-1799. Estimation by INED (Institut national d'études démographiques)[269]

1770	1771	1772	1773	1774	1775	1776	1777	1778	***1779***
732.1	818.6	921.7	884.7	855.1	883.1	773.9	796.3	797.8	***1 076.7***
1780	1781	***1782***	1783	1784	1785	1786	1787	1788	1789
944.6	947.7	***1 006.3***	987.8	926.7	975.8	951.9	912.0	912.7	876.3
1790	1791	1792	1793	***1794***	1795	1796	1797	1798	1799
871.1	939.4	966.3	884.9	***1 096.8***	828.9	753.8	734.3	706.4	713.2

The highest number of deaths in each decade has been marked in bold italics, whilst those for 1783 and 1784 are on a grey background.

From its high point in 1779, due to an epidemic of dysentery,[270] the number of deaths remained at an elevated level to 1794 whence it diminishes until the end of the century. It would appear that the reason for the spike in the total number of burials in 1782 was due to an influenza epidemic which swept through Europe during 1781-2,[271] although summer diarrhoea, one of the epidemical fevers or agues mentioned by Creighton, or smallpox may have made a contribution. If the most vulnerable members of the population, the old, the sick, or the very young, had been sufficiently weakened by any of these diseases, a further bout of environmental stress the following year – such as that caused by the Laki dry fog, a very hot summer and ensuing harsh winter – may have led to a higher rate of mortality than normal, particularly among those suffering from respiratory problems. If that were the case, how many people died as a result?

[269] BLAYO, Yves, 'Mouvement Naturel de La Population Française de 1740 à 1829', *Population* 30, no. 1 (November 1975): 56–57, https://www.persee.fr/issue/pop_0032-4663_1975_hos_30_1?sectionId=pop_0032-4663_1975_hos_30_1_15694.
[270] LEBRUN, François, 'Une Grande Épidémie En France Au XVIIIe Siècle : La Dysenterie de 1779', *Annales de Démographie Historique*, 1973, 403–15, https://doi. org/10.3406/adh.1973.1152.
[271] POST, John D., 'The Mortality Crises of the Early 1770s and European Demographic Trends', *The Journal of Interdisciplinary History* 21, no. 1 (Summer 1990): 42–45, https://doi.org/10.2307/204917.

In order to answer this question, an estimated mortality rate had to be determined for 1783 before taking Laki into account. An average total of burials from 1780 to 1789, less those for 1783, was calculated and the result deducted from the number of the interments for 1783, viz., 987.8k minus 939.3k; the difference of 48.5k being the number of deaths that may have been caused by air pollution from the Laki eruption, together with the physiological stress caused by a very hot summer. This was followed by a severe winter which lasted well into the following year. Data from the 53 parishes recorded in Table 4:14 shows a considerable increase in mortality during August to October 1783, and also from August 1783 to May 1784. Without a great deal more information, it is impossible to attribute all or any of the additional deaths to Laki. According to the available data, the low altitude fog had disappeared from Europe by early to late autumn 1783.[272] That being the case, would it still have been detrimental to the health of the population? If not, was the hot summer to blame for many of these deaths, and the severe winter that was to follow, for the increase in mortality during the first few months of 1784? It has now been acknowledged that "…*besides the undoubtedly profound impacts of Laki, it is likely that the relatively rare, synchronous occurrence of a negative NAO in the Atlantic and an El Niño in the Pacific during the 1783–1784 winter was more fundamentally to blame for the severe conditions over North America and Europe than the waning effects of Laki.*"[273]

<u>Summary</u>

From the available information it appears that in 1783, France experienced a higher than average death rate, although it was not as great as that for 1782. The overriding question is whether this was due to the epidemic of influenza which was rife in 1782 and reappeared in late summer or early autumn the following year; the sulphurous fog generated by the Laki eruption; or to the unusually high summer temperature caused primarily by a combined negative phase of the North Atlantic Oscillation (NAO) and an El Niño-Southern Oscillation (ENSO) warm event.

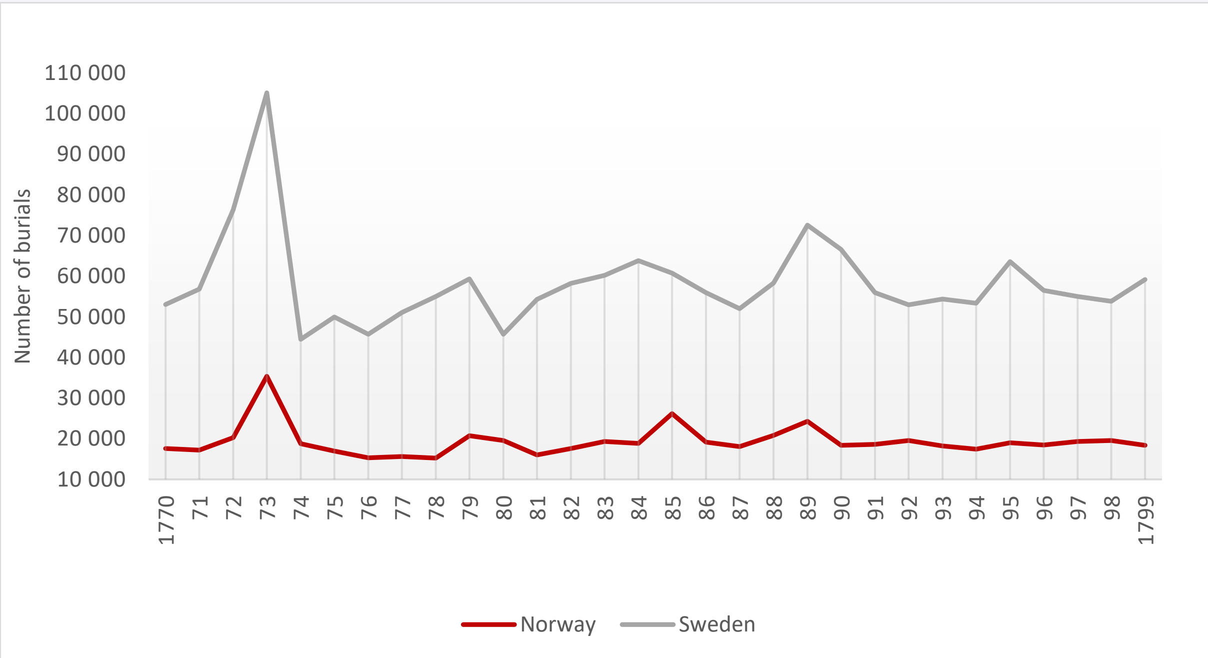
[272] THORDARSON, Thorvaldur, 'Volatile Release and Atmospheric Effects of Basaltic Fissure Eruptions', 103–4.
[273] D'ARRIGO, Rosanne et al., 'The Anomalous Winter of 1783-1784: Was the Laki Eruption or an Analog of the 2009-2010 Winter to Blame?', *Geophysical Research Letters* 38 (13 March 2011): 1–4, https://doi.org/10.1029/2011GL046696; BARRIOPEDRO, David et al., 'Witnessing North Atlantic Westerlies Variabilityfrom Ships' Logbooks (1685–2008)', *Climate Dynamics*, 8 October 2013, 7, https://doi.org/10.1007/s00382-013-1957-8.

Surprisingly, 1784 showed a decrease in the burial numbers, and one can only surmise that the weak and vulnerable had died during the events of the two previous years.

4:3:6 Continental Europe – The Netherlands, Norway, and Sweden

The following burial statistics as illustrated by Fig. 4:9 and Table 4:16 point to the fact that these countries suffered no more than a normal fluctuation in the annual burial pattern.[274] Unfortunately, it has not been possible to obtain national data relating to the Netherlands burial rates, but only on the very restricted level of 12 parishes. However, a comparison of Fig. 4:9 with Fig. 4:10 shows that for Norway and Sweden, the restricted data mirrors the national data reasonably accurately.

Figure 4:9 Number of burials in Norway and Sweden 1770 to 1799



[274] DRAKE, Michael, 'The Growth of Population in Norway 1735–1855', *Scandinavian Economic History Review* 13, no. 2 (1965): 133, https://doi.org/10.1080/03585522.1965.10414366; STATISTICS SWEDEN, 'Population and Population Changes 1749–2019', SCB, accessed 15 May 2020, https://www.scb.se/en/finding-statistics/statistics-by-subject-area/population/population-composition/population-statistics/pong/tables-and-graphs/yearly-statistics--the-whole-country/population-and-population-changes/.

Table 4:16 Number of burials in Norway and Sweden 1770 to 1799

	1770	1771	1772	1773	1774	1775	1776	1777	1778	1779	Total	Crisis
Nor.	17 606	17 176	20 231	35 362	18 784	16 933	15 270	15 655	15 232	20 768	193 017	28 953
Swe.	53 071	56 827	76 362	105 139	44 463	49 949	45 692	51 096	55 028	59 325	596 952	89 543
	1780	1781	1782	1783	1784	1785	1786	1787	1788	1789		
Nor.	19 523	16 051	17 563	19 357	18 825	26 144	19 164	18 034	20 834	24 315	199 810	29 972
Swe.	45 731	54 313	58 247	60 213	63 792	60 770	55 951	51 998	58 320	72 583	581 918	87 288
	1790	1791	1792	1793	1794	1795	1796	1797	1798	1799		
Nor.	18 371	18 574	19 564	18 227	17 399	19 010	18 476	19 336	19 580	18 354	186 891	28 034
Swe.	66 598	55 946	52 958	54 376	53 377	63 619	56 474	55 036	53 862	59 192	571 438	85 716

"*In eighteenth-century Europe, the annual number of deaths fluctuated significantly almost every year, and the fluctuations varied considerably from region to region and from country to country*."[275] Nevertheless, during the year 1773, both countries experienced a minor, though serious, crisis. This was due, no doubt, to a wave of acute epidemic diseases that struck central Europe and Scandinavia, with the exception of Finland.[276] The three most fatal causes of mortality were dysentery, typhus and typhoid fevers, and smallpox. Furthermore, there were some deaths due to starvation in districts that suffered famine. In Sweden, the number of deaths caused by these epidemics is shown in Table 4:17. To put these figures into perspective, the three diseases mentioned above, accounted for 52.9% of all deaths in 1773.[277]

Table 4:17 Number of deaths in Sweden caused by epidemics in 1773

Disease	1772	1773	% Increase
Dysentery	9 340	23 350	40%
Typhus and typhoid fevers	12 850	20 140	63.80%
Smallpox	5 440	12 130	44.85%
Grand Total	27 630	56 620	48.8%

275 POST, John D., 'The Mortality Crises of the Early 1770s and European Demographic Trends', 37.
276 POST, John D., 38.
277 POST, John D., 42–45.

If it were the case that the diseases mentioned above were, in aggregate, the main causes of death in central and northern Europe during the 1780s, could any of them have been exacerbated by the effects of the dry fog? Probably not. Dysentery and typhoid are spread by direct or indirect faecal-oral transmission, typhus by the human body louse and smallpox from person to person. It is entirely possible that the dry fog affected people who already were suffering from respiratory complaints, and although not necessarily fatal in itself, when combined with the effects of a very hot summer, proved lethal.

There was a further epidemic which swept through Europe in 1781-1782, namely, influenza. Although the mortality was low, the morbidity was high; it affected perhaps three-quarters of the population of Europe in the first eight months of 1782 and for the elderly and those already suffering from respiratory diseases could have proved fatal. The deaths throughout Europe possibly totalled hundreds of thousands.[278]

It appears – admittedly from a very limited survey – that the rate of mortality in 1783 and 1784 was within the expected norm for these three countries, notwithstanding the fact that the 1783-84 winter was one of the most severe in the last 250 years. In the Netherlands, the rate of mortality in 1784 was considerably lower than in the previous four years, even though the number of January burials was the highest in the year. See Table 4:18 and Fig. 4:9. From July 1783, there is a sudden increase in the number of burials in the Netherlands and Sweden, and these elevated totals continued into the New Year. The increase for Norway starts in August and continues at a higher than average level until October, whence it drops down to an average of around 91 deaths per month. See Fig. 4:11.

[278] HAYS, J. N., *Epidemics and Pandemics: Their Impacts on Human History* (Santa Barbara, Denver, Oxford: ABC-CLIO, 2006), 171–75.

Table 4:18 Number of burials in the Netherlands, Norway and Sweden for 12, 14 and 17 parishes respectively 1770 to 1799

	1770	1771	1772	1773	1774	1775	1776	1777	1778	1779	Total
Ned.	1 374	1 219	1 247	1 329	1 111	1 541	***1 839***	1 588	1 495	1 756	14 499
Nor.	954	791	1 079	2 139	791	753	622	759	780	***1 126***	9 794
Swe.	1 196	1 327	***1 977***	1 699	1 126	1 373	1 448	1 425	1 359	1 227	14 157
	1780	**1781**	**1782**	**1783**	**1784**	**1785**	**1786**	**1787**	**1788**	**1789**	**Total**
Ned	2 036	***2 465***	2 069	2 138	1 682	1 535	1 666	1 542	1 959	2 006	19 098
Nor	854	829	971	1 103	1 022	1 535	993	1 007	1 080	***1 606***	11 000
Swe	1 344	1 573	1 749	1 608	1 600	1 543	1 581	1 423	1 491	***1 810***	15 722
	1790	**1791**	**1792**	**1793**	**1794**	**1795**	**1796**	**1797**	**1798**	**1799**	**Total**
Ned	1 754	1 433	1 459	1 608	1 869	***2 319***	2 131	1 740	1 708	1 928	17 949
Nor	885	907	853	***1 111***	994	1 103	967	947	879	787	9 433
Swe	1 983	1 897	1 494	1 604	1 733	***2 105***	1 616	1 570	1 584	1 793	17 379

The highest number of deaths in each decade has been entered in italics, whilst those for 1783 and 1784 are on the grey background.

Figure 4:10 Number of burials in the Netherlands, Norway and Sweden for 12, 14 and 17 parishes respectively 1770 to 1799

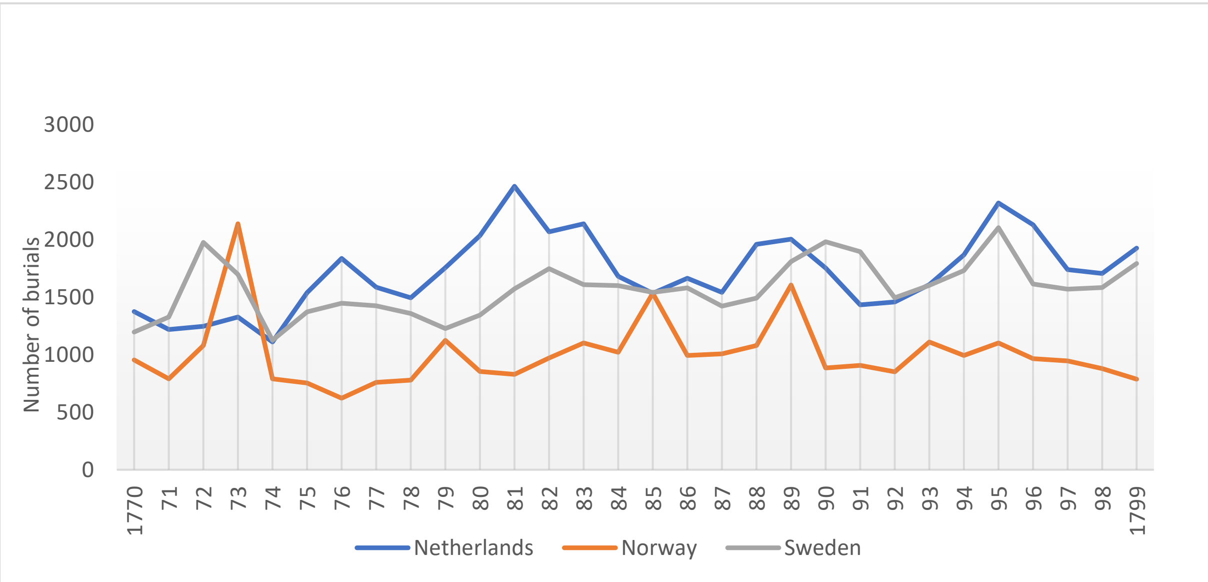
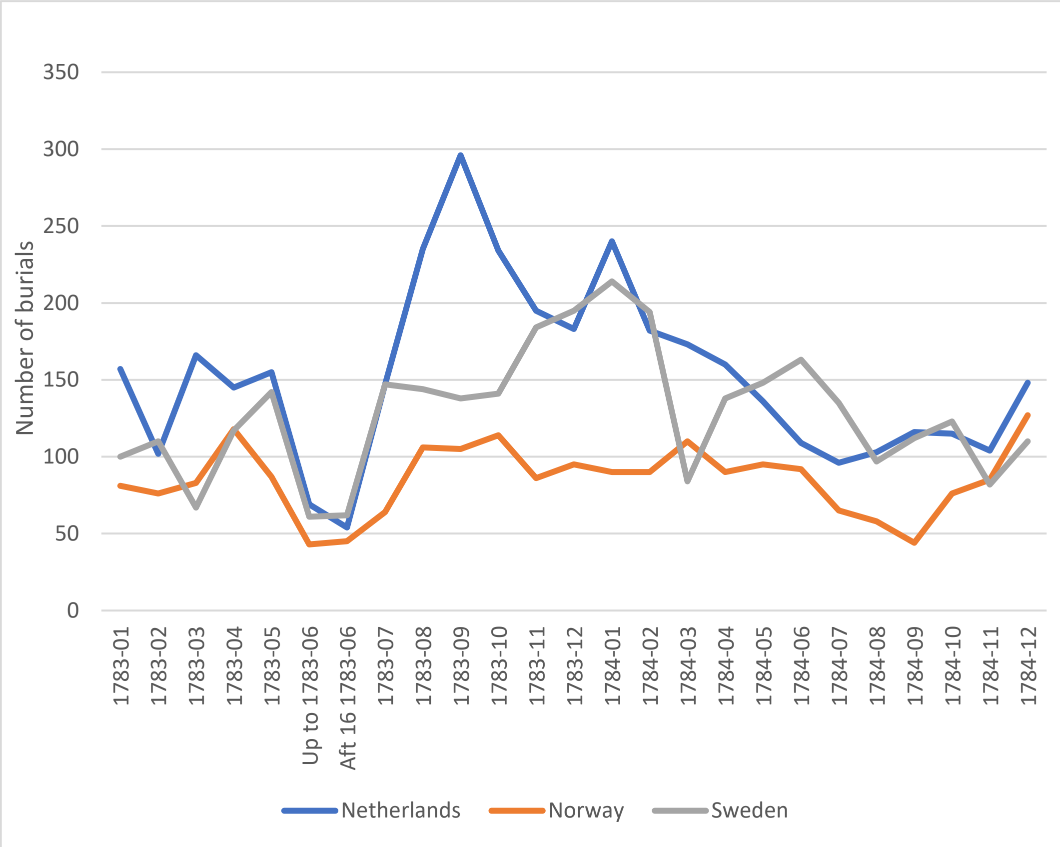


Figure 4:11 Analysis of burials in the Netherlands, Norway and Sweden for 12, 14 and 17 parishes respectively 1783 to 1784



1783	Netherlands	Norway	Sweden	1784	Netherlands	Norway	Sweden
Jan	157	81	100	Jan	240	90	214
Feb	102	76	110	Feb	182	90	194
Mar	166	83	67	Mar	173	110	84
Apr	145	118	117	Apr	160	90	138
May	155	87	142	May	136	95	148
Up to 16 Jun	69	43	61	Jun	109	92	163
Total	***794***	***488***	***597***	Jul	96	65	135
				Aug	103	58	97
Aft 16 Jun	54	45	62	Sep	116	44	112
Jul	147	64	147	Oct	115	76	123
Aug	235	106	144	Nov	104	85	82
Sep	296	105	138	Dec	148	127	110
Oct	234	114	141	***Total***	***1 682***	***1 022***	***1 600***
Nov	195	86	184				
Dec	183	95	195				
Total	***1 344***	***615***	***1 011***				
Total 1783	**2 138**	**1 103**	**1 608**				

Summary

With the exception of the disastrous epidemics in 1773 and the elevated mortality levels in 1789 – due no doubt to one of the epidemic fevers prevalent at the time – the 1780s burial rates for all three countries fall within the expected deviation from the ten-year averages. Although the severe winter of 1783-84 may have been the reason for an increase in the rate of mortality at the beginning of 1784, in the Netherlands and Sweden, it seems it had no lasting effect, as the burials for that year were lower than those for 1783.

Without further research it is impossible to ascertain the reason for the increase in the number of deaths during the second half of 1783, but a reasonable assumption would be dysentery; a reoccurrence of the 1782 influenza epidemic; fever such as typhus or typhoid; or even smallpox.

4:4 Aftermath of the Laki eruption outside Europe

We will now look at the role Laki may or may not have played in three other well documented disasters, namely those in Egypt, India and Japan.

4:4:1 Egypt

That the Laki eruption had a direct effect on rural Egypt there is no doubt. The amount of SO_2 aerosols released by the eruption led to the heating of the Arctic atmosphere, consequently resulting in a weaker westerly jet stream of warm air, which in turn contributed to the weakening of the African and Indian Ocean monsoons. The Indian Ocean monsoon feeds the river Nile which is the life blood of Egypt. During early summer it moves over the Ethiopian Highlands, where it releases a huge amount of rainfall. Much of this is taken by the Blue Nile and Atbarah rivers, and a lesser amount by the White Nile and Sobat rivers. [279]The rivers converge at Khartoum and continue as the Nile.

[279] MANNING, Joseph G., et al., 'Volcanic Suppression of Nile Summer Flooding Triggers Revolt and Constrains Interstate Conflict in Ancient Egypt', *Nature Communications* 8, no. 900 (17 October 2017), https://doi.org/10.1038/s41467-017-00957-y; DAMODARAN, Vinita et al., 'The 1780s: Global Climate Anomalies, Floods, Droughts, and Famines', in *The Palgrave Handbook of Climate History* (London: Palgrave Macmillan, 2018), 536.

Map 4:4 The River Nile and surrounding area

Creative Commons. Creator Hel-hama

The summer flood which was driven primarily by monsoon rainfall in the Ethiopian highlands, began with rising waters observed at Aswan as early as June, peaking from late August to early September, and largely receding by the end of October, when crop sowing began.[280] However, the Laki eruption which started in June, was just in time to interrupt the summer monsoons. This caused a drastic failure of the annual floods with the flow being reduced by an estimated 18%; the summers of 1783 and 1784 having the lowest and third lowest floods between 1737 and 1800.[281]

Contemporary sources make it patently clear that the eruption's effects on Egypt precipitated a massive crisis in the countryside.[282] The Egyptian chronicler, Abd al-Raḥman al-Jabartī, confirms this when writing about the autumn of 1783. *"The Nile did not rise sufficiently, and it fell rapidly […] The ground remained dry in the South as well as the north. Grain became scarce […] The price of wheat was on the loose … and the poor suffered greatly from hunger."* Almost a year later, another lack of summer floods exacted a similar toll on Egyptians, leading to great *"scarcity and dearth"* (*kaht ü galâ*). al-Jabartī wrote that the fall of 1784 was *"like the preceding one with distress, rising prices, an inadequate rise of the Nile, and continual internal strife."*[283]

The French traveller and orientalist, C. F. Volney, bore out al-Jabartī's description.

> the inundation of 1783 was scanty, great part of the lands could not therefore be sown for want of being watered, and another part was not plowed for want of feed. In 1784, the Nile again was unfavourable, and the dearth immediately became excessive. Soon after November, the famine carried off at Cairo, nearly as many as the plague; on the streets, formerly full of beggars, not a single one to be seen: all had perished, or deserted the city […] In March 1785, I saw, beneath the walls of ancient Alexandria,

[280] MANNING, Joseph G., et al., 'Volcanic Suppression of Nile Summer Flooding Triggers Revolt and Constrains Interstate Conflict in Ancient Egypt'; DAMODARAN, Vinita et al., 'The 1780s: Global Climate Anomalies, Floods, Droughts, and Famines', 536–37.
[281] DAMODARAN, Vinita et al., 'The 1780s: Global Climate Anomalies, Floods, Droughts, and Famines', 537.
[282] MIKHAIL, Alan, 'Ottoman Iceland: A Climate History', *Environmental History* 20, no. 2 (1 April 2015): 262–84; DAMODARAN, Vinita et al., 'The 1780s: Global Climate Anomalies, Floods, Droughts, and Famines', 537.
[283] MIKHAIL, Alan, 'Ottoman Iceland: A Climate History'; DAMODARAN, Vinita et al., 'The 1780s: Global Climate Anomalies, Floods, Droughts, and Famines', 537.

two wretches sat on the dead body of a camel, and disputing its putrid fragments with the dogs.[284]

Although Laki was the major driving force of the Egyptian famine, we must bear in mind that*:*

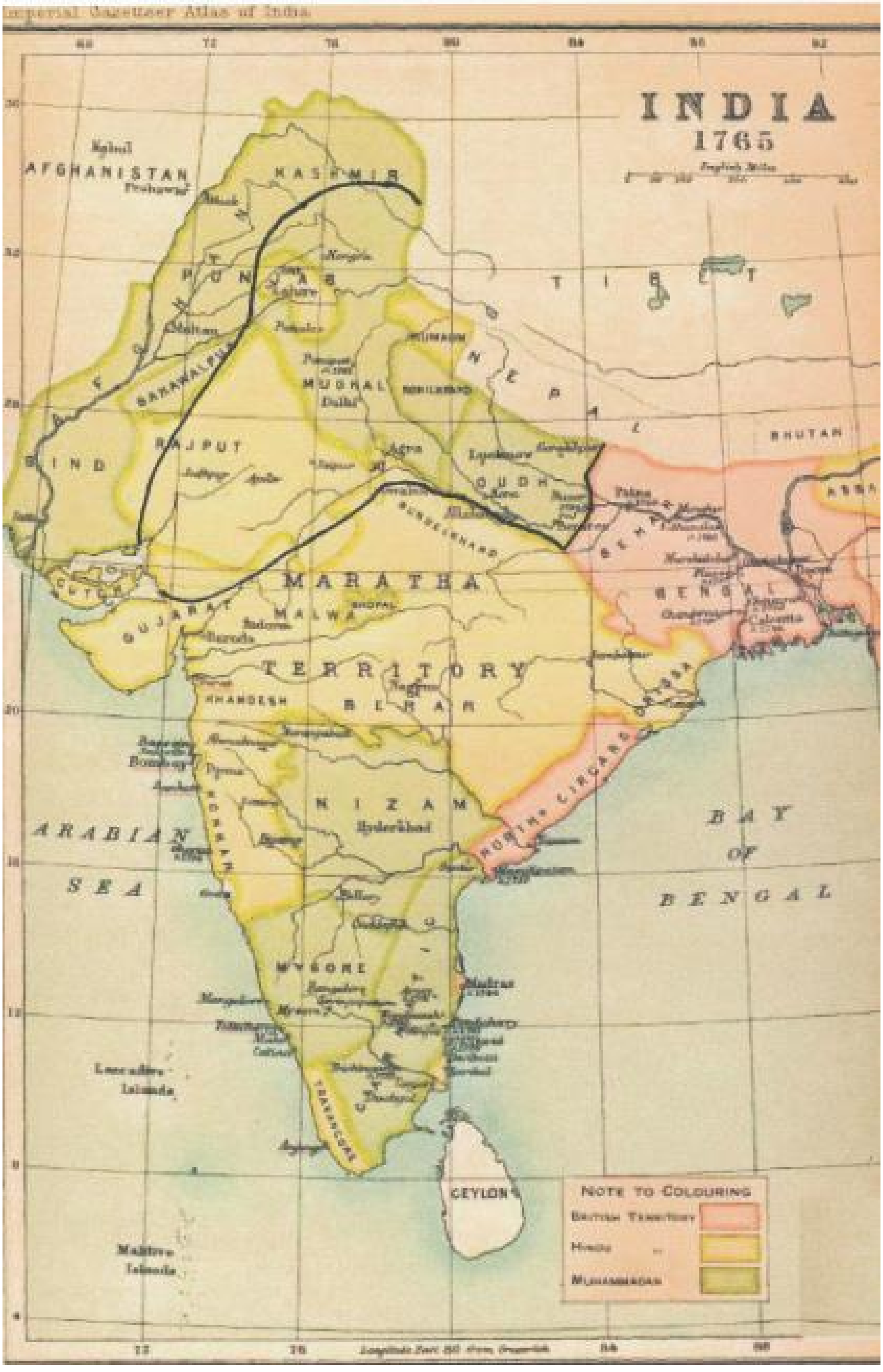
[…] years of political turmoil, civil war where control of grain transport was a major weapon, rapacious taxation that drove thousands from the land and outright brigandage had rendered Egyptian society vulnerable to a low flood of the Nile. The country was poorly administered and there were no reserves, thus the climatic influence of the eruption was intensified by the disorganisation of the state*.*[285]

4:4:2 India

It has been suggested that the Chalisa famine of 1783-84 which was estimated to have killed around 11 million people, was caused by the Laki eruption.[286] However, it was one of a series of famines that began in 1780 following an unusual El Niño event. This led to a failure of the annual monsoons, thereby causing severe droughts throughout the region. It affected many parts of northern India from Kashmir to the Punjab in the north, to Rajasthan in the west and Uttar Pradesh in the east.[287] See Map 4:5. Furthermore, this disastrous situation was exacerbated by warfare, extortionate taxation, and political conflict.[288]

[284] VOLNEY, Constantin François de Chasseboeuf, *Travels in Syria and Egypt, during the Years 1783, 1784 & 1785*, vol. 1 (London and Edinburgh: R. Morison, Will. Morrison, William Creech (Edin.) West & Hughes (Ldn), 1801), 133–34, https://ia802706.us.archive.org/2/items/travelsinsyriaa00volngoog/travelsinsyriaa00volngoog.pdf.
[285] GRATTAN, John Patrick, MICHNOWICZ, Sabina A. K., and RABARTIN, Roland, 'The Long Shadow: Understanding the Influence of the Laki Fissure Eruption on Human Mortality in Europe', in *Living under the Shadow : The Cultural Impacts of Volcanic Eruptions*, One World Archaeology 53 (Walnut Creek, California: Left Coast Press, 2007), 156.
[286] GROVE, Richard H., 'The Great El Niño of 1789–93 and Its Global Consequences: Reconstructing an Extreme Climate Event in World Environmental History', *The Medieval History Journal* 10, no. 1–2 (1 October 2006): 80, https://doi.org/10.1177/097194580701000203; GRATTAN, John Patrick, MICHNOWICZ, Sabina A. K., and RABARTIN, Roland, 'The Long Shadow: Understanding the Influence of the Laki Fissure Eruption on Human Mortality in Europe', 156–57.
[287] DAMODARAN, Vinita et al., 'The 1780s: Global Climate Anomalies, Floods, Droughts, and Famines', 523.
[288] GRATTAN, John Patrick, MICHNOWICZ, Sabina A. K., and RABARTIN, Roland, 'The Long Shadow: Understanding the Influence of the Laki Fissure Eruption on Human Mortality in Europe', 156; DAMODARAN, Vinita et al., 'The 1780s: Global Climate Anomalies, Floods, Droughts, and Famines', 523.

Map 4:5 India showing approximate boundary of Chalisa famine 1783-84



4:4:3 Japan

The Great Tenmei famine is considered to have begun in 1782 and to have ended in 1786. It occurred in the north-east region of Honshu, the main island of Japan, due to prolonged spells of cold weather and excessive rainfall during the summer months, which prevented the rice crop from ripening. This was caused by large amounts of volcanic ash ejected into the atmosphere by Mts Iwaki – November 1782 to June 1783, and Asama, 9th May to 5th August 1783 – leading to a decrease in the amount of solar radiation. This has been disputed by Zielinski et al. who think the climatic impact of Asama was minimal, although they do admit that another earlier eruption in 1783 may be a contributing factor to the prevailing atmospheric conditions.[289]

No one knows how many people died in the famine and there are wildly varying estimates, ranging from 20,000 to 100,000 or more, although it has been argued that the mortality has been greatly exaggerated and the number of deaths can be measured in the tens of thousands.[290]

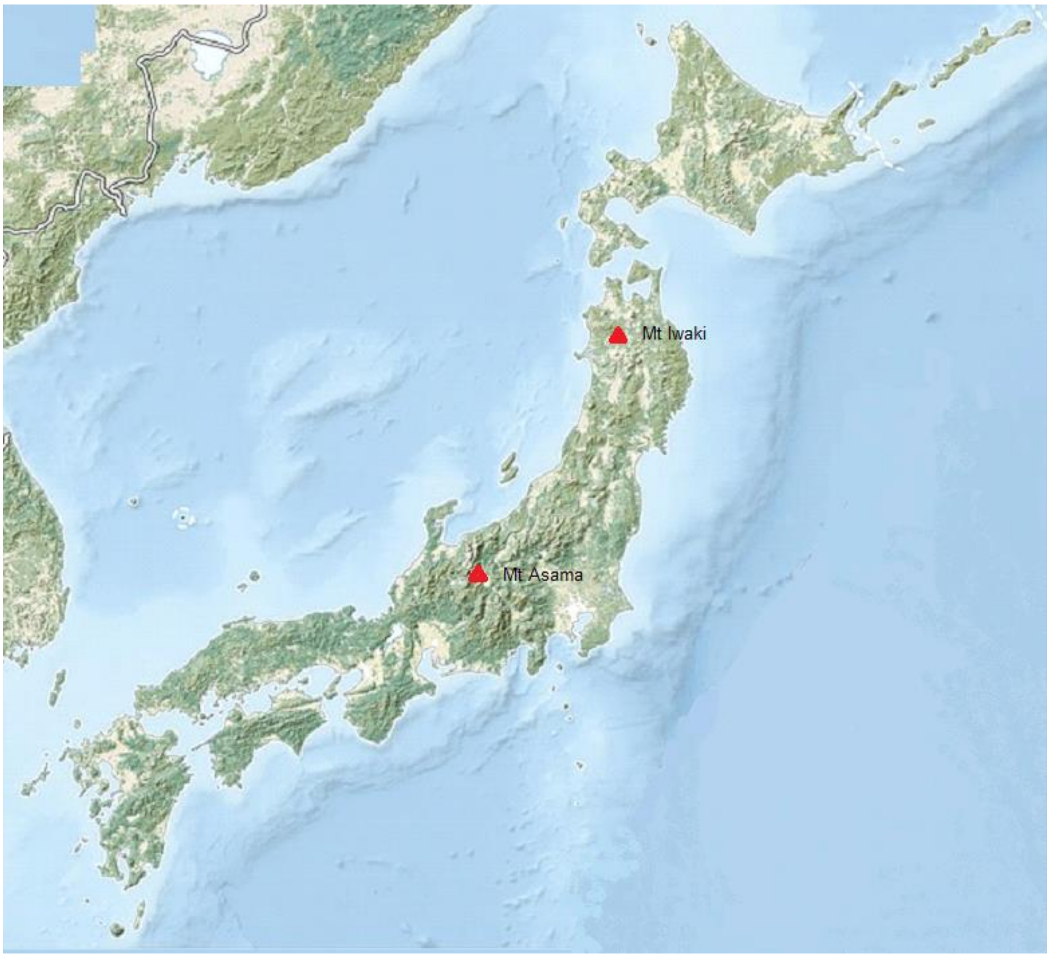
The following are some contemporary accounts which present a grim picture:

> Sugae Masumi, an itinerant scholar, travelled through the northern villages in 1785 and came across mounds of bleached bones. A peasant came up to him and explained that 'These are the bones of people who starved to death. During the winter and spring of the year before last, these people collapsed in the snow ...Their bodies blocked the road for miles and miles, and passers-by had to tread around them carefully ...We also used to catch chickens and dogs running around in the open and eat them. When we ran out of animals, we stabbed and killed our children, our brothers, or other people who were on death's door with some disease, and ate their flesh.'

[289] ZIELINSKI, G. A., et al., 'Climatic Impact of the A.D. 1783 Asama (Japan) Eruption Was Minimal: Evidence from the GISP2 Ice Core', *Geophysical Research Letters* 21, no. 22 (1 November 1994): 2365–68, https://digitalcommons.library.umaine.edu/cgi/viewcontent.cgi?article=1191&context=ers_facpub.
[290] MACFARLANE, Alan, 'The Three Major Famines of Japanese History.', 2002, 2–3, http://www.alanmacfarlane.com/savage/A-JAPFAM.PDF; WIKIPEDIA, 'Great Tenmei Famine', Wikipedia, 16 February 2018, https://en.wikipedia.org/wiki/Great_Tenmei_famine.

Another Samurai observer noted that the suffering was restricted to the northern provinces, yet it was terrible nonetheless. 'Although the shortages in the Kanto did not amount to a great famine, the loss of life through starvation in the northern provinces was dreadful. There was nothing to eat but horse-flesh or, when this ran short, dogs and cats. Once these were consumed, people died of sheer starvation in great numbers. In some villages of thirty, forty or fifty households not one person survived, and nobody could say who had died or when, for the corpses were unburied and had been eaten by beasts and birds.[291]

Map 4:6 Japan showing Mounts Asama and Iwaki



Wikipedia Geographical Survey Institute Japan amended

[291] MACFARLANE, Alan, 'The Three Major Famines of Japanese History.', 2.

Apart from famine, more than 1,500 people were killed when a pyroclastic flow and debris avalanche – the Kambara flow deposit – was generated by a large explosion that caused part of the northern flank of Mt Asama to collapse at 10 a.m. on 5th August. On its way to the foot of the mountain the avalanche devastated Kambara village before rushing into the Agatsuma River and causing a disastrous flood 160 km downstream from the summit; it even reached Edo – modern-day Tokyo – at 2 p.m. the following day, killing more than 1,500 people on its journey.[292]

At the present state of our knowledge, it would seem unwise to lay the blame for the Tenmei famine on Laki, although it may well have played its part.

4:5 Overall Conclusion

The statistics used in this chapter are largely based on data obtained from a close analysis of nearly 1,500 parish registers from Britain, the Isle of Man and Jersey, together with a further 43 from central and northern Europe. In addition, we have also utilised official mortality statistics relating to France, the Netherlands and Sweden.

The shortcomings of parish registers have been discussed in relation to their condition, completeness and accuracy, and appropriate examples have been quoted. It was also noted that there are many errors in transcriptions, perhaps the most important for our purposes being, records entered in the wrong year, and the number of duplicate entries.

[292] YASUI, Maya, and KOYAGUCHI, Takehiro, 'Sequence and Eruptive Style of the 1783 Eruption of Asama Volcano, Central Japan: A Case Study of an Andesitic Explosive Eruption Generating Fountain-Fed Lava Flow, Pumice Fall, Scoria Flow and Forming a Cone', *Bulletin of Volcanology* 66, no. 3 (March 2004): 245, https://www.researchgate.net/publication/226623258_Sequence_and_eruptive_style_of_the_1783_eruption_of_Asama_Volcano_central_Japan_A_case_study_of_an_andesitic_explosive_eruption_generating_fountain-fed_lava_flow_pumice_fall_scoria_flow_and_forming_a_; INOUE, Kimio, 'Debris Flows and Flood-Induced Disasters Caused by the Eruption of Asama Volcano in 1783 and Rest[o]Ration Projects Thereafter', Interpraevent 2010, 2010, 1–4, https://www.sff.or.jp/content/uploads/H22interparevent02.pdf.

Much use was made of the information provided by the FreeREG Genealogy website, whilst images of the original registers were used instead of transcriptions, wherever possible.

An analysis made of the parish register statistics showed that nationally, the Laki eruption was unlikely to have caused a huge surge in the rate of mortality in Britain. Nevertheless, there were five minor crises in England, and one in Wales, between August and September 1783, probably caused by one of the many gastric infections prevalent at the time. In 1783, the Isle of Man had the lowest number of burials during the last 30 years of the century, thus proving that the Laki eruption had little or no effect on the annual number of island deaths. In Jersey, the number of burials in 1783 and 1784 fall within the parameters of what could normally be expected. It is plain from the data, that in common with the Isle of Man, there is little or no evidence that Laki had a significant impact on the island's mortality.

Should the vastly increased number of deaths postulated to have occurred in France due to the effects of the Laki dry fog prove accurate, the figures would belie the number of burials estimated by INED. This would then pose the question as to whether the INED figures need to be recalculated. The previous epidemics in 1781/2 and 1783 probably killed off the most vulnerable in the population, thus accounting for the large drop in the number of deaths in 1784. The tentative number of additional deaths in 1783 that were calculated using INED's figures, comes to 48.5k, and it is possible that some, if not the majority, were due to Laki.

There were significant fluctuations in the number of deaths throughout eighteenth-century Europe, the greatest being in 1772 and 1773 in Norway and Sweden and 1781 in the Netherlands. The 1770s deaths were probably caused by epidemics of dysentery; typhus and typhoid fevers; and possibly smallpox, but the high rate of burials in the Netherlands was most likely due to the 1781/82 influenza epidemic. If these diseases were present throughout northern Europe in the mid-1780s they would not have been exacerbated by Laki, and they may have been the reason for the raised number of deaths in the second half of 1783, and also for the spikes in Sweden's burial rate in 1785 and 1789.

We have investigated the causes of three great famines occurring at about the same time as the Laki eruption – the Egyptian famines of 1783-1784; the Indian Chalisa famine 1783-1784; the Great Tenmei famine 1782-1786. There is no argument that the Laki eruption was the main driving force behind the 1783 and 1784 Egyptian famines by causing a massive failure of the annual Nile floods. Combined with years of political turmoil, exorbitant taxation that drove thousands from their land and poor administration, resulted in no reserves, thus leading to massive starvation and an untold number of deaths.

The Indian Chalisa famine was caused, not by Laki, but followed an unusual El Niño event which began in 1780. This led to a failure of the annual monsoons, ultimately causing severe droughts throughout the region and the death of many million people through famine and starvation.

It has been proposed that the Great Tenmei famine was a result of the Laki eruption. It is more likely, however, that it was caused by the eruption of two local volcanoes, Mt Iwaki, November 1782 to June 1783, and Mt Asama, 9th May to 5th August 1783.

CHAPTER 5 – Comparisons

Introduction

In this chapter a comparison will be made between the Laki eruption and five others of the same VEI or greater, in order to assess their effect on world climate, human mortality and people's perception of the events. We shall also compare the spread of the Laki dry fog to the London smog of 1952 and the radioactive cloud released by the Chernobyl disaster in 1986. Firstly, however, we shall briefly look at the Volcanic Explosivity Index and its use in historical research.

5:1 Volcanic Explosivity Index (VEI)

The Volcanic Explosivity Index (VEI) is a relative measure of the explosiveness of volcanic eruptions. It was devised by Chris Newhall of the United States Geological Survey and Stephen Self at the University of Hawaii in 1982, as a way to compare eruptions much in the way in which we measure earthquake magnitude by using the Richter Scale.[1] Like the Richter Scale, after VEI 1, the scale becomes logarithmic, thus each step in the scale represents a tenfold increase in the amount of material ejected. For example, a VEI 1 eruption produces from between 0.0001 and 0.001 km^3 of ejecta, a VEI 2 eruption produces between 0.001 and 0.01 km^3 of ejecta, with VEI 8 eruptions producing 1,000s km^3 of ejecta. See Figure 4:1. Volume of products, eruption cloud height, and qualitative observations (using terms ranging from "gentle" to "mega-colossal") are used to determine the explosivity value. The scale is open-ended with the largest volcanic eruptions in history (super-eruptions) given magnitude 8. A value of 0 is given for non-explosive eruptions, defined as less than 0001km^3 (350,000 cu ft) of tephra ejected; and 8 representing a mega-colossal explosive eruption that can eject 1,000km^3 (240 cubic miles) of tephra and have a cloud column height of over 20 km (12 mi).

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[1] NEWHALL, Christopher G. and SELF, Stephen, 'The Volcanic Explosivity Index (VEI): An Estimate of Explosive Magnitude for Historical Volcanism', *Journal of Geophysical Research-Oceans* 87, no. C2 (20 February 1982): 1231–38, https://doi.org/10.1029/JC087iC02p01231; WIKIPEDIA, 'Volcanic Explosivity Index', Wikipedia, 18 October 2016, https://en.wikipedia.org/wiki/Volcanic_Explosivity_Index.

Table 5:1 Comparison of the VEI of some famous volcanic eruptions

VEI	VOLCANO	DATE of ERUPTION	No of DEATHS
0	Kilauea, Hawaii	Almost continuous	
1	Nyiragongo, D.R. Congo	17th January 2002	>170[2]
2	Mt. Unzen, Japan	Nov. 1990 - May 1996	43[3]
3	Nabro, Eritrea	12th June, 2011	31[4]
4	**Laki**, Iceland Eyjafjallajökull, Iceland	8th June 1783 – 8 Feb. 1784 20th March 2010 – 23 June 2010	~10,000 Iceland[5] None[6]
5	Mt. St. Helens, Washington, USA Vesuvius, Naples, Italy	18^{th} May 1980 24 – 25 Aug. AD79	57[7] 2,000+[8]
6	Krakatau, Indonesia	26 – 27 Aug. 1883	>36,000[9]
7	Samalas, Indonesia Tambora, Indonesia	1257 5 – 10 April 1815	Unknown[10] 90,000-117,000[11]
8	Yellowstone, USA Toba, Sumatra, Indonesia	~630,000 years ago[12] 74,000 years ago[13]	Unknown Unknown

[2] TEDESCO, D et al., 'January 2002 Volcano-Tectonic Eruption of Nyiragongo Volcano, Democratic Republic of Congo', *Journal of Geophysical Research: Solid Earth (1978-2012)* 112, no. B9 (18 September 2007): 1–12, https://doi.org/10.1029/2006JB004762.
[3] HAYS, Jeffrey, 'Deadly Pyroclastic Flow on Mt. Unzen in 1991', Facts and Details: Major Volcanoe"s and Eruptions i_n Japan, January 2014, http://factsanddetails.com/japan/cat26/sub160/item867.html.
[4] IRIN NEWS, 'Thousands Need Aid after Volcano Eruption', IRIN, 6 July 2011, http://www.irinnews.org/q-and/2011/07/06/thousands-need-aid-after-volcano-eruption.
[5] DEMAREE, G. R. and OGILVIE, A. E. J., 'Bon Baisers d'Islande: Climatic, Environmental and Human Dimensions, Impacts of the Lakagigar Eruption (1783-1784) in Iceland.', in *History and Climate: Memories of the Future?* (New York: Kluwer, 2001), 219–46, https://books.google.fr/books?id=-cgnFsLkIAYC&pg=PA219&dq=demaree,+ogilvie+bon+baisers+d%27islande&hl=en&sa=X&ei=IBh2VdT3MMvkUczsgIAF&ved=0CCkQ6AEwAA#v=onepage&q=demaree%2C%20ogilvie%20bon%20baisers%20d%27islande&f=false.
[6] WIKIPEDIA, '2010 Eruptions of Eyjafjallajökull', Wikipedia, 30 June 2017, https://en.wikipedia.org/wiki/2010_eruptions_of_Eyjafjallaj%C3%B6kull#Health_effects.
[7] WIKIPEDIA, '1980 Eruption of Mount St. Helens', accessed 6 March 2015, http://en.wikipedia.org/wiki/1980_eruption_of_Mount_St._Helens.
[8] GIACOMELLI, Lisetta et al., 'The Eruption of Vesuvius of 79 AD and Its Impact on Human Environment in Pompei', *Episodes* 26, no. 3 (September 2003): 234–37.
[9] BAGLEY, Mary, 'Krakatoa Volcano: Facts About 1883 Eruption', Livescience, 2013, http://www.livescience.com/28186-krakatoa.html.
[10] VIDAL, Céline M. et al., 'The 1257 Samalas Eruption (Lombok, Indonesia): The Single Greatest Stratospheric Gas Release of the Common Era', *Scientific Reports* 6, no. 34868 (10 October 2016): 1–13, https://doi.org/10.1038/srep34868.
[11] SUTAWIDJAJA, I. S, SIGURDSSON, Haraldur, and ABRAMS, L, 'Characterization of Volcanic Depostis and Geoarchaeological Studies from the 1815 Eruption of Tambora Volcano', *Jurnal Geologi Indonesia* 1 (2006): 50; BRÖNNIMANN, Stefan and KRÄMER, Daniel, 'Tambora and the "Year Without a Summer" of 1816. A Perspective on Earth and Human Systems Science', *Geographica Bernensia G90*, 2016, 9, https://doi.org/10.4480/GB2016.G90.01.
[12] WIKIPEDIA, 'Volcanic Explosivity Index'.
[13] OPPENHEIMER, Stephen, 'The Mount Toba Volcanic Super-Eruption', accessed 16 February 2019, http://www.bradshawfoundation.com/journey/toba2.html.

5:2 The Famous Five

On a short-term basis, say for two to three years, large explosive tropical volcanic eruptions can significantly change the world's climate by causing global cooling and a variation in the distribution of precipitation.[14] As we shall see, this will be demonstrated by the following examples: Samalas, Tambora and Krakatau, whilst Mt. St Helens and Eyjafjallajökull had a far lesser impact.

5:2:1 Mt. Samalas, Lombok, Indonesia – A.D. 1257

The eruption of Mt. Samalas which most likely took place between May and October 1257, was one of the largest sulphur rich volcanic eruptions in recorded history. More than 40 km^3 of dense magma was ejected, and the eruption column is estimated to have reached a height of 43 km, and in doing so, released 158 ± 12 Mt of sulphur dioxide, 227 ± 18 Mt of chlorine and a maximum of 1.3 ± 0.3 Mt of bromine.[15]

The eruption is described in a palm leaf manuscript from an Indonesian poem known as *"Babad Lombok".* The document describes a series of catastrophic events associated with the eruption; the formation of the Segara Anak caldera; the collapse structure that cuts into the side of Mt. Rinjani and the massive ashfall and pyroclastic flows that overwhelmed and destroyed the land and villages around the volcano, as well as the Kingdom's capital, Pamatan, thereby killing thousands of people. Large parts of Lombok, Bali and Sumbawa were most likely left sterile for generations to come.[16] The following is a translation of verses, 274-277, of the poem "*Babad Lombok"* describing the event:

[14] ROBOCK, Alan and MAO, Jianping, 'Winter Warming from Large Volcanic Eruptions', *Geophysical Research Letters* 19, no. 24 (24 December 1992): 2405–8, https://doi.org/doi.org/10.1029/92GL02627; ROBOCK, Alan, 'Volcanic Eruptions and Climate', *Reviews of Geophysics* 38, no. 2 (May 2000): 202; LUTERBACHER, Jürg and PFISTER, Christian, 'The Year without a Summer', *Nature Geoscience* 8 (April 2015): 246.

[15] VIDAL, Céline M. et al., 'The 1257 Samalas Eruption (Lombok, Indonesia): The Single Greatest Stratospheric Gas Release of the Common Era'; LAVIGNE, Franck et al., 'Source of the Great A.D. 1257 Mystery Eruption Unveiled, Samalas Volcano, Rinjani Volcanic Complex, Indonesia', ed. Kushiro, Ikuo, *PNAS* 110, no. 42 (15 October 2013): 16742–47.

[16] LAVIGNE, Franck et al., 'Source of the Great A.D. 1257 Mystery Eruption Unveiled, Samalas Volcano, Rinjani Volcanic Complex, Indonesia', 16742–43.

274. Mount Rinjani avalanched and Mount Samalas collapsed, followed by large flows of debris accompanied by the noise coming from boulders. These flows destroyed (the seat of the kingdom) Pamatan. All houses were destroyed and swept away, floating on the sea, and many people died.

275. During seven days, big earthquakes shook the Earth, stranded in Leneng (Lenek), dragged by the boulder flows, People escaped and some of them climbed the hills.

276. Hiding in Jeringo (close to Mataram), all people moved with the rest of the king's family to several places: Samulia, Borok, Bandar, Pepumba Pasalun, Serowok, Piling, and Ranggi, Sembalun, Pajang, and Sapit.

277. At Nangan and Palemaron, big boulders rolled with soil, with pumices and sand, and granite sediments on the land, they evacuated to Brang Batun.[17]

Medieval chronicles record that the eruption had a profound effect on the weather of Western Europe. Incessant rainfall and an unseasonably cold summer resulted in bad harvests. This, in turn, led to high prices and a subsistence crisis over much of Europe, causing famine and mass starvation.[18] See Map 5:1. Proof of this was found in mass graves containing over 2000 skeletons which were found on the site of St Mary Spital, Spitalfields, London.[19] An unnamed source states that more than 20,000 people died of starvation and its attendant diseases in London alone,[20] whilst the monk, Matthew Paris, wrote in his chronicle:

[17] LAVIGNE, Franck et al., 'Supporting Information (to Samalas Volcano) 10.1073/Pnas.1307520110', *PNAS*, n.d., 2.
[18] STOTHERS, Richard B., 'Climatic and Demographic Consequences of the Massive Volcanic Eruption of 1258', *Climatic Change* 45 (2000): 361–74, https://doi.org/10.1023/A:1005523330643; LAVIGNE, Franck et al., 'Source of the Great A.D. 1257 Mystery Eruption Unveiled, Samalas Volcano, Rinjani Volcanic Complex, Indonesia'; GUILLET, Sébastien, CORONA, Christophe, and ORTEGA, Pablo, 'Climate Response to the Samalas Volcanic Eruption in 1257 Revealed by Proxy Records Together with Supplementary Information', *Nature Geoscience*, 23 January 2017, 123–28, 1–45, https://doi.org/10.1038/NGEO2875.
[19] JONES, Amy Gray, 'Defining Catastrophe: Mass Burial at St Mary Spital', in *A Bioarchaeological Study of Medieval Burials on the Site of St Mary S991-2007pital: Excavations at Spitalfields Market, London E1,* vol. 60, MOLA Monographs 60 (London: Museum of London Archaeology, 2012), 228–31.
[20] JONES, Amy Gray, 230.

> Moreover, food failing, (the harvest of the previous year had failed,) innumerable multitudes of poor people died, and their bodies were found lying all about swollen [dropsical] from want, and livid, five or six together, in the pig-sties, in muddy streets, and on dunghills… About the Festival of Trinity, the pestilence was immense – insufferable; it attacked the poor particularly. In London alone 15,000 of the poor perished; in England and elsewhere thousands died.[21]

According to Arnald Fitz-Thedmar:

> In this year, there was a failure of crops; upon which failure, a famine ensued, to such a degree that the people from the villages resorted to the City for food; and there, upon the famine waxing still greater, many thousand persons perished; many thousands more too would have died of hunger, had not corn just then arrived from Almaine.[22]

It appears that the Samalas eruption produced a widespread dry fog which spread over both the northern and southern hemispheres but had cleared by the end of August 1262.[23] Evidence of this is confirmed by reports of total lunar eclipses in 1258 and 1262. John Texster, writing in the Bury St Edmunds Abbey chronicle describes an unusually dark lunar eclipse on 18 May 1258, and an account appears in the Annales Ianuenses – which was written in Genoa – of an exceptionally dark lunar eclipse on 12 November 1258.[24] This report is arguably the most detailed description of a total lunar eclipse there is for the whole of the Medieval period.

[21] PARIS, Matthew, *Matthæi Parisiensis, monachi Sancti Albani, Chronica majora*, ed. LUARD, Henry Richards, vol. 5, Rerum britannicarum medii aevi scriptores, or Chronicles and Memorials of Great Britain and Ireland during the Middle Ages (London: Trübner, 1880), 690–702, https://ia902604.us.archive.org/13/items/matthiparisiens01luargoog/matthiparisiens01luargoog.pdf; FARR, William, 'The Influence of Scarcities and of the High Prices of Wheat on the Mortality of the People of England', *Journal of the Statistical Society of London* 9, no. 2 (June 1846): 161; STOTHERS, Richard B., 'Climatic and Demographic Consequences of the Massive Volcanic Eruption of 1258', 365.
[22] FITZ-THEDMAR, Arnald, *Chronicles of the Mayors and Sheriffs of London A.D. 1188 to A.D. 1274 Tr. from the Original ... Attributed to Arnold Fitz-Thedmar. ... The French Chronicle of London, A.D. 1259 to A.D. 1343. Tr. from ... "Chroniques de London*, trans. RILEY, Henry Thomas (London: Trübner, 1893), 40, https://babel.hathitrust.org/cgi/pt?id=mdp.39015067247729;view=1up;seq=3.
[23] STOTHERS, Richard B., 'Climatic and Demographic Consequences of the Massive Volcanic Eruption of 1258', 363–64.
[24] STOTHERS, Richard B., 363; GUILLET, Sébastien, CORONA, Christophe, and ORTEGA, Pablo, 'Climate Response to the Samalas Volcanic Eruption in 1257 Revealed by Proxy Records Together with Supplementary Information', 16–17.

The same year, on the night of November 12th, the moon appeared at the 16th hour…….., then it disappeared completely. Those who did not see it thought it had not risen yet, they did not believe those who had seen it because no trace appeared at the spot where it was supposed to be found, despite clear weather conditions. Then the top of the moon, which was at the same position as the sun in summer when it is more than the third hour, began, as never before, to be clearly visible, and little by little the moon resumed its normal appearance. Hence the following verse:

The night of November 12, 1258,
While the sky was clear, cloudless and bright,
The moon remained hidden for a long time, whereas it should have been full.
Dark, it withdrew entirely from the vision of men,
After a delay, the Moon unveiled its long horns again
Gradually it grew and recovered the full light it had lost.[25]

The normal colour of an eclipsed moon is red, but if the stratosphere contains a large number of aerosols, sunlight can no longer be refracted and scattered into the earth's shadow and the moon becomes darker and may vanish completely. By 31st August 1262, the fog seems to have dissipated, because on that date, the eclipsed moon was a bloody colour.[26]

The following translations of contemporary chronicles give one an idea of the conditions existing during the years 1258 and 1259.

[25] GUILLET, Sébastien, CORONA, Christophe, and ORTEGA, Pablo, 'Climate Response to the Samalas Volcanic Eruption in 1257 Revealed by Proxy Records Together with Supplementary Information', 17.
[26] STOTHERS, Richard B., 'Climatic and Demographic Consequences of the Massive Volcanic Eruption of 1258', 363–63; GUILLET, Sébastien, CORONA, Christophe, and ORTEGA, Pablo, 'Climate Response to the Samalas Volcanic Eruption in 1257 Revealed by Proxy Records Together with Supplementary Information', 16–17; ANON, 'Chronica Minor Auctore Minorita Erphordiensi', in *Monumenta Germaniae Historica*, Societas Aperiendis Fontibus Rerum Germanicarum Medii Aevi (ed.), vol. 24 (Hanover: Hahn, 1879), 202.

In this year of 1258, there was no summer during summer. The weather was very rainy and cold at harvest time, neither the crop harvest nor the grape harvest were good. Never before was such a poor wine seen for grapes could not reach maturity; they were green, altered and in poor health. The next year, in April, there was a high mortality in Paris, and people died almost instantly. This same year, in 1259, there was a heat wave, there were storms in numerous places, lightning, hail, and this repeatedly, causing heavy damage in numerous places.[27]

On the vigil of the festival of the blessed John the Baptist [June 23], a terrible storm of wind, accompanied by torrents of rain, fell on and raised all the waters of the Severn from Shrewsbury to Bristol, to a degree that has not been seen in our times: owing to which inundation, which, as it were, burst forth (as men say) from the secretest gulfs of hell, all the meadows and all the corn-fields near the Severn were overwhelmed, and the crops utterly destroyed. Some men were even drowned in the violent waters, and innumerable boys, and great quantities of animals of every sort. The same summer, many thousand men died in London, and other parts of England, from being wasted away by famine. And the ripening of crops was so late in the autumn, owing to the excessive abundance of rain, that, in many parts of the kingdom, the feast was not got in before the feast of All Saints [Nov. 1].[28]

Year of the Lord 1258, vineyards were frozen and grape harvest occurred around All Saints' Day (1st November). At Easter time there was a large mortality in Paris, and before the harvest the wine was sold 4 deniers in all Paris.[29]

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[27] ANON, 'Notae Constantienses', in *Recueil des historiens des Gaules et de la France*, ed. DE WAILLY, DELISLE, and JOURDAIN, vol. 23 (Paris: H. Welter, 1894), 543, https://ia600209.us.archive.org/0/items/recueildeshistor23bouq/recueildeshistor23bouq.pdf; GUILLET, Sébastien, CORONA, Christophe, and ORTEGA, Pablo, 'Climate Response to the Samalas Volcanic Eruption in 1257 Revealed by Proxy Records Together with Supplementary Information', 34.

[28] MATTHEW of WESTMINSTER, *Flowers of History : Especially Such as Relate to the Affairs of Britain : From the Beginning of the World to the Year 1307*, trans. YONGE, C. D., vol. 2 (London: Henry G. Bohn, 1853), 357, https://ia800202.us.archive.org/23/items/flowershistorye03parigoog/flowershistorye03parigoog.pdf.

[29] ANON, 'Notes sur quelques Manuscrits du Musée Britannique - Annales Clerici Parisiensis', in *Memoires de la Société de l'Histoire de Paris et de lIlle de France*, ed. DELISLE, L, vol. 4, Libraire de la Société de l'Histoire de Paris (Paris: H. Chambon,

However, the climate during the following year was much improved and most contemporary accounts agree that there was a marked improvement in weather conditions in Western Europe.[30] This can be seen in the following report by Matthew of Westminster, although there were still areas of subsistence crises and famine. See Map 5:2.

> During this year (1259), and especially in the autumn season, there was such fine weather, and a dry time, that though the crops were thin, they were nevertheless got in in good time, to the farmer's wish…now in this year (1259), though the crop was but moderate, there nevertheless was such abundance, that owing to the dry season of the harvest, there was a very sufficient provision made quite unexpectedly.[31]

A famine followed by a great pestilence was also reported from the Middle East in the region of Iraq, Syria, and southeastern Turkey during 1258. However, the famine may have been one of the side effects of the Mongol invasion of Baghdad that year, with the pestilence following in its wake.[32]

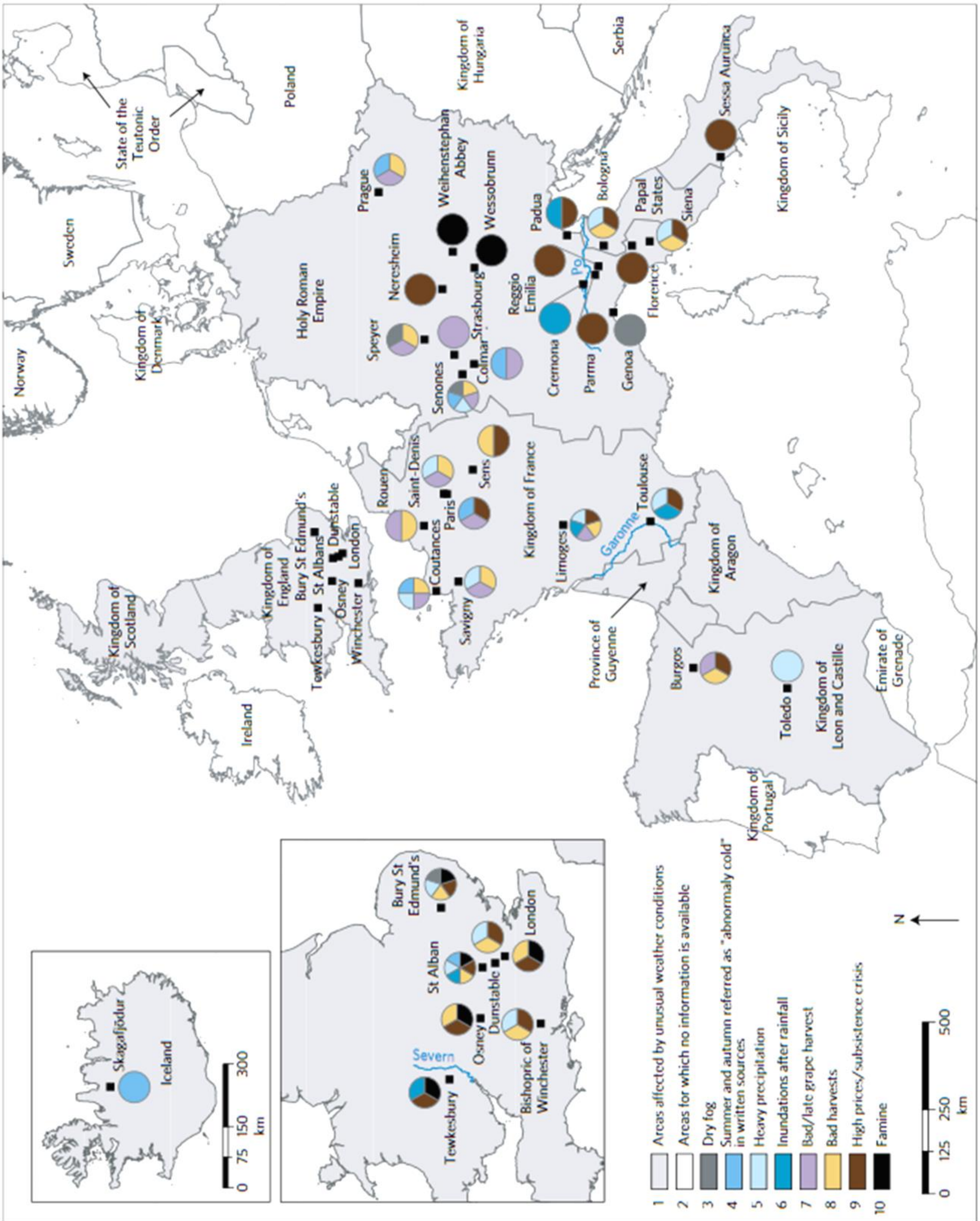
1877), 183, https://gallica.bnf.fr/ark:/12148/bpt6k6296410s/f3.image; GUILLET, Sébastien, CORONA, Christophe, and ORTEGA, Pablo, 'Climate Response to the Samalas Volcanic Eruption in 1257 Revealed by Proxy Records Together with Supplementary Information', 6.

[30] GUILLET, Sébastien, CORONA, Christophe, and ORTEGA, Pablo, 'Climate Response to the Samalas Volcanic Eruption in 1257 Revealed by Proxy Records Together with Supplementary Information', 33.

[31] MATTHEW of WESTMINSTER, *Flowers of History : Especially Such as Relate to the Affairs of Britain : From the Beginning of the World to the Year 1307*, 2:373.

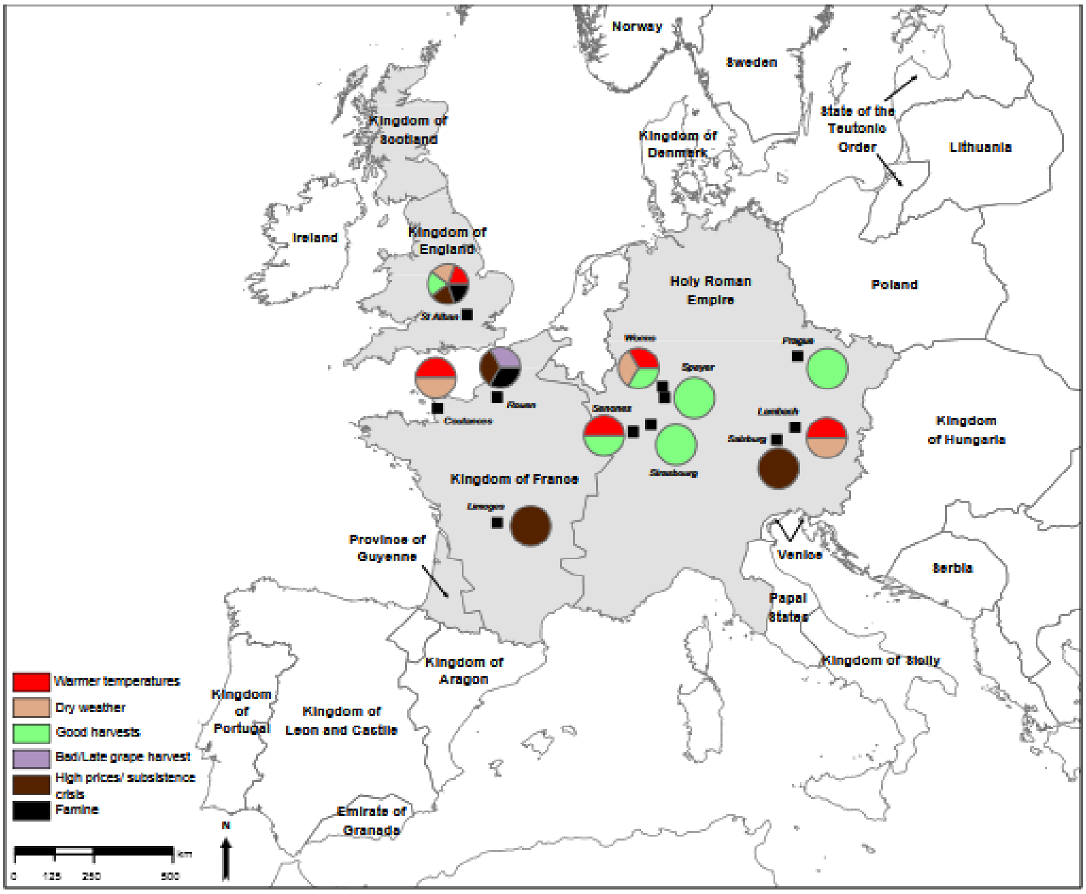
[32] STOTHERS, Richard B., 'Climatic and Demographic Consequences of the Massive Volcanic Eruption of 1258', 366.

Map 5:1 Spatial extent of weather and optical anomalies observed in Europe in 1258



From Guillet et al 2017

Map 5:2 Evidence for a hot and dry summer in Western Europe in 1259



From Guillet et al 2017

5:2:2 Tambora, 10 -11 April 1815, Sumbawa, Indonesia

Introduction and local impact

The eruption of Mount Tambora was one of the largest, and deadliest in recorded history. It has been estimated that it killed between 90,000 to 117,000 people locally, and possibly many more worldwide.[33] The eruption was so violent that it lost over 1,400m in height, being reduced from a mountain 4,300m high, to a caldera whose rim, today, lies 2850m above sea level, measures 6 km across and is between 600 to 700 m deep.[34] As can be seen from Map 5:3, Tambora occupies most of the Sanggar

[33] BRÖNNIMANN, Stefan and KRÄMER, Daniel, 'Tambora and the "Year Without a Summer" of 1816. A Perspective on Earth and Human Systems Science', 9; SUTAWIDJAJA, I. S, SIGURDSSON, Haraldur, and ABRAMS, L, 'Characterization of Volcanic Depostis and Geoarchaeological Studies from the 1815 Eruption of Tambora Volcano', 50.
[34] STOTHERS, Richard B, 'The Great Tambora Eruption in 1815 and Its Aftermath', *Science* 224, no. 4654 (15 June 1984): 1192; SIGURDSSON, Haraldur and CAREY, Steven, 'The Eruption of Tambora in 1815: Environmental Effects and Eruption Dynamics', in *The Year Without a Summer? World Climate in 1816*, ed. HARRINGTON, C.R. (Ottawa, Canada: Canadian Museum of Nature, 1992), 17, https://ia800700.us.archive.org/19/items/yearwithoutsumme1992hari/yearwithoutsumme1992hari.pdf; OPPENHEIMER, Clive,

Peninsula on Sumbawa Island. Although presumed extinct, the volcano reportedly started to awaken three years earlier with rumbling sounds and the issue of smoke from around its summit.[35] There is a report from Banyuwangi on the east coast of Java stating that a noise like a cannonade was heard in the evening of 1st April, which lasted until nine o'clock the following day.

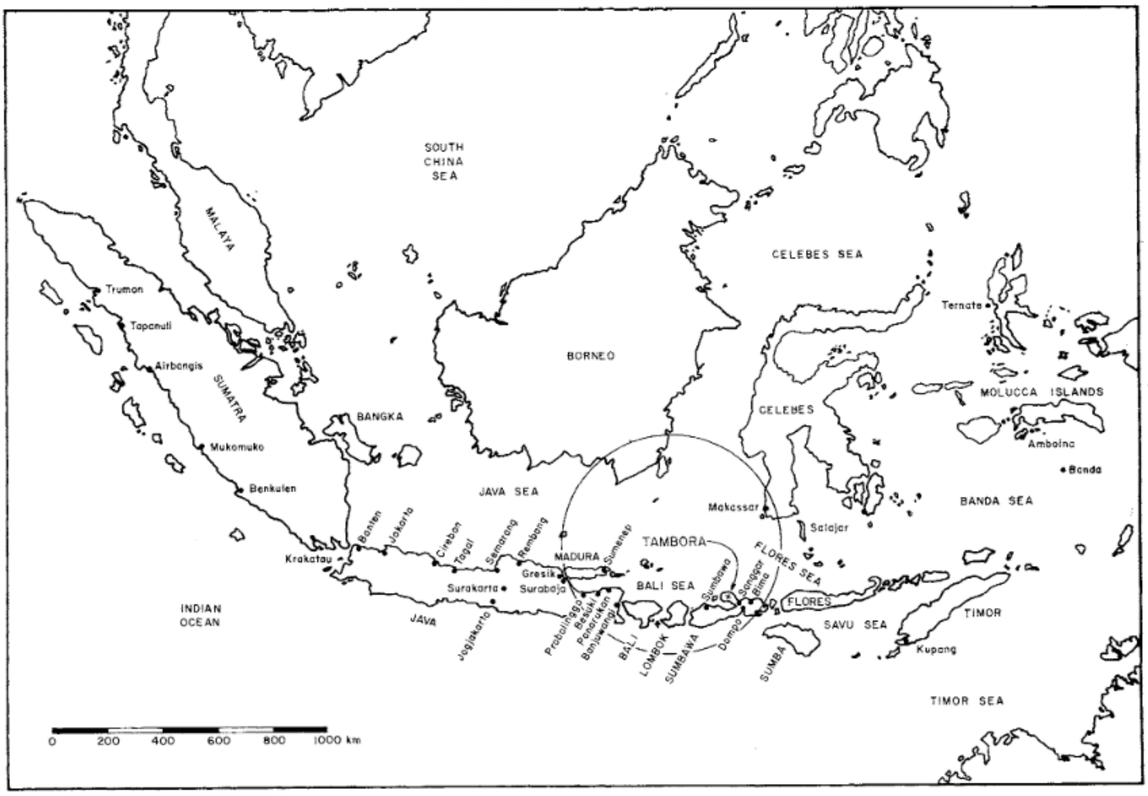
> At ten P.M. of the 1st of April we heard a noise resembling a cannonade, which lasted at intervals, till 9 o'clock next day; it continued at times loud, at others resembling distant thunder; but on the night of the 10th the explosions became truly tremendous, frequently shaking the Earth and Sea violently. Towards morning they again slackened, and continued to lessen gradually till the 14th, when they ceased altogether. On the morning of the 3rd of April, ashes began to fall like fine snow; and in the course of the day they were half-an-inch deep on the ground. From that time till the 11th the air was constantly impregnated with them to such a degree, that it was unpleasant to stir out of doors. On the morning of the 11th, the opposite shore of Bali was completely obscured in a dense cloud, which gradually approached the Java shore, and was dreary and terrific. By one P.M., candles were necessary; by four, P.M., it was pitch-dark; and so it continued until two o'clock of the afternoon of the 12th, ashes continuing to fall abundantly: they were eight inches in depth at this time. After two o'clock it began to clear up; but the sun was not visible till the 14th, and during this time it was extremely cold. The ashes continued to fall, but less violently, and the greatest depth, on the 15th of April, was 9 inches.[36]

'Climatic, Environmental and Human Consequences of the Largest Known Historic Eruption: Tambora Volcano (Indonesia) 1815', *Progress in Physical Geography* 27, no. 2 (2003): 241, https://doi.org/10.1191/0309133303pp379ra.

[35] STOTHERS, Richard B, 'The Great Tambora Eruption in 1815 and Its Aftermath', 1191.

[36] RAFFLES, Sophia, Lady, *Memoir of the Life and Public Services of Sir Thomas Stamford Raffles / Particularly in the Government of Java, 1811-1816, Bencoolen and Its Dependencies, 1817-1824 ; with Details of the Commerce and Resources of the Eastern Archipelago, and Selections from His Correspondence. / By His Widow.*, A New Edition, vol. 1 (London: James Duncan, 1835), 271–72, http://www.sabrizain.org/malaya/library/memraffles1.pdf.

Map 5:3 Map of Indonesia and its environs. The circle surrounds the area of greatest ash fall after the eruption of Tambora on 10 and 11 April 1815



From Stothers 1984 The Great Tambora Eruption in 1815 and Its Aftermath p.1192. Reprinted with permission from AAAS

The volcano began a moderately sized eruption during the evening of April 5th, with tremendous explosions which were so loud they were heard hundreds of kilometres away; Makassar in the Celebes (380km), Batavia (Jakarta) in Java (1260km), and Ternate in the Molucca Islands (1400km). These were initially attributed to distant cannon fire and troops were marched from Djocjocarta in the expectation that a neighbouring post was being attacked.[37] The following morning a fine ash fell on eastern Java and continued falling, whilst the explosions grew fainter and less frequent until about 7 p.m. in the evening of April 10th when the volcano literally blew its top.[38] The following eyewitness report, given to Lieutenant Owen Phillips by the Raja of Saugur, who was about 30km from Tambora, shows just how frightening the eruption was:

[37] STOTHERS, Richard B, 'The Great Tambora Eruption in 1815 and Its Aftermath', 1191; RAFFLES, Sophia, Lady, *Memoir of the Life and Public Services of Sir Thomas Stamford Raffles / Particularly in the Government of Java, 1811-1816, Bencoolen and Its Dependencies, 1817-1824 ; with Details of the Commerce and Resources of the Eastern Archipelago, and Selections from His Correspondence. / By His Widow.*, 1:267.

[38] STOTHERS, Richard B, 'The Great Tambora Eruption in 1815 and Its Aftermath', 1191; SIGURDSSON, Haraldur and CAREY, Steven, 'The Eruption of Tambora in 1815: Environmental Effects and Eruption Dynamics', 17–18.

The sea rose nearly 12 feet (3.7m) higher than it had ever been known to be before, and completely spoiled the only small spots of rice-lands in Saugur, sweeping away houses and every thing within its reach.

The whirlwind lasted about an hour. No explosions were heard till the whirlwind had ceased, at about eleven A. M. From midnight till the evening of the 11th, they continued without intermission; after that, their violence moderated, and they were only heard at intervals; but the explosions did not About seven P.M., on the 10th of April, three distinct columns of flame burst forth, near the top of Tomboro Mountain, all of them apparently within the verge of the crater; and after ascending separately to a very great height, their tops united in the air in a troubled confused manner. In a short time the whole Mountain next Saugur appeared like a body of liquid fire extending itself in every direction.

The fire and columns of flame continued to rage with unabated fury, until the darkness caused by the quantity of falling matter obscured it at about eight P.M. Stones at this time fell very thick at Saugur; some of them as large as two fists, but generally not larger than walnuts. Between nine and ten P.M. ashes began to fall; and soon after a violent whirlwind ensued, which blew down nearly every house in the village of Saugur, carrying the tops and light parts along with it. In the part of Saugur adjoining Tomboro, its effects were much more violent, tearing up by the roots the largest trees, and carrying them into the air, together with men, houses, cattle, and whatever else came within its influence - (this will account for the immense number of floating trees seen at sea.[39]

The noise of the explosions on 10 April were so loud that they were heard as far west as Benkulen (1800 km), Mukomuko (2000 km), in Java, Trumon (2600 km) in Sumatra,

[39] RAFFLES, Sophia, Lady, *Memoir of the Life and Public Services of Sir Thomas Stamford Raffles / Particularly in the Government of Java, 1811-1816, Bencoolen and Its Dependencies, 1817-1824 ; with Details of the Commerce and Resources of the Eastern Archipelago, and Selections from His Correspondence. / By His Widow.*, 1:282–84; STOTHERS, Richard B, 'The Great Tambora Eruption in 1815 and Its Aftermath', 1191–92; OPPENHEIMER, Clive, 'Climatic, Environmental and Human Consequences of the Largest Known Historic Eruption: Tambora Volcano (Indonesia) 1815', 234–36.

and in the east at Ternate (1400 km) in the Moluccas. Explosions were also heard in Borneo, and the Celebes.[40]

The Raja's graphic description is consistent with the passage of hot pyroclastic surges which destroyed the village of Tambora and the whirlwind which ripped through the nearby village of Saugur (Sanggar) carrying off large trees, houses, men and livestock.[41] The tsunami which hit the shores of the Indonesian islands on 10 April, was probably caused by pyroclastic flows smashing into the sea. Although of only moderate size, it was still strong enough to destroy the remaining rice fields in Saugur and sweep away anything in its path.[42] Some two hours later, at around midnight, the tsunami reached Besuki and Surabaya in eastern Java with a height of between 1-2 m throwing boats far inland.[43]

The captain of the East India Company's cruiser, *Benares*, described the ash fallout, which was to prove extremely fatal, in a letter to the *Asiatic Journal* in August 1815:

> ... which was about eight A.M. it was very apparent that some extraordinary occurrence had taken place. The face of the heavens to the southward and westward had assumed the most dismal and lowering aspect, and it was much darker than when the sun rose. At first it had the appearance of a very heavy squall or storm approaching, but as it came nearer it assumed a dusky red appearance and continued to spread very

[40] STOTHERS, Richard B, 'The Great Tambora Eruption in 1815 and Its Aftermath', 1192; SIGURDSSON, Haraldur and CAREY, Steven, 'The Eruption of Tambora in 1815: Environmental Effects and Eruption Dynamics', 20.
[41] RAFFLES, Sophia, Lady, *Memoir of the Life and Public Services of Sir Thomas Stamford Raffles / Particularly in the Government of Java, 1811-1816, Bencoolen and Its Dependencies, 1817-1824 ; with Details of the Commerce and Resources of the Eastern Archipelago, and Selections from His Correspondence. / By His Widow.*, 1:282–84; STOTHERS, Richard B, 'The Great Tambora Eruption in 1815 and Its Aftermath', 1191–92.
[42] STOTHERS, Richard B, 'The Great Tambora Eruption in 1815 and Its Aftermath', 1191; SIGURDSSON, Haraldur and CAREY, Steven, 'The Eruption of Tambora in 1815: Environmental Effects and Eruption Dynamics', 18.
[43] ANON, *The Asiatic Journal and Monthly Register for British India and Its Dependencies*, vol. 1 (London: The Honourable East India Company, 1816), 117, https://books.google.fr/books?id=YgwoAAAAYAAJ&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false; STOTHERS, Richard B, 'The Great Tambora Eruption in 1815 and Its Aftermath', 1192–93; SIGURDSSON, Haraldur and CAREY, Steven, 'The Eruption of Tambora in 1815: Environmental Effects and Eruption Dynamics', 19; OPPENHEIMER, Clive, 'Climatic, Environmental and Human Consequences of the Largest Known Historic Eruption: Tambora Volcano (Indonesia) 1815', 240.

fast over the heavens. By ten it was so dark that I could scarcely discern the ship from the shore, though not a mile distant. I then returned on board.

It was now evident that an eruption had taken place from some volcano, and that the air was filled with ashes or volcanic dust, which already began to fall on the decks. By eleven the whole of the heavens was obscured, except a small space near the horizon to the eastward; the wind being from that quarter prevented for a short time the approach of the ashes; it appeared like a streak of light at day-break, the mountains in Celebes being clearly visible, while every other part of the horizon was enveloped in darkness. The ashes now began to fall in showers, and the appearance altogether was truly awful and alarming. By noon, the light that had remained in the eastern part of the horizon disappeared, and complete darkness had covered the face of day: our decks were soon covered with falling matter; the awnings were spread fore and aft to prevent it as much as possible front getting below, but it was so light and subtle that it pervaded every part of the ship.

The darkness was so profound throughout the remainder of the day, that I never saw any thing equal to it in the darkest night; it was impossible to see your hand when held up close to the eye. The ashes continued to fall without intermission through the night. At six in the morning, when the sun ought to have been seen, it still continued as dark as ever; but at half past seven I had the satisfaction to perceive that the darkness evidently decreased, and by eight I could faintly discern objects on deck. From this time it began to get lighter very fast, and by half past nine the shore was distinguishable; the ashes falling in considerable quantities, though not so heavily as before. The appearance of the ship, when daylight returned, was most extraordinary; the masts, rigging, decks, and every part being covered with the falling matter; it had the appearance of a calcined pumice stone, nearly the colour of wood ashes; it lay in heaps of a foot in depth in many parts of the deck, and I am convinced several tons weight were thrown over board; for although a perfect impalpable powder or dust when it fell, it was, when compressed, of considerable weight; a pint measure filled with it weighed $12^{1}/_{4}$ oz.(347.3 gr); it was perfectly tasteless, and did not affect the eyes with any painful sensations; it had a faint burning smell, but nothing like sulphur.[44]

The fall of ashes, although now only occasional, continued until 17 April when heavy rains spread over the region. Stamford Raffles, the Governor of Java, on hearing that much distress had been occasioned by the eruption, sent Lieutenant Owen Phillips with a supply of rice, to distribute as necessary. He was also asked to report on the local effects of the volcano:

> On my trip towards the Western part of the island, I passed through nearly the whole of Dompo, and a considerable part of Bima. The extreme misery to which the inhabitants have been reduced is shocking to behold: there were still on the road-side the remains of several corpses, and the marks of where many others had been interred; the villages almost entirely deserted, and the houses fallen down…
>
> Since the eruption, a violent diarrhoea has prevailed in Bima, Dompo, and Saugar, which has carried off a great number of people. It is supposed by the natives to have been caused by drinking water which has been impregnated with the ashes; and horses have also died, in great numbers, from a similar complaint.[45]

In his letter quoted above, the captain of the *Benares* relates that when nearing the island of Sumbawa on 18 April, the ship had to navigate huge rafts of pumice:

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[44] ANON, *The Asiatic Journal and Monthly Register for British India and Its Dependencies*, vol. 2 (London: The Honourable East India Company, 1816), 165–66, https://books.google.fr/books?id=4clbidvyN84C&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false; OPPENHEIMER, Clive, 'Climatic, Environmental and Human Consequences of the Largest Known Historic Eruption: Tambora Volcano (Indonesia) 1815', 239.

[45] RAFFLES, Sophia, Lady, *Memoir of the Life and Public Services of Sir Thomas Stamford Raffles / Particularly in the Government of Java, 1811-1816, Bencoolen and Its Dependencies, 1817-1824 ; with Details of the Commerce and Resources of the Eastern Archipelago, and Selections from His Correspondence. / By His Widow.*, 1:281–82.

> […] passed through great quantities of pumice-stone floating on the sea, which at first had the appearance of shoals; so much so, that I hove too, and sent a boat to examine one, which at the distance of less than a mile I took for a dry sand bank, upwards of three miles (4.8 km) in length, with black rocks upon several parts of it, concluding it to have been thrown up during the eruption. It proved to be a complete mass of pumice floating on the sea, with great numbers of large trunks of trees and logs among it, that appeared to be burnt and shivered as if blasted by lightning. The boat had much difficulty in pulling through it; and until we got into the entrance of Bima bay, the sea was literally covered with shoals of pumice and floating timber.[46]

The pumice rafts were carried great distances by the South Equatorial Current which was driven by the south-east trade winds. Between 1 and 3 October 1815, the East India Company's ship, *Fairlie*, which was crossing the Indian Ocean bound for Calcutta, sailed for two days through rafts of pumice, about 3,600 km west of Tambora.[47]

Worldwide consequences

The huge quantity of sulphur injected into the stratosphere during the eruption, some 60 to 80 Mt., had, unsurprisingly, a profound effect on the weather, not only locally but also globally.[48] The eruption occurred in the middle of the coldest decade during the 19th century, which had the longest period of sustained below-average temperatures in the last 500 years; it also coincided with a period of lower solar activity known as the Dalton Minimum, that lasted from around 1790 to 1830.[49] This meant that global temperatures may have already been lowered by the time Tambora erupted, possibly

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[46] ANON, *The Asiatic Journal and Monthly Register for British India and Its Dependencies*, 1816, 2:166.
[47] OPPENHEIMER, Clive, 'Climatic, Environmental and Human Consequences of the Largest Known Historic Eruption: Tambora Volcano (Indonesia) 1815', 241; SIGURDSSON, Haraldur and CAREY, Steven, 'The Eruption of Tambora in 1815: Environmental Effects and Eruption Dynamics', 21.
[48] OPPENHEIMER, Clive, 'Climatic, Environmental and Human Consequences of the Largest Known Historic Eruption: Tambora Volcano (Indonesia) 1815', 243; LUTERBACHER, Jürg and PFISTER, Christian, 'Nat. Geosci.', 246.
[49] GUEVARA-MURUA, A. et al., 'Observations of a Stratospheric Aerosol Veil from a Tropical Volcanic Eruption in December 1808: Is This the Unknown~1809 Eruption?', *Climate of the Past*, no. 10 (2014): 1707, https://doi.org/10.5194/cp-10-1707-2014; BRIFFA, K. R. et al., 'Influence of Volcanic Eruptions on Northern Hemisphere Summer Temperature over the Past 600 Years', *Nature* 393, no. 6684 (4 June1998): 450–55, https://doi.org/10.1038/30943; D'ARRIGO, Rosanne, WILSON, Rob, and TUDHOPE, Alexander, 'The Impact of Volcanic Forcing on Tropical Temperatures during the Past Four Centuries', *Nature Geoscience* 2 (2009): 51, https://doi.org/10.1038/NGEO393.

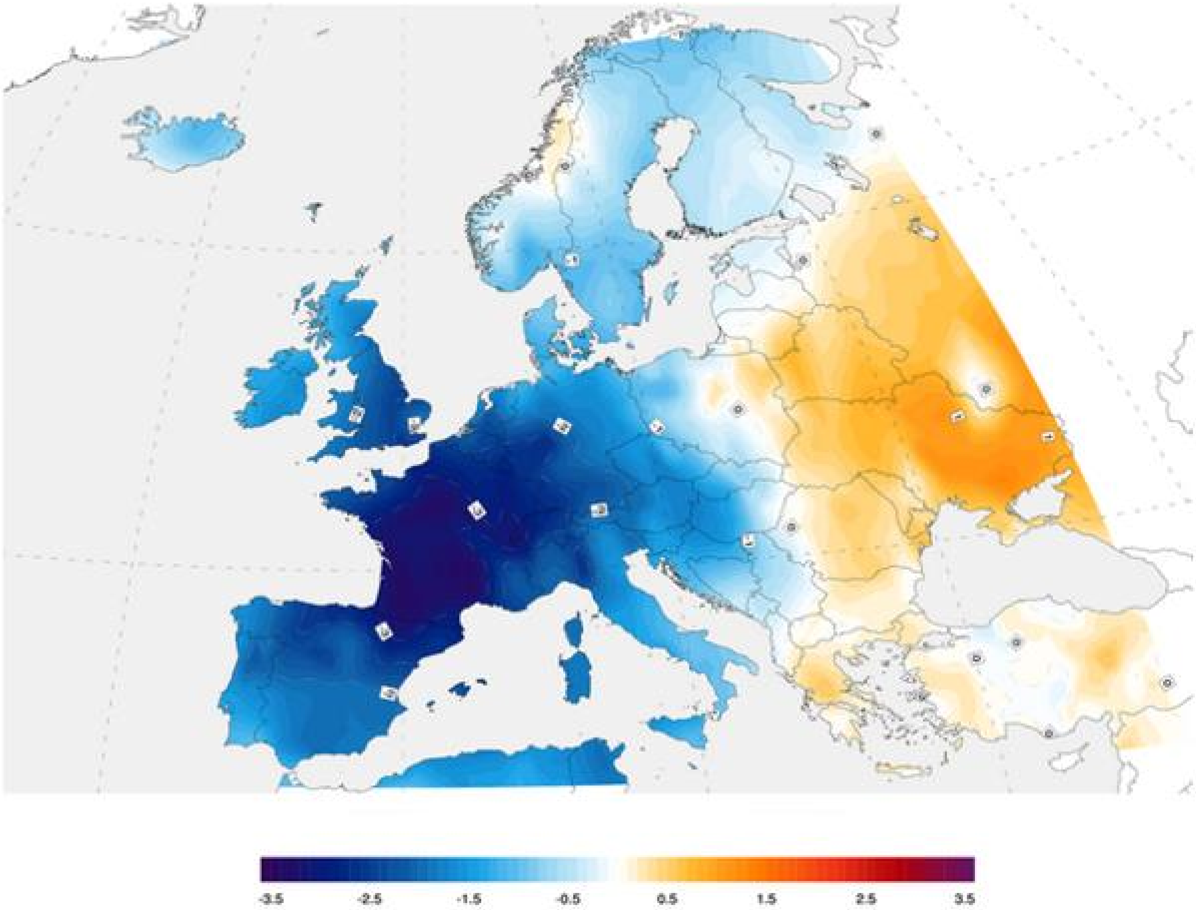
as much as between 0.5 to 1.3°C below the 20th century average.[50] This fall in temperature was then exacerbated by the quantity of sulphuric aerosol expelled by the Tambora eruption, resulting in the “year without a summer” in 1816.[51]

Map 5:4 shows the temperature anomalies in the summer of 1816, but we should be wary of attributing the cause solely to the Tambora eruption. The eruption took place in the middle of the coldest decade during the 19th century which had the longest period of sustained below-average temperatures in the last 500 years.[52] Temperatures, had however, begun to fall between 1809 and 1810.

According to D’Arrigo et al, there was a decrease in tropical sea temperatures of 0.53° and this has been attributed to an unrecognised tropical eruption which took place in 1808.[53] It has been conjectured that this eruption measured at least VEI 6 on the explosivity index, and according to sulphate deposition in Greenland and Antarctic ice cores, it was one of the most SO_2-rich stratospheric tropical eruptions in the last 500 years. Its sulphate output was half that of Tambora, but more than twice that of Krakatau. Not only do large volcanic eruptions produce a haze such as Laki’s, but they can also result in some stunning visual effects like the ones seen after Tambora. According to two contemporary scientific reports, one from Bogotá, Colombia, by Francisco José de Caldas and the other by José Hipólito Unanue from Lima, Peru, the unknown eruption did just this.[54]

[50] PFISTER, Christian and WHITE, Sam, ‘A Year Without a Summer, 1816’, in *The Palgrave Handbook of Climate History* (London: Palgrave Macmillan, 2018), 552.
[51] SIGURDSSON, Haraldur and CAREY, Steven, ‘The Eruption of Tambora in 1815: Environmental Effects and Eruption Dynamics’, 38; STOTHERS, Richard B, ‘The Great Tambora Eruption in 1815 and Its Aftermath’, 1196.
[52] GUEVARA-MURUA, A. et al., ‘Observations of a Stratospheric Aerosol Veil from a Tropical Volcanic Eruption in December 1808: Is This the Unknown~1809 Eruption?’, 1707; BRIFFA, K. R. et al., ‘Influence of Volcanic Eruptions on Northern Hemisphere Summer Temperature over the Past 600 Years’; D’ARRIGO, Rosanne, WILSON, Rob, and TUDHOPE, Alexander, ‘The Impact of Volcanic Forcing on Tropical Temperatures during the Past Four Centuries’, 51.
[53] D’ARRIGO, Rosanne, WILSON, Rob, and TUDHOPE, Alexander, ‘The Impact of Volcanic Forcing on Tropical Temperatures during the Past Four Centuries’, 51; GUEVARA-MURUA, A. et al., ‘Observations of a Stratospheric Aerosol Veil from a Tropical Volcanic Eruption in December 1808: Is This the Unknown~1809 Eruption?’, 1707–22.
[54] GUEVARA-MURUA, A. et al., ‘Observations of a Stratospheric Aerosol Veil from a Tropical Volcanic Eruption in December 1808: Is This the Unknown~1809 Eruption?’, 1707–8.

Map 5:4 Temperature anomalies across Europe in the summer of 1816



Wikipedia

It would seem that judging from its size, this unknown volcano may well have contributed to global cooling and the coolest decade for half a millennium.[55] The drop in temperature weakened the Asian and African monsoon, an all-important source of rainfall for crops that fed 50% of the world's population. It also caused the displacement southward of the Azores anti-cyclone, which enhanced the flow of cool wet air into the southern regions of central and western Europe, thus causing an extremely cold, wet summer.[56]

[55] UNIVERSITY OF BRISTOL, 'Mysterious Volcanic Eruption of 1808 Described', ScienceDaily, 18 September 2014, www.sciencedaily.com/releases/2014/09/140918111220.
[56] PFISTER, Christian and WHITE, Sam, 'A Year Without a Summer, 1816'.

The effects, however, were not the same over the whole of Europe. From June to August 1816, temperatures in central and western Europe and the western Mediterranean were continually cold, between 1 to 2°C cooler than the 1810–1819 average, and from 2 to 4°C cooler than the 1951–1980 mean. In eastern Europe, parts of eastern Scandinavia and western Russia, summer temperatures were either normal or slightly above average, which enabled Emperor Alexander I of Russia to export grain to western Europe, as well as providing some monetary assistance.[57] Meanwhile, most districts in Iceland had a very severe winter and spring, with sea ice being recorded off the northern coasts from March to mid-June. The summer was mixed with some districts being wet and cold, and others dry and fine during harvest.[58]

Except for the eastern Mediterranean, rainfall was unusually high over most of Europe. In the Czech lands, for example, the writer, Václav Jan Mašek reported that it started to rain almost continually from St Medards day, 8 June, for eight weeks,[59] whilst the British Isles, France, Germany, Belgium, the Netherlands, Luxembourg and Switzerland had around twice the June rainfall when compared with the 1951–1980 mean. There was less rain in July, but the conditions returned in August. However, north western Scotland, Orkney, Shetland, Denmark, Norway and Italy were drier than usual.[60] The following contemporary accounts give a good impression of the state of the weather:

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[57] OPPENHEIMER, Clive, 'Climatic, Environmental and Human Consequences of the Largest Known Historic Eruption: Tambora Volcano (Indonesia) 1815', 245; LUTERBACHER, Jürg and PFISTER, Christian, 'Nat. Geosci.', 246; PFISTER, Christian and WHITE, Sam, 'A Year Without a Summer, 1816'; RAMPINO, Michael R. and SELF, Stephen, 'Historic Eruptions of Tambora (1815), Krakatau (1883), and Agung (1963), Their Stratospheric Aerosols, and Climatic Impact', *Quaternary Research* 18, no. 2 (September 1982): 130, https://doi.org/10.1016/0033-5894(82)90065-5; NEUMANN, J., 'The 1810s in the Baltic Region, 1816 in Particular: Air Temperatures, Grain Supply and Mortality', in *The Year Without a Summer? World Climate in 1816* (Ottawa, Canada: Canadian Museum of Nature, 1992), 392, 406, https://ia800700.us.archive.org/19/items/yearwithoutsumme1992hari/yearwithoutsumme1992hari.pdf.

[58] OGILVIE, A. E. J., '1816 - a Year without a Summer in Iceland', in *The Year Without a Summer? World Climate in 1816* (Ottawa, Canada: Canadian Museum of Nature, 1992), 337–50, https://ia800700.us.archive.org/19/items/yearwithoutsumme1992hari/yearwithoutsumme1992hari.pdf.

[59] BRAZDIL, Rudolf et al., 'Climatic Effects and Impacts of the 1815 Eruption of Mount Tambora in the Czech Lands', *Climate of the Past* 12 (2016): 1366, https://doi.org/10.5194/cp-12-1361-2016.

[60] KINGTON, John, 'Weather Patterns over Europe in 1816', in *The Year Without a Summer? World Climate in 1816* (Ottawa, Canada: Canadian Museum of Nature, 1992), 368–70, https://ia800700.us.archive.org/19/items/yearwithoutsumme1992hari/yearwithoutsumme1992hari.pdf; OPPENHEIMER, Clive, 'Climatic, Environmental and Human Consequences of the Largest Known Historic Eruption: Tambora Volcano (Indonesia) 1815', 246 & 251; LUTERBACHER, Jürg and PFISTER, Christian, 'Nat. Geosci.', 246; STOTHERS, Richard B, 'The Great Tambora Eruption in 1815 and Its Aftermath', 1196.

Melancholy accounts have been received from all parts of the Continent of the unusual wetness of the season; property in consequence swept away by inundation, and irretrievable injuries done to the vine yards and corn crops. In several provinces of Holland, the rich grass lands are all under water, and scarcity and high prices are naturally apprehended and dreaded. In France the interior of the country has suffered greatly from the floods and heavy rains. *(The Norfolk Chronicle, 20 July 1816.)*[61]

In 1816, the spring was unusually late; the summer and autumn excessively wet and cloudy; the quantity of rain which fell in this year, measured in the gauge nearly thirty-one inches (78cm), a circumstance perhaps, unprecedented in this country. There were 142 wet days, and these principally in the summer and autumnal months. The mean temperature of the spring, summer, and autumn was three and a-half degrees below that of the preceding year […] The winter of 1816 was remarkably mild.

The harvest of grain was uncommonly late both in this country and in England; corn remained uncut during the latter parts of October and November, and much of it was altogether lost. The cold of this season proved highly injurious to the crop of potatoes also.

The harsh and unnatural weather experienced here for months past seems not to be confined to Ireland. In every part of Europe there has been the same cause of complaint. Great thunder-storms occurred during the month of July, accompanied with hail of an unusually large size.

A bad harvest in France owing to the continual rains…

(The Census of Ireland, 1851)[62]

[61] THE NORFOLK CHRONICLE, 'Melancholy Accounts Have Been Received from All Parts of the Continent', *The Norfolk Chronicle*, 20 July 1816; KINGTON, John, 'Weather Patterns over Europe in 1816', 368.
[62] IRELAND. GENERAL REGISTER OFFICE, *The Census of Ireland for the Year 1851. Part V. Tables of Deaths. Vol. I. Containing the Report, Tables of Pestilences, and Analysis of the Tables of Deaths.*, vol. 1 (Dublin: Alexander Thom & Son for H.M.S.O., 1856), 175–77, https://ia800207.us.archive.org/19/items/op1247882-1001/op1247882-1001.pdf.

The Royal Cornwall Gazette printed a letter which had been sent from Bourdeaux – une commune de la Drôme – on the15th June 1816, which tells of the conditions they had to endure:

> We really do not know here, where we are. We sit with our doors and windows closed, and fire burning as in the middle of winter. It is cold as in October, and the sky is dark and rainy; violent winds, accompanied with heavy rain and hail, rage round our country houses: the low grounds are under water…The oldest people in the country do not recollect such a summer. Vegetation suffers, particularly the vines. The time of the blossom should be past, and they have not yet begun to blossom…the grapes cannot possibly ripen.[63]

However, not all the news from France was bad, with the Evening Mail printing a letter dated 14th August from Strasbourg that: *"The harvest is now general throughout this department, and is very fine."*[64]

As previously mentioned, Germany suffered from some very severe weather. The Lower Rhine flooded for five months; after weeks of incessant rain, the Saale burst its banks at Halle, flooding many villages and drowning many cattle; on 10th of June, the left bank of the Danube near Munich, was destroyed by a shower of hail which resulted in great area of flooding, and five days later in the environs of Bamberg there was so much rain that 17 villages were entirely laid waste. Hundreds of cattle died, several houses were carried away by torrents from the mountains, and 15 people lost their lives.[65] Information received from Berlin dated 18th November states that in the neighbourhood of Halle, whole fields of young wheat have been destroyed by snails, and a note from Hamburg dated 22nd November reports that the Elbe is full of drift-ice

[63] ANON, 'The Weather', *Royal Cornwall Gazette*, 13 July 1816, 4.
[64] ANON, 'A Letter from Strasburg', *Evening Mail*, 23 August 1816, 4.
[65] EVANS, Richard J., *The Pursuit of Power : Europe, 1815-1914*, vol. 7, The Penguin History of Europe (Penguin Books, 2017), https://books.google.fr/books?id=aIK0CwAAQBAJ&pg=PT27&lpg=PT27&dq=riots+europe+1817&source=bl&ots=Y59uQm9ka2&sig=ACfU3U0-8fV4WmT_R-ev7ql6eraYrc-LdQ&hl=en&sa=X&ved=2ahUKEwir0sHExZPgAhVG1hoKHSdgBa4Q6AEwEXoECAQQAQ#v=onepage&q=riots%20europe%201817&f=false; ANON, 'Halle, June 24', *Evening Mail*, 10 July 1816; ANON, 'The Weather', 4.

and may be considered unnavigable.[66] The following article received from Augsburg dated 28th June gives details of an horrendous hail storm:

> On the 21st, at six in the evening, such a dreadful storm from the north-east arose near Spielberg, that the oldest inhabitants remember so terrible; the hail fell of the size of hen's eggs, and covered the earth in many places a foot deep. Birds, several hares, and deer, were found killed, sheep were wounded in the meadows, and labourers in the fields; the whole land looked as if it had been trampled by horses, the trees stand stripped of their blossoms, leafless and broken. Not a house in the plain but what is damaged…[67]

The worst affected areas were the alpine countries, especially Switzerland, which experienced months of "sunless cold and rain". There were only a few days of fine weather between May and September and eight successive weeks of rain from June to July. It snowed throughout the summer down to an altitude of 800m and the glaciers advanced rapidly. During 1816 the hardest hit areas were the vine growing regions to the north of the Alps, whilst those to the south were shielded by the mountains from northwest winds and heavy frosts. The bad weather inevitably led to a failure of the potato and grain crops thereby causing much misery.[68]

In order to assess whether the bad weather which occurred after the eruption had any impact upon the mortality of the population in Britain, a series of burial records was extracted for 1409 parishes in England, Wales and the Isle of Man covering the years 1800 to 1820. The results thus obtained have been summarised in Figures. 5:1-3. In all three countries the number of burials from 1815 to 1819 exceeded those from 1810 to 1814, in England by some 6.3%, in Wales by 20.75% and the I.O.M. by 4.5%. These figures would seem to show that the weather had a measurable effect upon the rates

[66] ANON, 'Hamburgh Mail', *Morning Post*, 2 December 1816, 2.
[67] ANON, 'The Weather', 4.
[68] PFISTER, Christian and WHITE, Sam, 'A Year Without a Summer, 1816', 552–53.

of mortality during the 1815-1819 period. We can see this in greater detail from the following graphs, Figs. 5:1-3. In England, by far the greatest number of burials occurred in 1800, fifteen years before the Tambora eruption, and these were most likely due to epidemics of smallpox and fevers of one sort or another.[69] However, after Tambora, the greatest years of mortality were in 1816, 1818 and 1819. In Wales, as in England, the largest number of post-Tambora burials occurred in 1816, 1818, and 1819, whilst in the I.O.M., in 1817, 1819 and 1820. These figures, would seem to confirm that the Tambora eruption had a pronounced impact on the mortality in Wales, but less so upon that in England and the I.O.M. It will be noticed that there was a huge spike in the I.O.M. burials for the year 1809. Unfortunately, there is no explanation for this in the parish records, but as there had been several outbreaks of smallpox in the past this could well have been the reason.

It is interesting to note that the burial rate in Jersey, which is approximately 95 miles due south of the English coast, was unaffected by the eruption, the number of burials from 1815 to 1819 being 26.57% less than those from 1810 to 1814. See Fig. 5:4.

Canada and northern New England suffered from frequent northwest winds which brought snow and frost, with the Hudson's Bay area of eastern Canada experiencing around 2$^1/_2$ years of exceptionally cold weather from October 1815 to March 1818.This was no doubt exacerbated by the heavy build-up of sea ice in the Bay itself.[70] The place of 1816 in the memory of the regional population of New England has been succinctly summed up by the historian H.F. Wilson, when he wrote that, in 1816, farmers experienced an *"almost total crop failure".* There was a fair yield of winter grain, but other crops such as corn and hay failed leading to the loss of many sheep and cattle for lack of feed during the following winter. As a result, 1816 has come down to us as the *"cold year", "the famine year" and "eighteen hundred and froze to death".*[71]

[69] CREIGHTON, Charles, *A History of Epidemics in Britain. Vol. 2 From the Extinction of Plague to the Present Time.*, 1st ed., vol. 2, 2 vols (Cambridge: Cambridge University Press, 1894).
[70] WILSON, Cynthia, 'Climate in Canada, 1809-20: Three Approaches to the Hudson's Bay Company Archives as an Historical Database', in *The Year Without a Summer? World Climate in 1816* (Ottawa, Canada: Canadian Museum of Nature, 1992), 162, https://ia800700.us.archive.org/19/items/yearwithoutsumme1992hari/yearwithoutsumme1992hari.pdf.
[71] WILSON, Harold Fisher, *The Hill Country of Northern New England: Its Social and Economic History, 1790-1930*, Columbia University Studies in the History of American Agriculture 3 (New York: Columbia University Press, 1936), 22, https://books.google.fr/books?redir_esc=y&hl=fr&id=DIAuAAAAMAAJ&focus=searchwithinvolume&q=famine+year; BARON, William R., '1816 in Perspective: The View from the Northeastern United States', in *The Year Without a Summer? World Climate*

Figure 5:1 Burials per year in England 1800 to 1820

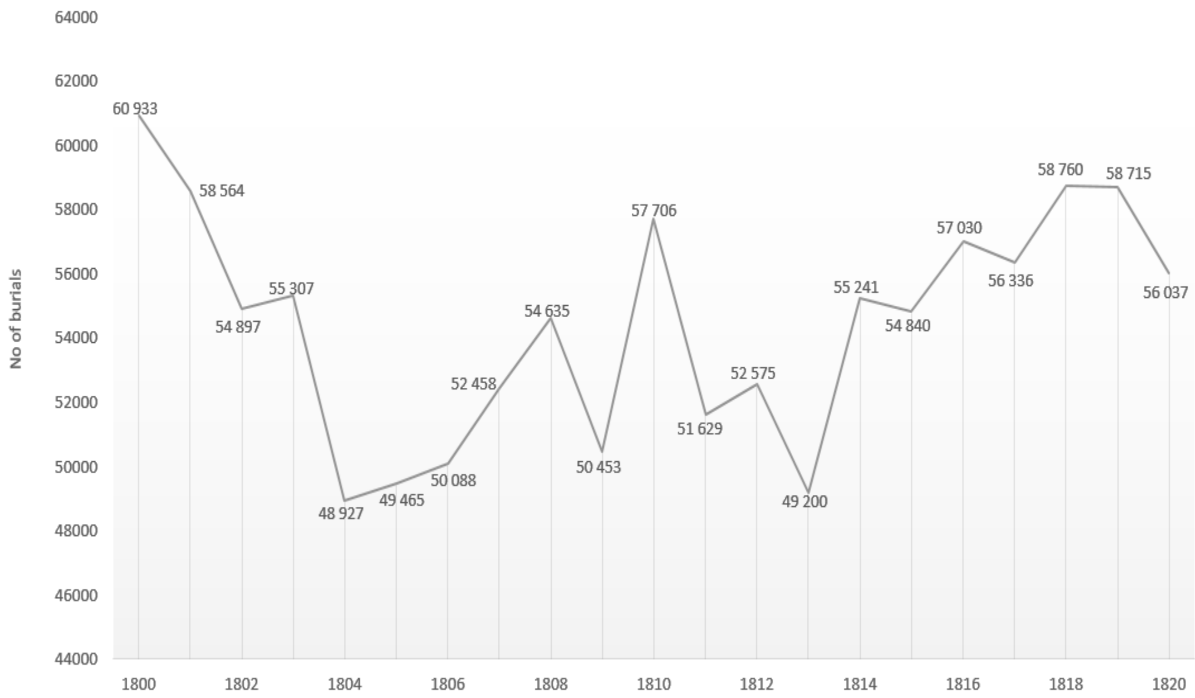
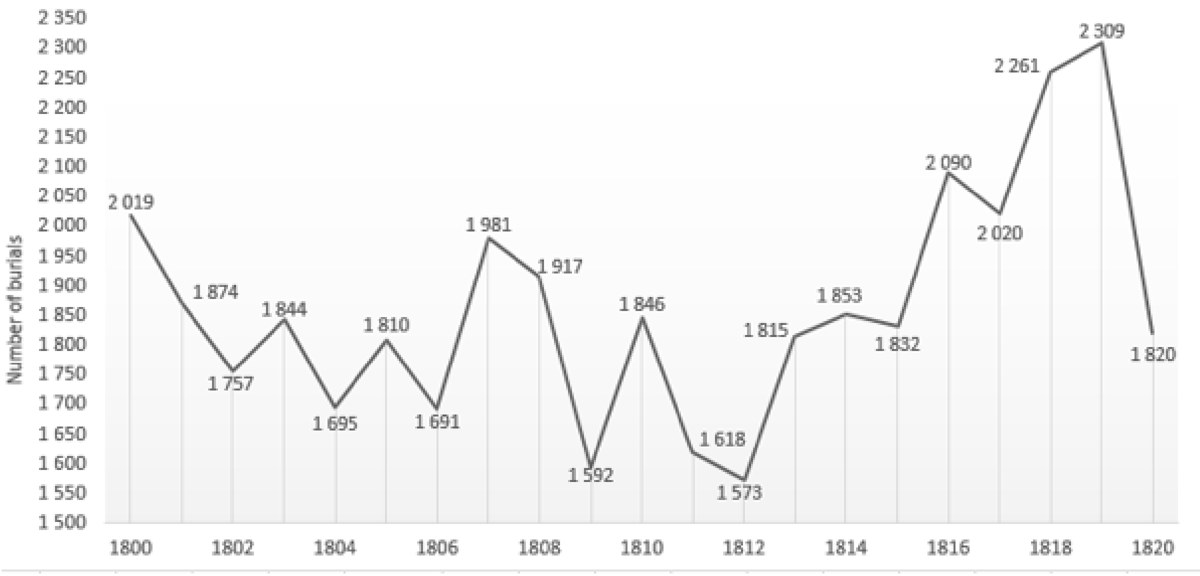


Figure 5:2 Burials per year in Wales 1800 to 1820



in 1816 (Ottawa, Canada: Canadian Museum of Nature, 1992), 124–44, https://ia800700.us.archive.org/19/items/yearwithoutsumme1992hari/yearwithoutsumme1992hari.pdf.

Figure 5:3 Burials per year in the I.O.M. 1800 to 1820

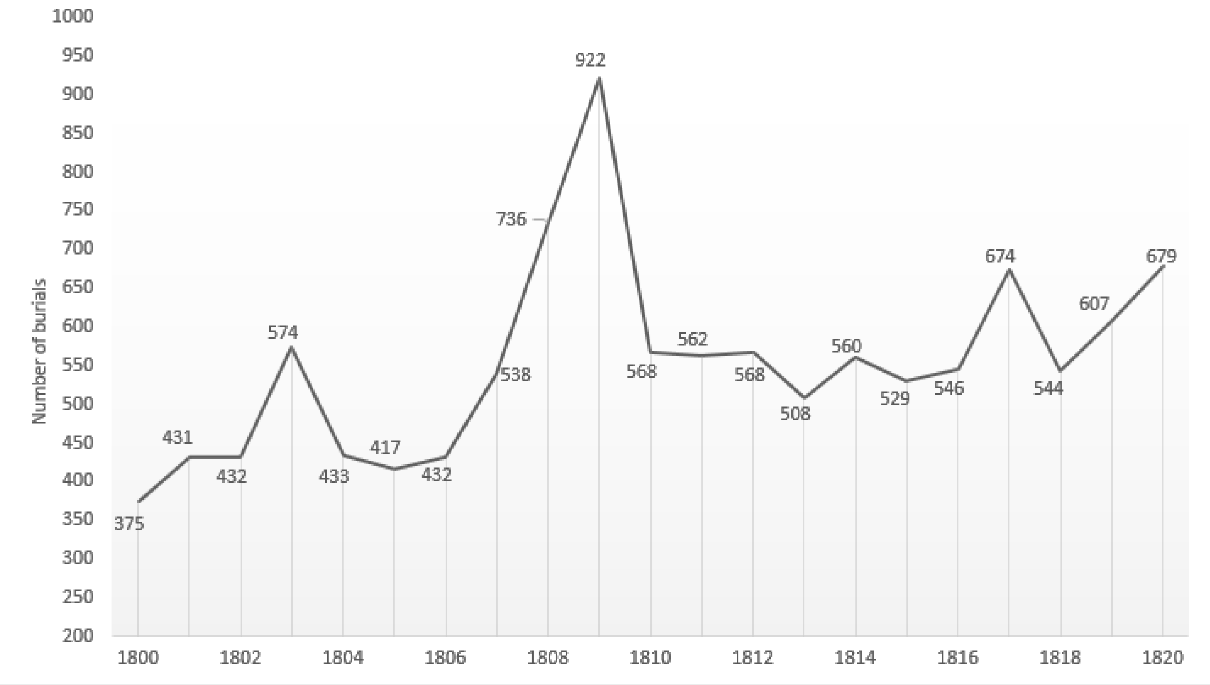
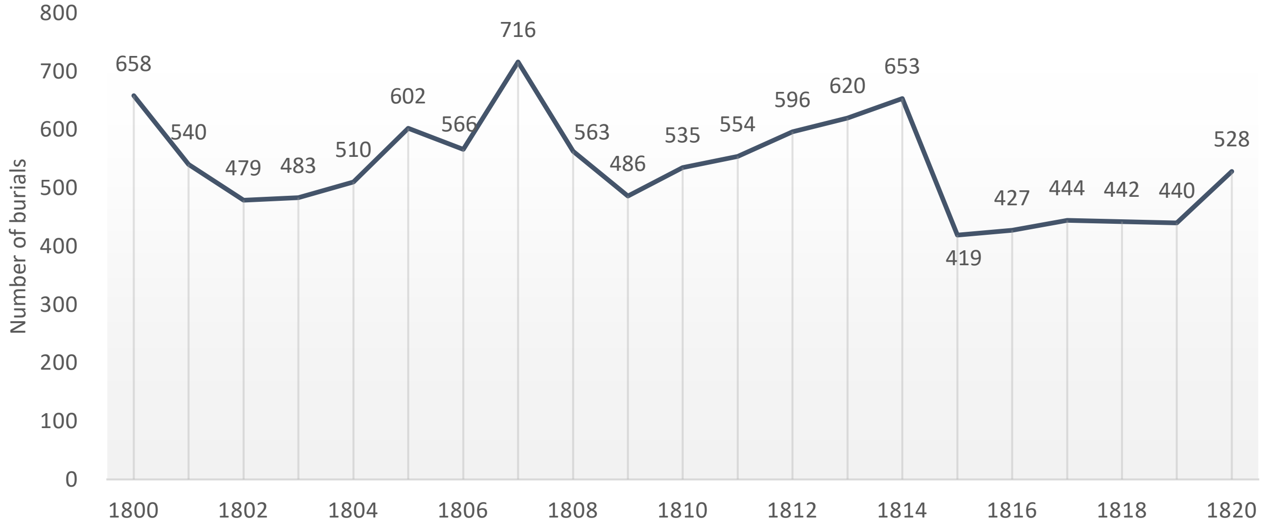


Figure 5:4 Burials per year in Jersey 1800 to 1820



Social responses

In the period following the end of the Napoleonic wars (1792-1815), Europe experienced a period of great economic and social unrest. This was due, in no small part, to the demobilization of several million men from military service, which saturated the labour market and caused mass unemployment. Together, the combination of cold weather, malnutrition, and famine caused by poor harvests, made the population susceptible to epidemics of diseases such as typhus, dysentery and fevers of various kinds.[72] Ireland was badly affected by an epidemic of typhus for two years during 1817-1818. 100,000 cases were known to have passed through hospitals, but Harty estimated that seven times that number were sick in their cabins or houses, making 800,000 cases in all, and the mortality during the epidemic was 44,300.[73] England and Scotland fared little better. According to Hancock: *"The year 1819, in most parts of Great Britain and Ireland, concluded the career of that epidemic fever, which, in the two preceding years, had been visiting almost every town and village of the United Kingdoms."* [74]

Popular reaction to these disastrous circumstances inevitably led to demonstrations and riotous behaviour, with the most serious of these, the so called "Bread and Blood" riots, taking place in East Anglia during April and May 1816. According to a report in the Caledonian Mercury dated 23rd May, a mob, presumed to be made up of agricultural labourers who were discontented because a rise in their wages did not immediately follow a rise in the price of corn, smashed up threshing machines, and set fire to barns and corn stacks.[75]

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[72] OPPENHEIMER, Clive, 'Climatic, Environmental and Human Consequences of the Largest Known Historic Eruption: Tambora Volcano (Indonesia) 1815', 253; BRÖNNIMANN, Stefan and KRÄMER, Daniel, 'Tambora and the "Year Without a Summer" of 1816. A Perspective on Earth and Human Systems Science', 28.

[73] CREIGHTON, Charles, *A History of Epidemics in Britain. Vol. 2 From the Extinction of Plague to the Present Time.*, 2:256–68; OPPENHEIMER, Clive, 'Climatic, Environmental and Human Consequences of the Largest Known Historic Eruption: Tambora Volcano (Indonesia) 1815', 251–53; HARTY, William, *An Historic Sketch of the Causes, Progress, Extent, and Mortality of the Contagious Fever Epidemic in Ireland during the Years 1817, 1818, and 1819* (Dublin, London: Hodges and M'Arthur, Hurst, Robinson, and Co. F. and G. Underwood, Burgess and Hill, and John Callow, 1820) quoted in Creighton (1894) and Oppenheimer (2003).

[74] HANCOCK, Thomas, *Researches into the Laws and Phenomena of Pestilence; Including a Medical Sketch and Review of the Plague of London, In 1665; and Remarks on Quarantine. With an Appendix: Containing Extracts and Observations Relative to the Plagues of Morocco, Malta, Noya, and Corfu; Being the Subject of the Anniversary Oration, Delivered before the Medical Society of London, in the Spring of 1820, and Published at Their Request* (London: William Phillips, 1821), 39, https://ia600305.us.archive.org/28/items/researchesintola00hanc/researchesintola00hanc.pdf; CREIGHTON, Charles, *A History of Epidemics in Britain. Vol. 2 From the Extinction of Plague to the Present Time.*, 2:167–81; OPPENHEIMER, Clive, 'Climatic, Environmental and Human Consequences of the Largest Known Historic Eruption: Tambora Volcano (Indonesia) 1815', 251–53.

[75] ANON, 'Riots in Suffolk', *Caledonian Mercury*, May 1816, 2; OPPENHEIMER, Clive, 'Climatic, Environmental and Human Consequences of the Largest Known Historic Eruption: Tambora Volcano (Indonesia) 1815', 251; LINTHICUM, Kent, '"Bread or Blood": Climate Insecurity in East Anglia in 1816', Historical Climatology, 5 August 2017, https://www.historicalclimatology.com/blog/bread-or-blood-climate-insecurity-in-east-anglia-in-1816.

> The disturbance broke out again on Saturday (the following day), with increased violence, and the malcontents shewed themselves in considerable force. Their whole number amounted to about 1500, divided in several parties, marching in several directions, for the purpose of attacking the houses of those persons who were obnoxious to them. At Brandon they destroyed several houses, including Mr Willet's, the butcher; that they completely levelled to the ground. Another party of them proceeded to the village of Halesworth, it is supposed for a like purpose… They were armed with long heavy sticks, the ends of which, to the extent of several inches, were studded with short iron spikes, sharp at the sides and points. Their flag was inscribed, *"Bread or Blood!"* [76]

Meanwhile, in Europe, France became the centre of protests and riots, passive at first, but turning violent in the spring of 1817, with raids on farms and granaries, and even the forcible occupation of whole villages. Due to their violence, the riots must, for some anyway, have had resonances of "la Grande Peur".[77] In many parts of France, mobs prevented the movement of grain outside their own area, whilst in Germany there were grain riots in Augsburg and Munich, and in Italy, granaries were looted.[78]

Although there were acute food shortages in Britain owing to bad harvests, and the price of bread doubled between 1817-1818, the government managed to stave off mass starvation by importing large quantities of grain and flour from the American West – ½ million barrels of flour were imported into Liverpool during 1818.[79] Prussia, France, Italy and The Netherlands also imported grain from wherever they could, and this of course, increased prices. For example, the increased demand from Europe for wheat, increased on average, from US $ 1.565 per bushel to US $ 2.406 in 1817, and for wheat flour, US $8.57 per hundred pounds to US $ 11.72 in 1817.[80]

[76] ANON, 'Riots in Suffolk', 2.
[77] BRÖNNIMANN, Stefan and KRÄMER, Daniel, 'Tambora and the "Year Without a Summer" of 1816. A Perspective on Earth and Human Systems Science', 34.
[78] EVANS, Richard J., *The Pursuit of Power : Europe, 1815-1914*, 7:unpaginated.
[79] BRAGG, Melvyn, '1816, the Year Without a Summer', *In Our Time* (BBC 4, 21 April 2016), http://www.bbc.co.uk/programmes/b077j4yv; YouTube, '1816, the Year Without a Summer (In Our Time)', BBC Podcast, In Our Time: History, accessed 4 February 2019, https://www.youtube.com/watch?v=lbkoiE8YOxs.
[80] U.S. BUREAU of the CENSUS, *Historical Statistics of the United States: Colonial Times to 1957* (Washington, D.C.: Social Science Research Council, 1960), 124, https://fraser.stlouisfed.org/files/docs/publications/histstatus/hstat_1957_cen_1957.pdf; WEBB, Patrick, 'Emergency Relief during Europe's Famine of 1817 Anticipated Crisis-Response Mechanisms of Today', *The Journal of Nutrition* 132, no. 7 (1 July 2002): 2092S-2095S.

In Munich, towards the end of 1816 one observer wrote: *"beggars appeared from all directions, as if they had crawled out of the ground"*. Hungary was overrun with beggars and in Rome and Vienna the police carried out raids to clear them from the streets and put them to work on public works projects.[81] According to the Scots Magazine, the spread of typhus was:

> …effected by hordes of beggars traversing the island in every direction; who, pressed by famine, rush into every house the aspect of which affords the hope of relief, and the same breath that thanks the owner for his charity, blasts the hand that bestows it, and spreads desolation through his family.[82]

Many people decided to escape from the misery in Europe and cross the Atlantic in the hope of a better life in America. Most emigrants came from Great Britain and Ireland, and thousands left, or at least tried to leave, Switzerland and Germany; some under the auspices of their local authorities who were only too glad to be rid of them. However, fewer than 60,000 prospective immigrants managed to cross the Atlantic, whilst some 9,000 of the poor from Württemberg made the long journey to Russia under promises of assistance from Alexander I, and in 1818, 2000 left Baden for Rio de Janeiro.[83]

The year without a summer, did however have some unforeseen consequences, perhaps the most bizarre being the Bologna Prophecy. This was inspired by a dramatic increase in sunspot activity and caused alarm and consternation throughout Britain and Europe:[84]

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[81] EVANS, Richard J., *The Pursuit of Power : Europe, 1815-1914*.
[82] ANON, 'Fever in Ireland', *The Scots Magazine*, 1 September 1817, 81–82.
[83] LUTERBACHER, Jürg and PFISTER, Christian, 'Nat. Geosci.', 247; EVANS, Richard J., *The Pursuit of Power : Europe, 1815-1914*.
[84] VAIL, Jeffrey, '"The Bright Sun Was Extinguish'd": The Bologna Prophecy and Byron's "Darkness"', *The Wordsworth Circle* 28, no. 3 (1997): 184–85.

In France as well as in this country, and generally throughout Europe, the prediction of the mad Italian prophet, relative to the end of the world, had produced great dread in the minds of some, so that they neglected all business, and gave themselves up entirely to despondency. A Bath paper says, that "a maiden lady, who resides in a village in Somersetshire, was deeply affected at the expected approach of a second chaos, and had taken much pains to impress the younger branches of the family with similar apprehensions. The latter, however, laughed at her folly, and were severely rebuked for their *unbelief.* On Thursday morning, between six and seven o'clock, a girl eight years of age, got out of bed, and ran to the lady's chamber, crying out, "*Aunt, Aunt, the World's at an end!* "These words struck so much terror into the mind of the lady, that she has not spoken since; and at nine o'clock, on Friday morning she remained in a state of insensibility."

At Ghent the apprehension was increased by the sound of trumpets at nine at night on the 18th instant. The following account is given in one of the French papers:

Courtray, July 19. – "An inhabitant of this town, who arrived this morning from Ghent, witnessed a scene there which deserves to be known. – Yesterday, about nine in the evening, the trumpets of a regiment of cavalry, which had arrived during the day, sounded the retreat, as is usual, at the different quarters. The weather was gloomy, the thunder roared, and flashes of lightning furrowed the dark clouds accumulated over the town. Suddenly, cries, groans, tears, lamentations, were heard on every side. Three-fourths of the inhabitants rushed from their houses, and threw themselves on their knees in the streets and public places. It was not without infinite trouble that the cause of this extraordinary terror was discovered. The *good folks* of Ghent, persuaded that the end of the world was at hand, believed they had heard the *Seventh Trumpet*, which

according to *Revelations*, chap. X.v.7; is to announce *the last judgment*."
– *(Journal du Nord.)*[85]

The writer in the "*London Chronicle*" who also reported the same stories *"lamented that in this philosophic age 'the multitude are more ignorant and credulous than in the most barbarous times' and that 'the people are full of dread and apprehension' merely because of 'the paleness of the moon and the spots on the Sun.'"*[86]

Artistic responses

The poet, Lord Byron, left England in 1816 in order to avoid disgrace and humiliation and journeyed to Switzerland with his doctor and companion, John Polidori. There, in a hotel on the shores of Lake Geneva, they met up with Percy Bysshe Shelley, his future wife Mary Godwin and Mary's stepsister Claire Clairmont, a former lover of Lord Byron. Shortly after, both parties abandoned their hotel, Byron taking a lease on the Villa Diodati, and Shelley one on a neighbouring property. As the weather in June was particularly bad, the group spent their evenings discussing literary projects. One night, Byron suggested they each write a ghost story, inspiration being taken from a collection of German horror stories entitled "*Fantasmagoriana*". One of the outcomes of these late-night conversations was Mary Shelley (as she preferred to be known) having a nightmare in which *"I saw the hideous phantasm of a man stretched out, and then, on the working of some powerful engine show signs of life and stir with an uneasy, half-vital motion …*" and this gave her the idea of writing the novel *"Frankenstein or The Modern Prometheus*". Byron wrote *"A Fragment"* an unfinished horror story, which Polidori later developed in his novel, *"The Vampyre*" [87]. Byron, himself, was also greatly influenced by his surroundings when he wrote the apocalyptic poem *"Darkness"* [88].
The idea that Mary Shelley was influenced by the effects of the Tambora eruption is refuted in an article by Alan Marshall et al., entitled "*The Tambora – Frankenstein Myth:*

[85] ANON, 'The Prophecy', *Stamford Mercury*, 26 July 1816, 2; VAIL, Jeffrey, '"The Bright Sun Was Extinguish'd": The Bologna Prophecy and Byron's "Darkness"', 186.
[86] VAIL, Jeffrey, '"The Bright Sun Was Extinguish'd": The Bologna Prophecy and Byron's "Darkness"', 186.
[87] BUZWELL, Greg, 'Mary Shelley, Frankenstein and the Villa Diodati', British Library, Discovering Literature: Romantics & Victorians, 15 May 2014, https://www.bl.uk/romantics-and-victorians/articles/mary-shelley-frankenstein-and-the-villa-diodati#; SHELLEY, Mary Wollstonecraft, *Frankenstein, or, The Modern Prometheus*, revised and corrected by the author (London, Edinburgh, Dublin: Henry Colburn and Richard Bentley, Bell and Bradfute, and Cumming., 1831), x Introduction.
[88] VAIL, Jeffrey, '"The Bright Sun Was Extinguish'd": The Bologna Prophecy and Byron's "Darkness"', 189–91.

The Monster Inspired". The following brief extract from the article's abstract gives a flavour of the whole piece.

> The link between the volcanic eruption of Mount Tambora in 1815 and Mary Shelley's composition of Frankenstein has attained mythic status. The myth uses a scientific frame to promote the idea that the Tambora event led to Mary Shelley's invention of the Frankenstein story because the eruption so altered the climate of Europe (lowering the temperatures, creating rainy electrical storms…that Shelley dreamt up the idea for her monstrous horror tale as a result….[89]

Furthermore, it has been proposed that the spectacular sunsets painted by Turner and other famous artists, for example, Karl Friedrich Schinkel, Caspar David Friedrich and Theodore Gericault, were influenced by volcanic aerosols injected into the stratosphere by the Tambora eruption.[90] See Figs 5:5 and 5:6.

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[89] MARSHALL, Alan, et al., 'The Tambora – Frankenstein Myth: The Monster Inspired', *Humanities Bulletin* 2, no. 2 (11 2019): 217–35.

[90] ZEREFOS, C.S. et al., 'Atmospheric Effects of Volcanic Eruptions as Seen by Famous Artists and Depicted in Their Paintings', *Atmospheric Chemistry and Physics* 7 (2 August 2007): 4034–36.

Figure 5:5 Joseph Mallord William Turner: The Decline of the Carthaginian Empire Exhibited 1817

Figure 5:6 Caspar David Friedrich: Two Men by the Sea – Exhibited 1817

Wikipedia

Summary

We have seen that Tambora's eruption was one of the largest and arguably one of the most deadly in recorded history, killing between 90,000 to 117,000 people locally and possibly many more worldwide. It helped to change weather patterns globally, causing severe food shortages. Crop failures in Canada and New England caused much hardship and many livestock died through lack of feed during the winter of 1816–17. Harvests were ruined throughout northern Europe, causing famine in many places. Popular reaction led to demonstrations in grain markets and in front of bakeries, and in some places rioting and the destruction of property, especially that belonging to persons perceived by the rioters to be obnoxious to them.

Disease, especially typhus, was rife, and to escape to a better life many people attempted to emigrate to the United States, Georgia and other parts of Russia or South America.

Furthermore, we must consider the part that may have been played by the unidentified 1808 eruption and the effect that this had in contributing towards the climate cooling of the following decade.

On a brighter note, the visual effects produced by Tambora were particularly stunning, and the bad weather in Switzerland resulted in the creation of some world-famous literature. Frankenstein has never been out of print since its first publication on 1st January 1818.[91]

[91] WOLFSON, Susan and LEVAO, Ronald, 'Frankenstein, Born January 1, 1818, Still Alive', Harvard University Press, 1 January 2018, https://harvardpress.typepad.com/hup_publicity/.

5:2:3 Krakatau (Krakatoa), Indonesia, 26th - 27th August 1883

Figure 5:7 View of Krakatoa during the Earlier Stage of the Eruption

Parker and Coward. From a photograph taken on Sunday the 27th of May, 1883.Public domain.

Before the 1883 eruption, Krakatau was an unpopulated island lying in the Sunda Strait between Java and Sumatra. It was composed of three volcanoes – Perbuatan, the northernmost; Danan, in the middle; and Rakata, the largest, which formed the southern end of the island – and had remained dormant since its previous eruption in May 1680.[92] See Maps 5:5 & 5:6.

The worldwide importance of the Krakatau eruption stems from the following facts.

1. The news travelled extremely quickly around the world due to the existence of a functioning telegraph system. This had been active for some 40 years; Europe having been linked to both North America and India since the 1860's. News of the eruption spread quickly and accounts soon appeared in newspapers globally. Much of the world's mercantile shipping passed through the Sunda Straits and so it would have been important for the maritime community to keep up to date with ongoing events.

2. Owing to the fact that news of the eruption's effects had been broadcast universally, it enabled observers everywhere to connect events to the eruption. See the section regarding sunsets and other unusual phenomena later in this chapter.

Newspapers were quick to cash in on a good story and the following is a down-to-earth report from The Morning Post 30th August quoting telegrams received from Reuters:

[92] SIMKIN, Tom and FISKE, Richard S., *Krakatau 1883: The Volcanic Eruption and Its Effects* (Washington, D.C.: Smithsonian Institution Press, 1983), 286; SCHALLER, Nathalie et al., 'Climate Effects of the 1883 Krakatoa Eruption: Historical and Present Perspectives', *Vierteljahrsschrift Der Naturforschenden Gesellschaft in Zürich* 154, no. 1/2 (2009): 32; SYMONS, G. J., *The Eruption of Krakatoa and Subsequent Phenomena. Report of the Krakatoa Committee of the Royal Society* (Trübner, 1888), 10, https://ia601406.us.archive.org/6/items/eruptionkrakato00whipgoog/eruptionkrakato00whipgoog.pdf; FORBES, H. O., 'The Volcanic Eruption of Krakatau', *Proceedings of the Royal Geographical Society and Monthly Record of Geography* 6, no. 3 (March 1884): 144, https://doi.org/10.2307/1800671; HURLBUT, G. and VERBEEK, R. D. M., 'Krakatau', *Journal of the American Geographical Society of New York* 19 (1887): 233, https://doi.org/10.2307/196734.

Batavia, August 28, Noon.

All quiet. Sky clear. Communication with Serang restored. Telegraph inspector reports, whilst trying to repair the line at Anjer early on the morning of the 27th, saw a high column of sea approaching with roaring noise and fled inland. Knows nothing further of the fate of Anjer, but believes all lost …

Batavia 11 a.m.

Today Anjer, Tjeringin and Telokbetong destroyed.

11.30 a.m.

Eight houses, Sunda Straits disappeared.

Noon.

Where once Mount Kramatau (sic) stood the sea now plays.

12.30 p.m.

Aspect at Sunda Straits much changed. Navigation dangerous.

Intelligence from official sources announces that Anjer was completely destroyed by the tidal wave which followed the eruption of Krakatoa …[93]

Some newspapers, however, were rather more imaginative or should we say creative in their reporting, so-much-so in fact, that the following article borders on the farcical:

One of the most singular freaks of the eruption was the carrying in the midst of molten lava of a bed of solid ice of enormous size, which had been emitted from one of the craters. It was carried along by the current and landed on the extremity of Point St. Nicholas at the NE. corner of the island … It is supposed that this ice had formed the crust of some subterranean lake …[94]

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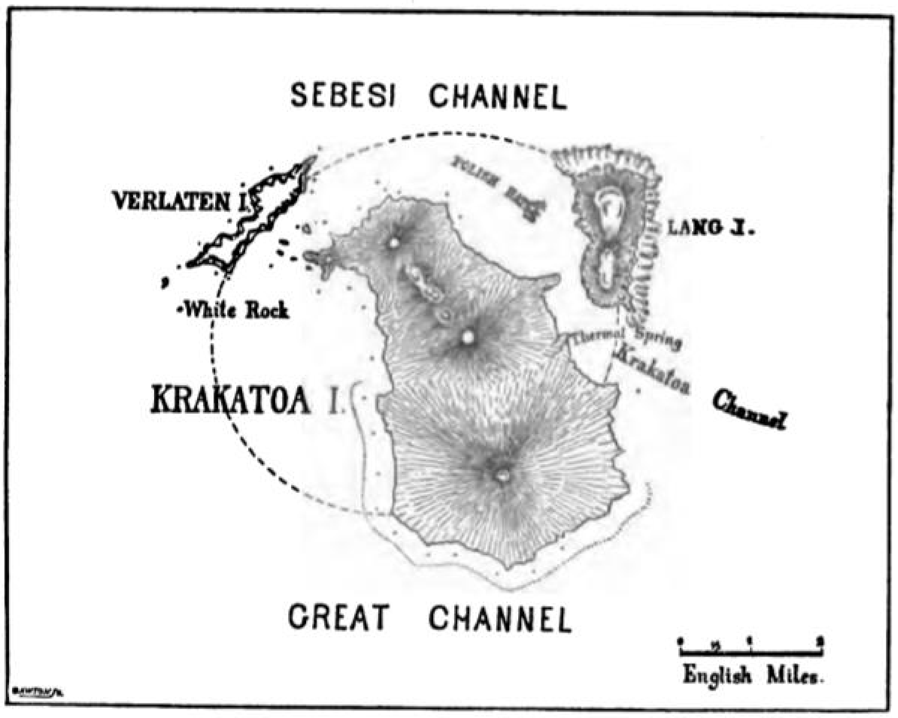
[93] ANON, 'The Eruption of Krakatoa', *Morning Post*, 30 August 1883, 5.

[94] ANON, 'A Cable Special to the New York Sun', *San Francisco Chronicle*, 30 August 1883, 3 Quoted in SIMKIN and FISKE pp. 160-162.

Map 5:5 The islands of the Krakatoa Group before the eruption (from the Admiralty chart). The nearly circular line ------- indicates approximately the submerged edge of the great crater



From Report of the Krakatoa Committee of the Royal Society, p.6.

On 20th May 1883, Perbuatan began to erupt. The Lloyds agent in Batavia reported: *"On Sunday morning last, from 6 to 10 o'clock, there was a tremendous eruption, with continual shaking and heavy rain of ashes. On Sunday evening and Monday morning it was continued."* The German warship Elisabeth, which was in the Sunda Straits at the time, had the best view of the eruption's start:

> On May 20 at 10:30 in the morning, a volcanic eruption was observed on the Island of Krakatau from the ship. At first we saw from the island a white cumulus cloud rising fast. It rose almost vertically until, after about half an hour, it had a height of about 11,000 m. (6.85mi).[95]

[95] SIMKIN, Tom and FISKE, Richard S., *Krakatau 1883: The Volcanic Eruption and Its Effects*, 28–45, 59, 61; ANON, 'Volcanic Eruption-Lloyds Agents at Batavia', *The Times*, 3 July 1883, 10; SCHALLER, Nathalie et al., 'NGZH', 52–53.

Eruptions continued spasmodically. By 11th August, three major vapour columns together with 11 steam vents were regularly erupting on the volcano, but this activity increased dramatically on Sunday the 26th August with a huge explosion at 1.06 pm and another at 5.20 pm. These were followed on 27th August by a series of four gigantic explosions which occurred at 5.30 am, 6.44 am, 8.20 am and 10.02 am local time. The fourth and greatest explosion – the loudest ever sound in recorded history – was heard some 3,600 km away in Alice Springs, South Australia, and 4,800 km away in Rodrigues Island, near Mauritius. The detonations were heard over $^{1}/_{12}$ of the earth's surface and the air waves created by the explosions travelled seven times round the world.[96] See Map 5:7. Initially, according to one theory, this may have been caused by the last eruption opening the walls of the volcano and allowing sea water to pour into the magma chamber, with the result that superheated steam destroyed most of the island. However, this explanation has been refuted by Self and Rampino, who propose:

> … that seawater in large quantities did not gain access to the vent during the most explosive stages of the eruption, but that seawater may have leaked slowly into the conduit area, sparking small phreatomagmatic explosions. Such explosions would have broken a cap of viscous magma and allowed sudden, explosive release of large batches of vesiculated magma from beneath the upper conduit system. Contemporary accounts indicate that the explosive activity subsided in the early hours of 27 August before the large explosions started. This may have allowed a partly solidified plug to develop in the vent, facilitating the above mechanism. The presence of juvenile obsidian clasts in the ignimbrite might indicate partly solidified magma in the vent.[97]

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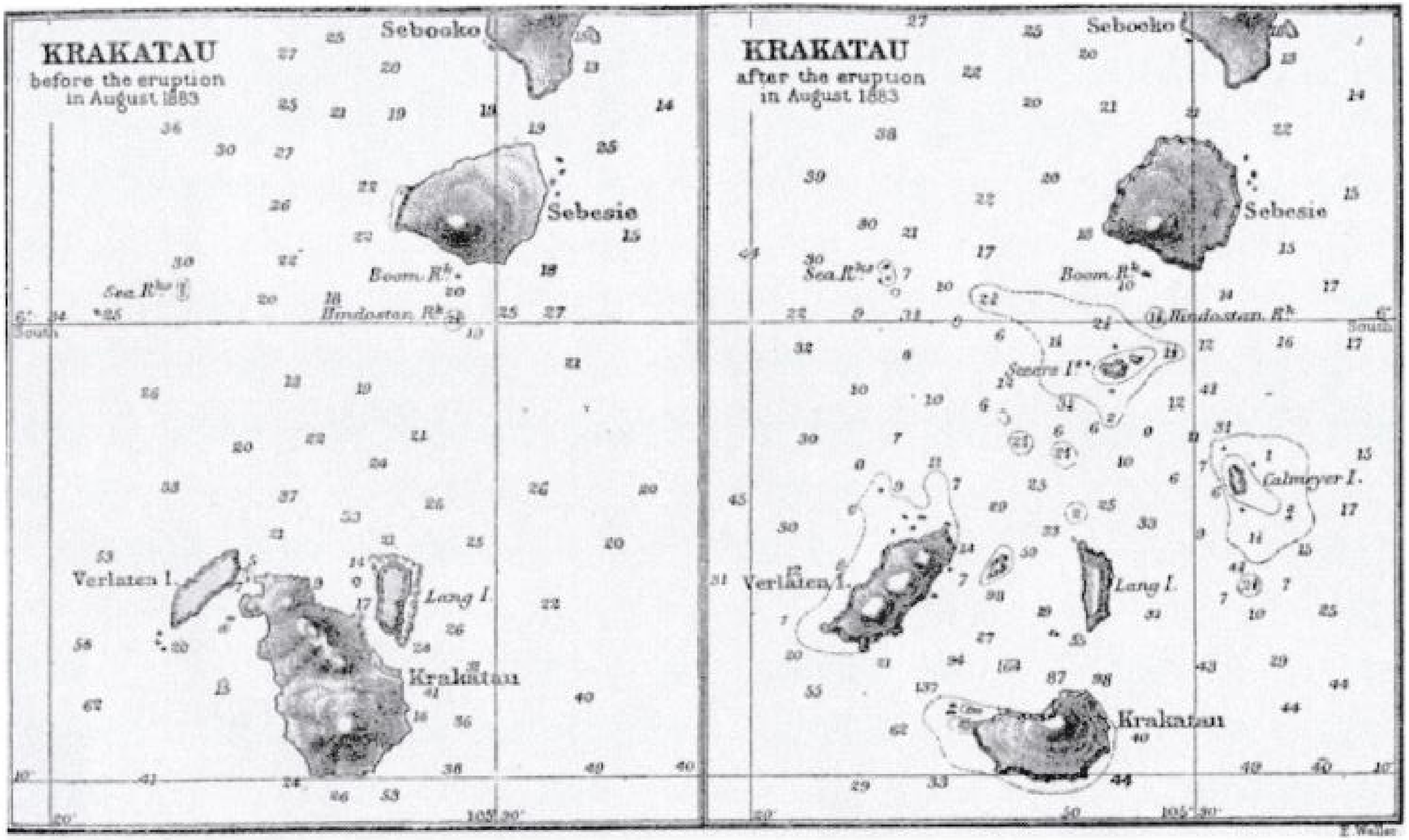
[96] SYMONS, G. J., *The Eruption of Krakatoa and Subsequent Phenomena. Report of the Krakatoa Committee of the Royal Society*, 79, 84, 87; SCHALLER, Nathalie et al., 'NGZH', 33; SIMKIN, Tom and FISKE, Richard S., *Krakatau 1883: The Volcanic Eruption and Its Effects*, 32 et seq.; AUSTRALIAN GOVERNMENT, BUREAU of METEOROLOGY, 'The Eruption of Krakatoa, August 27, 1883', Australian Government, Bureau of Meteorology, 2010, http://www.bom.gov.au/tsunami/history/1883.shtml.

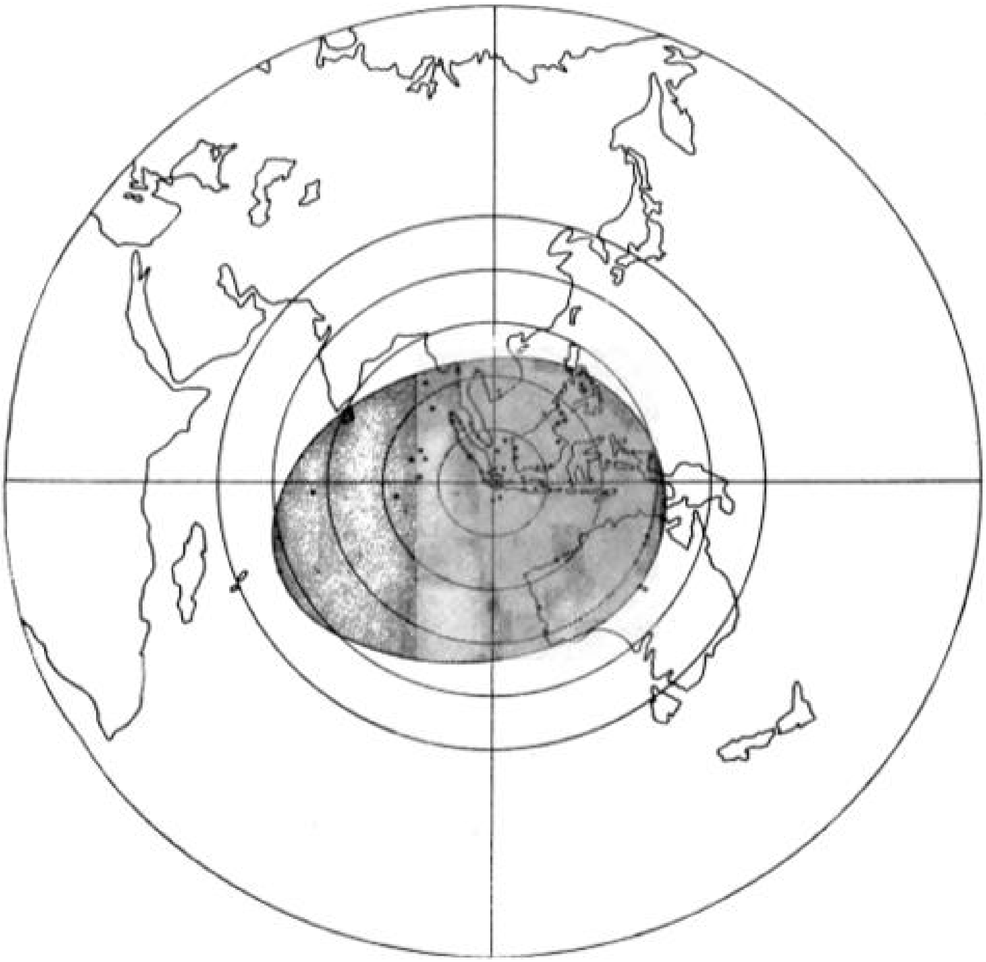
[97] SYMONS, G. J., *The Eruption of Krakatoa and Subsequent Phenomena. Report of the Krakatoa Committee of the Royal Society*, 22; SELF, Stephen and RAMPINO, Michael R., 'The 1883 Eruption of Krakatau', *Nature* 294 (24 December 1981): 702–3; AUSTRALIAN GOVERNMENT, BUREAU of METEOROLOGY, 'The Eruption of Krakatoa, August 27, 1883'.

Map 5:6 Krakatau before and after the eruption on 26th August 1883



Forbes: The Volcanic eruption of Krakatoa p. 143. ©Royal Geographical Society (with IBG)

Map 5:7 Showing the places at which the sounds of the explosions were heard on August 26th - 27th 1883 as indicated by the shaded portion



From Report of the Krakatoa Committee of the Royal Society, Plate XVI

No one is known to have been killed directly by the volcano, but over 36,000 – official reports put the death toll at 36,417 – people were drowned by the resultant tsunamis. In addition to this, around 1,000 people were killed by superheated volcanic ash which rushed over the surface of the ocean.[98] Small tsunamis began in the afternoon of 26th August after the first eruptions, causing little damage. However, at 7.30 pm the Chinese camp and quarry facilities at Merak in the north west of Java were washed away. A report from Anjer, 12 km to the south of Merak, said that the wave *"was only about 5 ft*

[98] AUSTRALIAN GOVERNMENT, BUREAU of METEOROLOGY, 'The Eruption of Krakatoa, August 27, 1883'.

high." At about 6.30 am on the following day, a large wave inundated much of the Java coast and almost destroyed Anjer;[99] at 7.30 am a huge wave appeared off the coast at Merak, and the following account which graphically describes the enormity of the event, was given by a survivor six weeks later:

> I was working a long way from the sea – four or five paalen [5-6 km] from the coast. A lot of other natives were with me in the *paddee* field…We had gone to work as usual, in spite of the volcano. We did not think it would hurt us. And all of a sudden there came a great noise. We looked round at once and saw a great black thing, a long way off, coming towards us. It was very high and strong, and we soon saw that it was water. Trees and houses were washed away as it came along. The people near began to cry out and run for their lives. Not far off was some steep sloping ground. We all ran towards it and tried to climb up and out of the way of the water. It was too quick for most of them, and many were drowned almost at my side. I managed to get a long way up, and then the water came very near to me. When I thought I was safe I looked back and saw the wave wash the people down one after the other as they tried to scramble out of its way. There was a general rush to climb up in one particular place. This caused a great block, and many of them got wedged together and could not move. Then they struggled and fought, screaming and crying out all the time. Those below tried to make those above them move on again by biting their heels. A great struggle took place for a few moments, but all was soon over. One after another they were washed down and carried far away by the rushing waters … Some of those who were washed off dragged others down with them. They would not let go their hold, nor could those above them release themselves from this death-grip. Many were high enough up to have altogether escaped if they had not thus been dragged down by their unfortunate companions.[100]

[99] SELF, Stephen and RAMPINO, Michael R., 'The 1883 Eruption of Krakatau', 703; SYMONS, G. J., *The Eruption of Krakatoa and Subsequent Phenomena. Report of the Krakatoa Committee of the Royal Society*, 90; SIMKIN, Tom and FISKE, Richard S., *Krakatau 1883: The Volcanic Eruption and Its Effects*, 33–37; SCHALLER, Nathalie et al., 'NGZH', 33.
[100] SIMKIN, Tom and FISKE, Richard S., *Krakatau 1883: The Volcanic Eruption and Its Effects*, 77.

The following is an account of the final and greatest of the Tsunami:

> An immense wave inundated the whole of the foreshores of Java and Sumatra, bordering the Strait of Sunda, and carried away the remaining portions of the towns of Tjiringin, Merak, and Telok Betong, as well as many other hamlets and villages near the shore at sometime after 10 o'clock.[101]

The tsunamis were even reported from thousands of kilometres away. At Port Elizabeth in South Africa, a wave measuring 26 inches high was recorded on the local tide gauge, having travelled more than 7,540 km in a little over 15 hours, at a speed of approximately 500 km per hour.[102]

The eruptions produced vast amounts of pumice which was first seen on 22nd May. On 9th July, RMS Quetta sailed 1,380 km through a continual field of pumice for 3 days. In places the pumice was so thick that ships were unable to sail through it. On 28th August, Captain T. H. Lindemann, on board the *Gouverneur Generaal Loudon* reported the pumice to be 7 or 8 ft thick. Pumice lasted a long time in the open ocean, with some being washed ashore in Durban, South Africa a year after the eruption and 8,170 km from Krakatau.[103]

On a more sober note, the following is an extract of a letter from a crew member of the ship Samoa, posted from St Helena on 25th October and reprinted in The Times:

> When we reached Anjer, what a sight met our eyes! Anjer all gone; not one living soul left; the land on both sides white as snow with ashes; trees all dead – a fearful sight! ... For two days after passing Anjer we passed through masses of dead bodies, hundreds and hundreds striking the ship

[101] SIMKIN, Tom and FISKE, Richard S., 39.
[102] SIMKIN, Tom and FISKE, Richard S., 44.
[103] SIMKIN, Tom and FISKE, Richard S., 28–51, 91, 149–53.

> on both sides – groups of 50 to 100 all packed together, most of them naked. … For ten days we went through fields of pumice stone.[104]

A huge amount of fine volcanic ash and sulphate aerosol was injected high into the stratosphere by Krakatau's eruption, where it was caught up by strong (>30 m/s) global winds known as the Krakatoa easterlies. Owing to its minute size, less than 50 µm in diameter, the finest ash was able to remain in the stratosphere for long periods of time, often for many months. The persistence of ash particles and sulphate aerosol at a height of up to 40 km in the atmosphere, produced spectacular sunsets and other optical phenomena around the world.[105] The following is graphic account of how the sunset appeared in Edinburgh on 30th November 1883:

> Yesterday afternoon, at sundown, a beautiful and impressive atmospheric phenomenon was witnessed in Edinburgh … Shortly after four o'clock the whole western horizon was suffused with a soft greenish glow; higher up some light fleecy clouds had a pinky hue, these, again, being dominated by a large diagonal mass of dark clouds, with lanes of silvery light running towards the south. By-and-bye a regular transformation scene occurred. The emerald light faded away, and anon in its place came a deep blood-red, which had drawn over it a thin black vaporous veil, through which it shone with a lurid glow. Then the crimson changed into a dark orange, and the vapour gathered into black patches of fantastic shape. Immediately over the luminous orange glow was a broad belt of bluish grey, while higher up, and spreading far to the south and north, the heavens were of a dull fiery red, as if a huge conflagration were raging below. This lurid, murky hue shaded gradually into grey, which was lost in the resplendent blue of the zenith, in which the stars were shining with great brilliancy.[106]

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104 ANON, 'The Recent Sunrises and Sunsets', *The Times*, 12 December 1883, 10.

105 RUSSELL, F. A. Rollo and ARCHIBALD, E. Douglas, 'On the Unusual Optical Phenomena of the Atmosphere, 1883-6, Including Twilight Effects, Coronal Appearances, Sky Haze, Coloured Suns, Moons, &c.', in *The Eruption of Krakatoa and Subsequent Phenomena. Report of the Krakatoa Committee of the Royal Society* (London: Trübner, 1888), 151–463, https://ia601406.us.archive.org/6/items/eruptionkrakato00whipgoog/eruptionkrakato00whipgoog.pdf; AUSTRALIAN GOVERNMENT, BUREAU of METEOROLOGY, 'The Eruption of Krakatoa, August 27, 1883'; SELF, Stephen and RAMPINO, Michael R., 'The 1883 Eruption of Krakatau', 703; SIMKIN, Tom and FISKE, Richard S., *Krakatau 1883: The Volcanic Eruption and Its Effects*, 154; SCHALLER, Nathalie et al., 'NGZH', 34.

106 ANON, 'Remarkable Atmospheric Phenomena', *The Scotsman*, 1 December 1883, 6.

Many instances were also noted where suns and moons appeared either blue or green. The following occurrence was recorded at Puliadierakam, Ceylon, between 9th to 12th September 1883:

> Sun rose splendidly green, turning to blue later. When at about 45° it is too dazzling to look at, but even at midday it is blue, like the moon. Turns green again at setting. Moon looks blue after sunset; and, in declining, gives a fiery light.[107]

And on 17th September the SS Superb reported from 12°12'N 146°7'W (the middle of the Pacific Ocean): "*Sun like a green ball when rising … moon also green.*"[108]

The Reverend S. E. Bishop made the following observation at Honolulu on 5th September, some 12 days after the eruption: *"… very peculiar corona or halo extending from 20° to 30° from the sun, which has been visible every day with us, and all day, of whitish haze with pinkish tint, shading off into lilac or purple against the blue."* This phenomenon has since been known as Bishop's ring and is characteristically seen after large volcanic eruptions.[109]

There has been much discussion of what the Krakatau eruption may have had on world climate. A recent study quoted by Rampino and Self, indicated a maximum reduction in temperature of around 0.25° C for the Northern Hemisphere for 2 to 3 years following the eruption.[110]

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[107] RUSSELL, F. A. Rollo and ARCHIBALD, E. Douglas, 'On the Unusual Optical Phenomena of the Atmosphere, 1883-6, Including Twilight Effects, Coronal Appearances, Sky Haze, Coloured Suns, Moons, &c.', 283.
[108] RUSSELL, F. A. Rollo and ARCHIBALD, E. Douglas, 286.
[109] RUSSELL, F. A. Rollo and ARCHIBALD, E. Douglas, 232; SIMKIN, Tom and FISKE, Richard S., *Krakatau 1883: The Volcanic Eruption and Its Effects*, 156, 405–7.
[110] RAMPINO, Michael R. and SELF, Stephen, 'Historic Eruptions of Tambora (1815), Krakatau (1883), and Agung (1963), Their Stratospheric Aerosols, and Climatic Impact', 132.

The Banten Rebellion or The Peasants' Revolt

As is often the case with religious movements, a charismatic leader, a religious fanatic, is able to build up a following of zealous adherents. It so happened that just such a religious mystic from Banten, the westernmost province in Java, called Hajji Abdul Karim, had by the 1870s, built up a huge following of fanatical disciples by his teachings of piety, orthodoxy and asceticism. However, his teachings changed, and by the time he left to go to Mecca in 1876 he predicted the coming of the Mahdi who would lead the people in a holy war against the infidel. The Mahdi's arrival would be accompanied by a series of signs: there would be diseases of cattle; floods; blood-coloured rain; volcanoes would erupt and people would die.[111] And that is exactly what happened. In 1879 there was a very severe cattle plague in which $^{2}/_{3}$ of the stock either died or had to be destroyed. The following year saw a fever epidemic in which more than 10% of the population perished.[112] And the occurrence of the Krakatau eruption followed by tsunamis, rain tinted brown by volcanic ash and a huge loss of life, prompted the mullahs to preach that these disasters were the revenge of Allah, not only against the unbelievers, but also against the local people who served them. Had all this not been prophesied by Abdul Karim?[113]

The eventual outcome of this religious fervour was the Banten Rebellion, or Peasants' Revolt in 1888. This was easily supressed by the Dutch authorities, but it was the precursor of an independence movement which only finally succeeded in 1949.

Artistic Responses

Krakatoa, like Tambora, has inspired artists and poets by its spectacular atmospheric effects. Frederick Edwin Church, Jules Adolphe Breton, see Fig. 5:8, and William Ascroft, who made more than 530 pastel sketches over three years from late 1883 to

[111] KARTODIRDJO, Sartono, *The Peasants' Revolt of Banten in 1888 : Its Conditions, Course and Sequel : A Case Study of Social Movements in Indonesia*, vol. 50, Verhandelingen van Het Koninklijk Instituut Voor Taal-, Land- En Volkenkunde ('s-Gravenhage, Netherlands: Martinus Nijhoff, 1966), 66–67, 166–67, https://rechercher.bu.univ-rennes2.fr/primo-explore/fulldisplay?docid=TN_oapen613377&context=PC&vid=33UDR2_VU1&lang=fr_FR&search_scope=default_scope&adaptor=primo_central_multiple_fe&tab=default_tab&query=any,contains,peasants%20renolt%20in%20banten%20in%201888&offset=0; WINCHESTER, Simon, *Krakatoa : The Day the World Exploded, 27 August 1883*, 1st Harper Perennial (New York: HarperCollins, 2005), 331–32.
[112] KARTODIRDJO, Sartono, *The Peasants' Revolt of Banten in 1888 : Its Conditions, Course and Sequel : A Case Study of Social Movements in Indonesia*, 50:66–67.
[113] WINCHESTER, Simon, *Krakatoa : The Day the World Exploded, 27 August 1883*, 332–33.

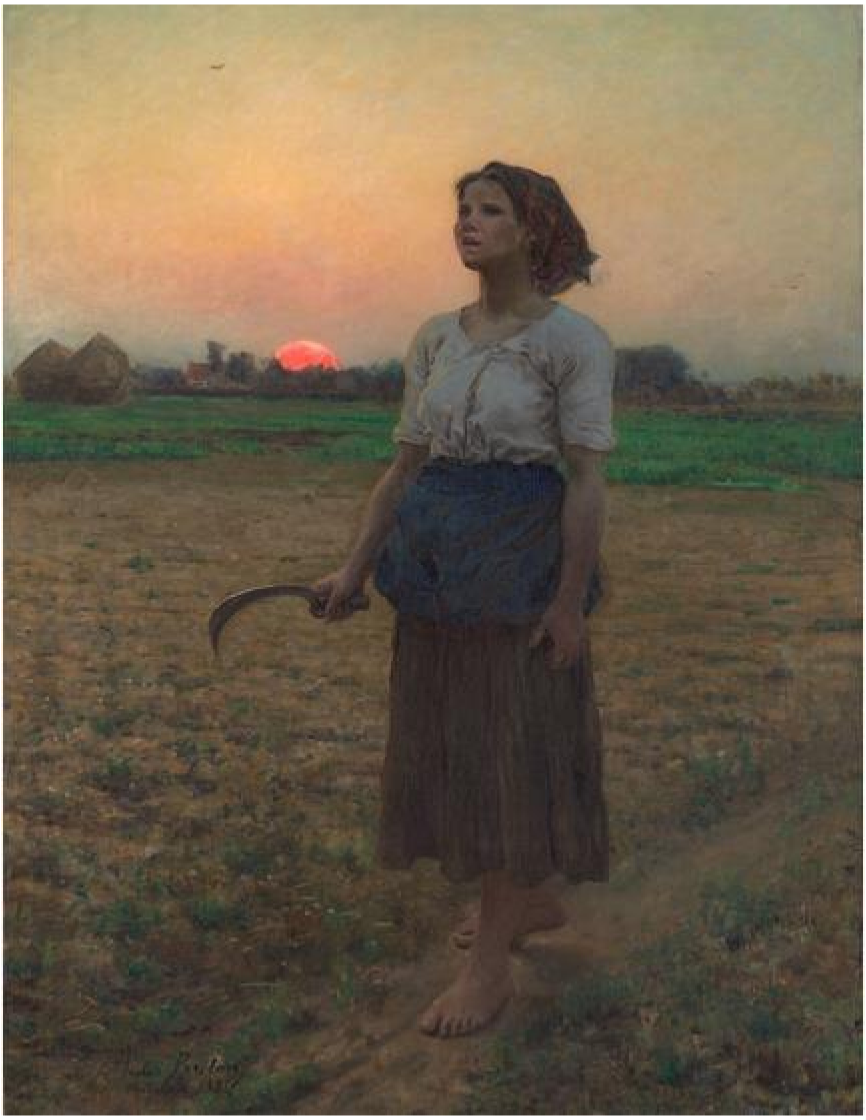
1886, from a window in his house in Chelsea. Fig. 5:9.[114] It is also said that the sunsets moved the poet, Alfred, Lord Tennyson, to write the following opening lines in his poem, St Telemachus:

Had the fierce ashes of some fiery peak,
Been hurled so high they ranged about the globe?
For day by day, thro' many a blood-red eye …
The wrathful sunset glared …[115]

The eruption has also inspired writers and film makers. The well-known children's author, R. M. Ballantyne, wrote a novel entitled, "*Blown to Bits or the Lonely Man of Rakata*" which is set in the Malay Archipelago. In Chapters 27 to 29 there is a long and reasonably realistic account of the tremendous eruptions which occurred in 1883.[116]

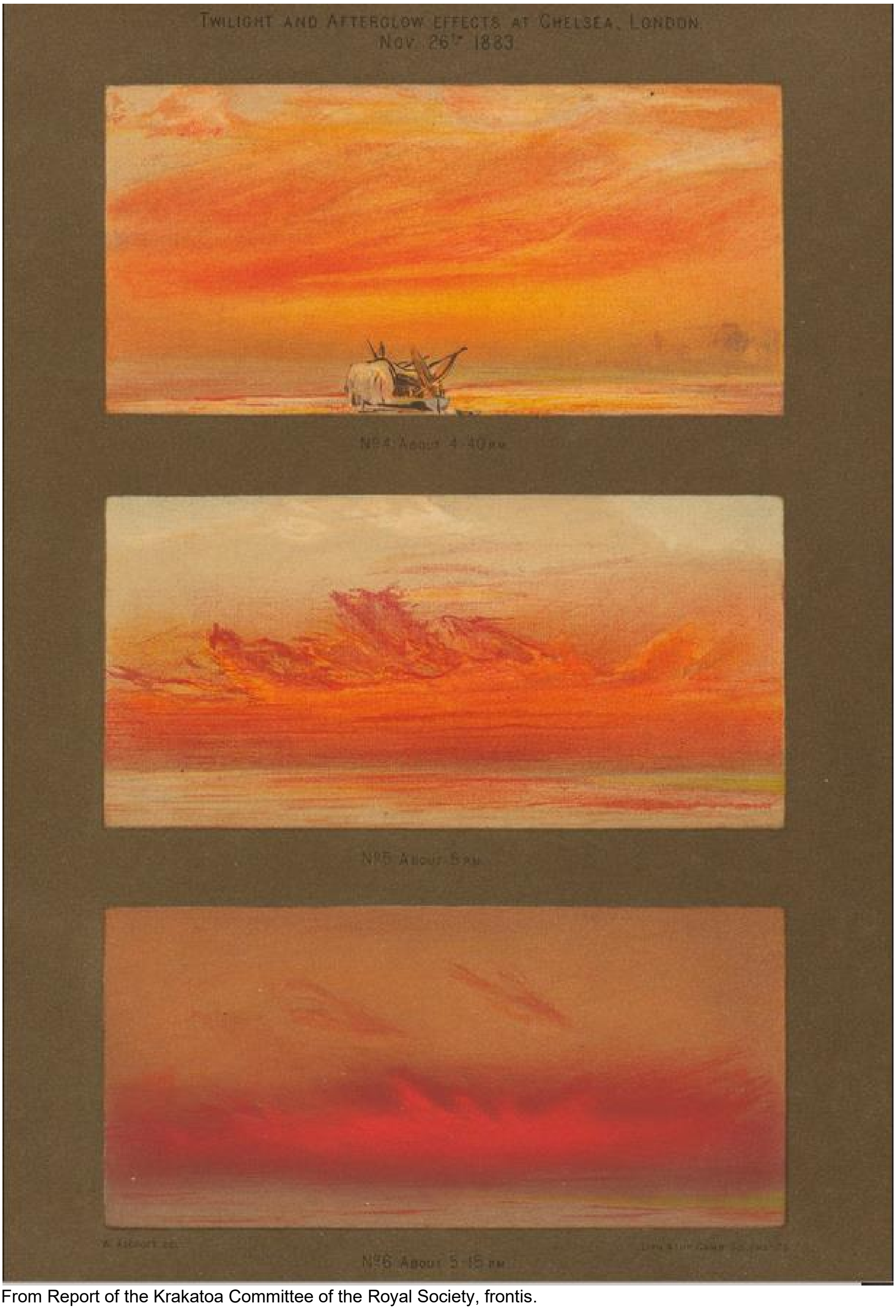
[114] ZEREFOS, C.S. et al., 'Atmospheric Effects of Volcanic Eruptions as Seen by Famous Artists and Depicted in Their Paintings', 4036.
[115] TENNYSON, Alfred, *The Death of Œnone : Akbar's Dream, and Other Poems* (London and New York: Macmillan, 1892), 15–22; SIMKIN, Tom and FISKE, Richard S., *Krakatau 1883: The Volcanic Eruption and Its Effects*, 395.
[116] BALLANTYNE, Robert Michael, *Blown to Bits, or, the Lonely Man of Rakata : A Tale of the Malay Archipelago* (London: James Nisbet, 1889).

Figure 5:8 Jules Adolphe Breton: The Song of the Lark 1884



Public Domain

Figure 5:9 Twilight and afterglow effects at Chelsea, London. Chromolithographs by William Ashcroft, November 1883



From Report of the Krakatoa Committee of the Royal Society, frontis.

In 1929, the Chinese writer, Kwee Tek Hoay, wrote novel in vernacular Malay called "*Drama dari Krakatau* (*Drama of Krakatoa*)", which was inspired by Edward Bulwer-Lytton's 1834 novel "*The Last Days of Pompeii"*, and the 1883 eruption of Krakatoa.[117] *"Fair Wind to Java"* is an adventure novel written by the American writer, Garland Roark. First published in 1948, it was later adapted into a film of the same name in 1953, directed by Joseph Kane, and starred Fred MacMurray and Vera Ralston. The film tells the story of an American sea captain who goes in search of a fortune in diamonds from a Dutch ship, which sank in the vicinity of a volcanic island in the Dutch East Indies. He has to contend with various mysteries, pirates, and finally an exploding volcano – based on the 1883 eruption of the island of Krakatoa.

"Krakatoa, East of Java" is a 1969 American disaster movie directed by Bernard L. Kowalski, starring Maximilian Schell, Diane Baker, and Brian Keith. The story is loosely based on events surrounding the 1883 eruption of Krakatoa, which is actually *west* of Java. The film follows an event-filled voyage of the steamer *Batavia Queen* from its home port of Anjer on the west coast of Java where the commander of the vessel, Captain Hanson, takes on board a motley set of passengers and cargo and at the last minute, 30 convicts and their jailer. Aided by a diving bell, a balloon and some Japanese pearl divers he hopes to discover the shipwreck of the *Ariana*, a steamer that sank perilously close to the volcano, and which was carrying a valuable cargo of pearls that he hopes to recover before the volcano erupts.

Apart from documentaries, two outstanding docudramas have been made about Krakatau, the first: "*Krakatoa: The Last Days"* (also issued in the US as, *"Krakatoa: Volcano of Destruction"*) is a BBC Television docudrama which was first broadcast on 7th May 2006. The program is based upon a selection of four eyewitness accounts of the 1883 eruption of Krakatoa, an active volcano between the islands of Java and Sumatra. The special effects convincingly portray ash clouds, collapse of a mountain, pyroclastic flows and a giant tsunami. There are also sub-plots concerning Rogier Verbeek, the Dutch geologist who was the first to write a detailed monograph on the

117 WIKIPEDIA, 'Drama Dari Krakatau', Wikipedia, 18 November 2018, https://en.wikipedia.org/wiki/Drama_dari_Krakatau.

eruption in 1885, a ship with over 100 passengers trying to ride out the giant tsunami, and a family attempting to escape the eruption.[118]

The second docudrama, "Krakatoa: The Great Volcanic Eruption", released in 2015, was written and directed by Jeremy Hall. It has a very similar story line to the BBC production and uses computer generated graphics and dramatic re-enactments drawn from the narratives of preserved journal entries to chronicle the eruption. The dramatic narrative is interspersed with input from modern day researchers and volcanologists, who give us some of the scientific background behind the eruption.[119]

There is a most extraordinary story connected with Krakatoa, which apparently, has entered local folklore. It involved a German quarry manager who recounted how he was swept off the roof of his three-storey office building at the summit of a 30 m high hill. He remembered being carried along on the crest of the wave, when to his right, he saw a giant crocodile being swept along beside him. With great presence of mind, he decided the only way to survive was to ride to safety on the crocodile, so he leapt on its back, and once safely aboard, dug his thumbs into the creature's eye sockets and was carried along for about 3km until he was dumped on the jungle floor when the wave broke on a distant hill. He then ran off to safety. Two other survival stories are worth recording. A man who was asleep at home, awoke to find that a giant wave had lifted him and his bed to the top of a hill and deposited him there quite safely. Another grabbed hold of a cow's body and used it to float to high ground.[120]

[118] MILLER, Sam, *Krakatoa: The Last Days (Also Titled Krakatoa: Volcano of Destruction in the U.S.)*, Docudrama (BBC, Discovery Channel, 2006), https://www.youtube.com/watch?v=9A9-9Z6r8eA///https://www.youtube.com/watch?v=sNfSftgBrdM.
[119] HALL, Jeremy, *Krakatoa: The Great Volcanic Eruption*, Docudrama (Naked Science, 2015), https://topdocumentaryfilms.com/krakatoa-great-volcanic-eruption/.
[120] MAYNARD, Roger, 'The Legacy of Krakatoa', The Independent, 24 August 2008, https://www.independent.co.uk/news/world/australasia/the-legacy-of-krakatoa-907230.html; WINCHESTER, Simon, 'Krakatoa: The First Modern Tsunami', BBC News, 8 January 2005, http://news.bbc.co.uk/2/hi/programmes/from_our_own_correspondent/4153109.stm; WINCHESTER, Simon, *Krakatoa : The Day the World Exploded, 27 August 1883*, 231.

Summary

The eruption of Krakatau was one of the largest, and most certainly the loudest, in recorded history, being heard 4,800 km (3,000 mi) away in Rodrigues Island, near Mauritius. The air waves created by the explosions travelled seven times round the world.

The eruption generated massive Tsunamis that washed away many villages and towns, and in so doing, killed well over 36,000 people. In places, hundreds of bodies were seen floating in the sea and amid the sheets of floating pumice, vast amounts of which had been ejected by the eruption and covered the sea for miles around. The RMS Quetta sailed 1,380 km (858 mi) through a continual field of pumice for 3 days, and in some places, it was so thick that ships could not sail through it.

Large quantities of sulphate aerosols and fine ash had been injected high into the stratosphere, where they were caught up by strong winds, the Krakatoa easterlies, and circled the globe, producing spectacular sunsets and other sensational phenomena. According to recent studies, the aerosols seem to have had little effect on world climate, only reducing the temperature in the Northern Hemisphere by 0.25° C for two to three years.

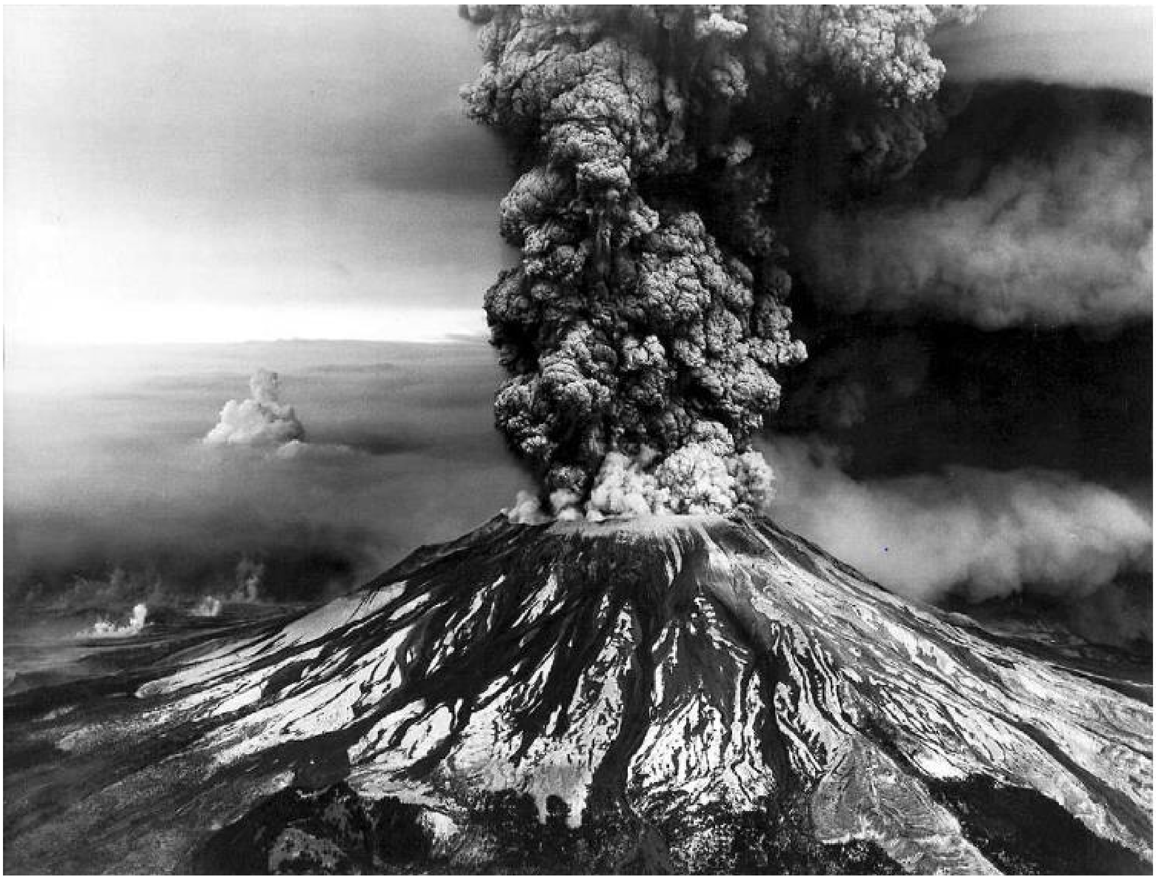
Due to the existence of a functioning telegraph system, news of the eruption spread quickly around the world, thereby alerting shipping that passed through the Sunda Straits of delays they might encounter. As news of the event had been broadcast worldwide, it enabled interested observers to connect atmospheric events to the eruption.

The eruption and its aftermath, together with two other unconnected calamities enabled a religious prophecy to be fulfilled, which eventually led to an unsuccessful revolt against the Dutch in 1888.

The eruption has proved inspirational to artists, authors and recently, film makers; it has even established its own place in local folklore.

5:2:4 Mount St. Helens, Washington, USA, 18th May 1980

Figure 5:10 Aerial photograph of the eruption of Mount St. Helens 18th May 1980



courtesy of the U.S. Geological Survey

The following paragraphs are an amended version of USGS Fact Sheet 036-00, courtesy US Geological Survey.

The first sign of activity at Mount St. Helens in the spring of 1980 was a series of small earthquakes that began on March 16. After hundreds of additional earthquakes, steam explosions blasted a crater through the ice cap on the volcano's summit. Within a week the crater had grown to about 1,300 feet (396 m) in diameter and two giant crack systems crossed the entire summit area. By May 17, more than 10,000 earthquakes had shaken the volcano and there was strong evidence that molten rock had risen high in the system to form a bulge of around 450 feet (137 m) on the volcano's north flank.

On the following day, May 18, a magnitude 5.1 earthquake struck at 8.32 am, and the volcano's bulge and summit slid away in the Earth's largest landslide in recorded history. This covered an area of 23 mi^2 (59.6 km^2), a total volume of 0.67 mi^3 (2.8 km^3) and had a velocity of 110 to 155 miles (177 to 250 km) per hour. In its turn, this depressurized the volcano's magma system triggering powerful explosions that tore through the sliding debris. Rocks, ash, volcanic gas and steam were blasted upwards and outwards to the north. Calculations have shown that the blast – that was heard hundreds of miles away in parts of British Columbia, Montana, Idaho, and northern California – had an initial velocity of about 220 miles (355 km) an hour which quickly increased to about 670 miles (1,080 km) an hour and then slowed down as the rocks and ash fell to earth and spread away from the volcano. The blast devastated an area of about 230 square miles (596 km^2) in a fan-shaped sector north of the volcano. Some people on its western edge were able to escape the rapidly advancing cloud by driving at 65 to 100 miles (105 to 160 km) per hour! The blast cloud travelled 19 miles (30 km) northwards, and the landslide travelled some 14 miles (6.5 km) west down the North Fork Toutle River.

The lateral blast produced an eruption column that rose up more than 15 miles (24 km) into the atmosphere in only 15 minutes. Less than an hour later, a second eruption column formed as magma erupted explosively from the new crater. Then, just after noon, swift avalanches of hot ash, pumice and gas (pyroclastic flow) poured out of the crater at 50 to 80 miles (80 to 130 km) an hour and spread 5 miles (8 km) north. Based on the eruption rate of these pyroclastic flows, it's estimated that the eruption reached its peak between 3:00 and 5:00 pm. Over the course of the day, prevailing winds blew 520 million tonnes of ash eastward across the United States and caused complete darkness in Spokane, Washington, 250 miles (402 km) from the volcano.

During the first few minutes of this eruption, parts of the blast cloud surged over the newly formed crater rim and down the south, east, and west sides of the volcano. The hot rocks and gas quickly melted some of the snow and ice capping the volcano, creating surges of water that eroded and mixed with loose rock debris to form volcanic mudflows (lahars). Several lahars poured down the volcano into river valleys, ripping trees from their roots and destroying roads and bridges.

The largest and most destructive lahar was formed by water seeping from inside the huge landslide deposit through most of the day. This sustained flow of water eroded material from both the landslide deposit and channel of the North Fork Toutle River. The lahar increased in size as it travelled downstream, destroying bridges and homes and eventually flowing into the Cowlitz River at around midnight. It then moved into the Columbia at about 4 am the following day where it raised the river bed above the minimum ship channel depth, trapping ocean-going vessels for 13 days.[121] See Map 5:8.

Although this was a VEI 5 eruption, surprisingly, only 57 people lost their lives directly, either through lateral blast, ashfall, or lahars. There were four indirect deaths caused by a crop duster hitting powerlines during the ashfall, a traffic accident during poor visibility, and two heart attacks from shovelling ash.[122] However the toll on wildlife was devastating; an estimated 7,000 big game animals – deer, elk, cougars, mountain goats and bear – were killed, as were all birds and many small mammals, and many tens of thousands of acres of prime forest were destroyed or badly damaged.[123]

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[121] JANDA, R. J. et al., 'Lahar Movement, Effects, and Deposits', in *The 1980 Eruptions of Mount St. Helens, Washington*, Geological Survey Professional Paper 1250 (Washington, D.C.: US Geological Survey, 1982), 462, https://pubs.usgs.gov/pp/1250/report.pdf; BRANTLEY, Steven R. and MYERS, Bobbie, 'Mount St. Helens -- From the 1980 Eruption to 2000, Fact Sheet 036-00', U.S. Geological Survey, 2005, http://pubs.usgs.gov/fs/2000/fs036-00/; MAYNARD, J. B., 'Cascade Range Lahars (Volcanic Debris Flows)', www.sedimentaryores.net/, 2010, http://www.sedimentaryores.net/Cascades/MtStHelens/Cascade%20Range%20Lahars.pdf; TILLING, Robert I., TOPINKA, Lyn, and SWANSON, Donald A., 'Eruptions of Mount St. Helens: Past, Present, and Future', U.S. Geological Survey Special Interest Publication, USGS Unnumbered Series (Washington, D.C.: U.S. Geological Survey, 19 March 2002), 8,13, https://pubs.usgs.gov/gip/msh/title.html.

[122] OREGON STATE UNIVERSITY, 'What Were the Effects on People When Mt St Helens Erupted?', accessed 26 February 2019, http://volcano.oregonstate.edu/what-were-effects-people-when-mt-st-helens-erupted; WIKIPEDIA, '1980 Eruption of Mount St. Helens'.

[123] WIKIPEDIA, '1980 Eruption of Mount St. Helens'; UNITED STATES DEPARTMENT OF AGRICULTURE, 'Mount St. Helens - Frequently Asked Questions', U.S. Forest Service: Pacific Northwest Research Station, accessed 27 February 2019, https://www.fs.usda.gov/pnw/page/mount-st-helens-frequently-asked-questions; TILLING, Robert I., TOPINKA, Lyn, and SWANSON, Donald A., 'Eruptions of Mount St. Helens: Past, Present, and Future', 13.

Social responses

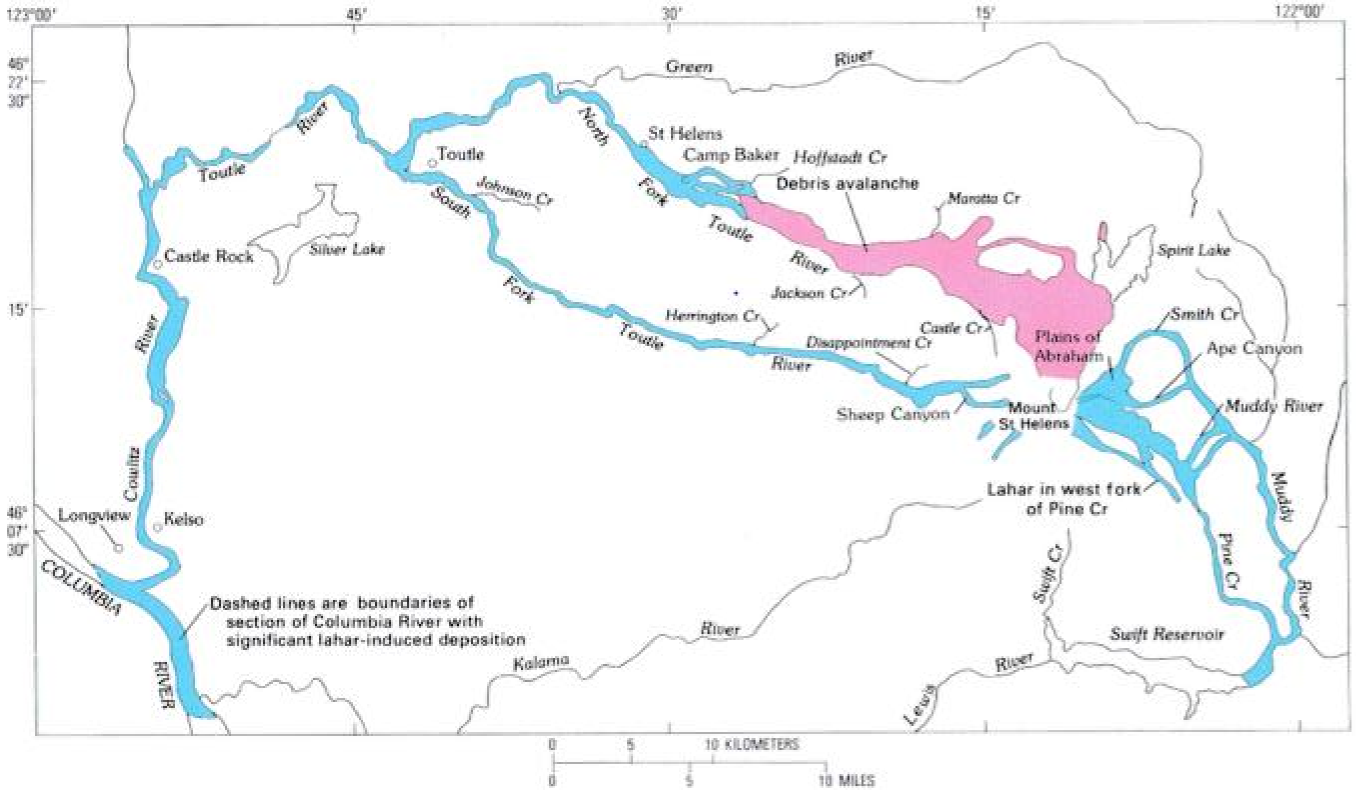
A small percentage of residents left the region because they had lost their jobs owing to the eruption. Several months later, a few people living near the eruption reported suffering from stress, troubled sleep and various emotional problems, even though they had coped successfully during the crisis. The counties in the region requested funding for mental health programmes to assist such people.[124]

The tourist industry, which is important to the Washington economy, was nearly dealt a crippling blow because of the eruption. Tourism not only went down in the Mount St. Helens-Gifford Pinchot National Forest area, but other cities and resorts in Washington and Oregon were also affected, even though they were untouched by the eruption. Fortunately, the setback was only temporary, and the area has once again become popular with tourists, so much so that several tourist centres have been set up.[125]

Although the Mount St. Helens eruption of 1980 was very explosive, it only injected an estimated 1±0.3Mt (10^9 kg) sulphur into the atmosphere.[126] It had, therefore, very little effect, if any, on global weather systems.

[124] TILLING, Robert I., TOPINKA, Lyn, and SWANSON, Donald A., 'Eruptions of Mount St. Helens: Past, Present, and Future', 13; OREGON STATE UNIVERSITY, 'What Were the Effects on People When Mt St Helens Erupted?'
[125] TILLING, Robert I., TOPINKA, Lyn, and SWANSON, Donald A., 'Eruptions of Mount St. Helens: Past, Present, and Future', 13.
[126] GERLACH, T. M. and McGEE, K. A., 'Total Sulfur Dioxide Emissions and Pre-Eruption Vapor-Saturated Magma at Mount St. Helens, 1980-88', *Geophysical Research Letters* 21, no. 25 (15 December 1994): 2833, https://doi.org/10.1029/94GL02761.

Map 5:8 Location map showing streams draining flanks of Mount St. Helens and areas impacted by lahars (shaded)



Map Courtesy US Geological Survey, Professional Paper 1250, pp. 461-478 After R. J. Janda et al., 1981

Artistic responses

Mount St Helens has inspired so many artists of varying degrees of competence that it would be invidious to choose any examples, but the interested reader can find a large selection on the internet. The written word is also catered for both in poetry and prose: https://www.terrain.org/2013/poetry/mount-st-helens/ whilst the song called "Harry Truman Your Spirit Lives On", was written by R. W. Stone as a tribute to an "old timer" who refused to leave his lodge at Spirit Lake, and died when it was completely covered by an avalanche of mud and snow.[127] There are, of course, many photographs of the eruption, some of the best being taken by the US Geological Survey and National Geographic photographers.

5:2:5 Eyjafjallajökull, Iceland 14th April – 22nd May 2010

Early in the morning of 14th April, the Eyjafjallajökull volcano which lay beneath the Eyjafjallajökull glacier started to erupt. By seven in the morning, the eruption, which took place along a 2 km long rift in the main crater of the volcano, had entered its explosive phase and melted its way through the 250m thick glacier ice cap, thus allowing the eruption to spew ash into the air.[128] Very little lava was produced, but huge quantities of gas and glass-rich ash were ejected into the atmosphere. Melting of the glacier ice cap released large amounts of water which led to flooding in southern Iceland. University of Iceland researchers estimated that there was around 1 km^3 of ice in the summit crater and that about 25 per cent of this was melted in the first two days of the eruption.[129]

By 10:30 in the morning the ash plume had risen to an altitude of 22,000 feet (6.7 km). The ash cloud from the eruption covered farmland south of the glacier, the worst affected being a strip of land some 10km wide and 50km long. This caused significant

[127] GRISHAM, Lori, '"I'm Going to Stay Right Here." Lives Lost in Mount St. Helens Eruption', USA Today, 19 May 2015, https://eu.usatoday.com/story/news/nation-now/2015/05/17/mount-st-helens-people-stayed/27311467/.
[128] JENKINS, Susanna, 'Observations of the Eyjafjallajökull Eruption', Cambridge Architectural Research, May 2010, 2–3, http://www.carltd.com/sites/carwebsite/files/Observations%20of%20the%20Eyjafjallajokull%20Eruption.pdf.
[129] ICELAND MAGAZINE STAFF, 'Seven Years Ago Today: Eruption in Eyjafjallajökull, the Volcano with the Un-Pronouncable Name', Iceland Magazine, 20 March 2017, https://icelandmag.is/article/seven-years-ago-today-eruption-eyjafjallajokull-volcano-un-pronouncable-name; WIKIPEDIA, '2010 Eruptions of Eyjafjallajökull', Wikipedia, 30 June 2017, https://en.wikipedia.org/wiki/2010_eruptions_of_Eyjafjallaj%C3%B6kull#Health_effects; BRITISH GEOLOGICAL SURVEY, 'Eyjafjallajökull Eruption, Iceland | April/May 2010', British Geological Survey, 2010, https://www.bgs.ac.uk/research/volcanoes/icelandic_ash.html.

disruption and hardship to farmers in the area, affecting around 200 farms. The maximum depth of ash on these farms was a few centimetres. See Fig. 5:11. However, its effects on air traffic in Europe were even greater.[130]

Figure 5:11 Vegetation beginning to push through ash fall deposits in Seljavellir, approximately 10km southeast of the volcano, May 2010

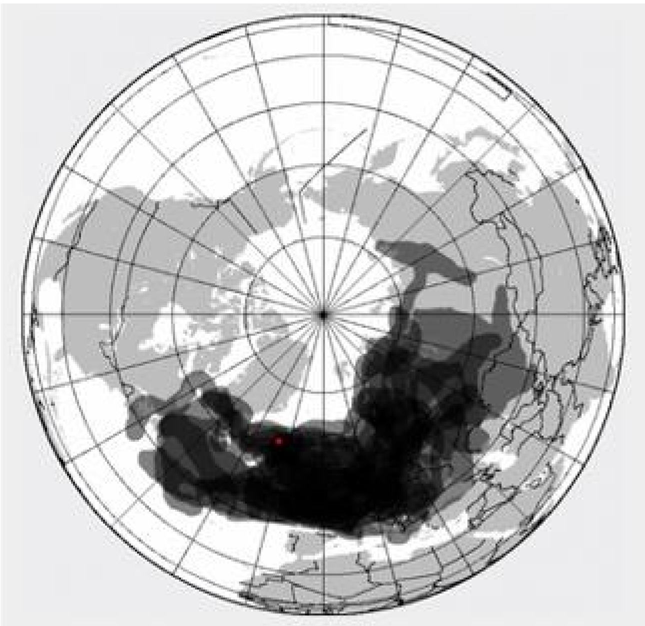
Photo courtesy Susanna Jenkins

It is estimated that around 250 million m^3 (330 million yd^3) of tephra and ash was ejected by the eruption. The gas and ash plume rose to 9 km (5.6 miles) and was carried by winds in a south-easterly direction across Europe, causing delays to air traffic in many countries, especially in Northern and Western Europe.[131] See Map 5:9.

[130] JENKINS, Susanna, 'Observations of the Eyjafjallajökull Eruption', 4; ICELAND MAGAZINE STAFF, 'Seven Years Ago Today: Eruption in Eyjafjallajökull, the Volcano with the Un-Pronouncable Name'.
[131] ICELAND MAGAZINE STAFF, 'Seven Years Ago Today: Eruption in Eyjafjallajökull, the Volcano with the Un-Pronouncable Name'.

Owing to concerns that aircraft engines would be damaged by ash from the Eyjafjallajökull eruption,10 countries closed their airspace to IFR (instrument flight rules) commercial jet traffic between the 14th and 15th April.[132] A total of 34 countries in all, closed their airspace to commercial air traffic at one time or another up until the 17th May, causing delays and cancelled flights which affected as many as 10 million travellers. This was the largest disruption to air traffic since the Second World War.[133] We can appreciate the near total lockdown from Map 5:10.

Map 5:9 A composite map of the volcanic ash cloud from the Eyjafjallajökull eruption covering 14th to 25th April 2010

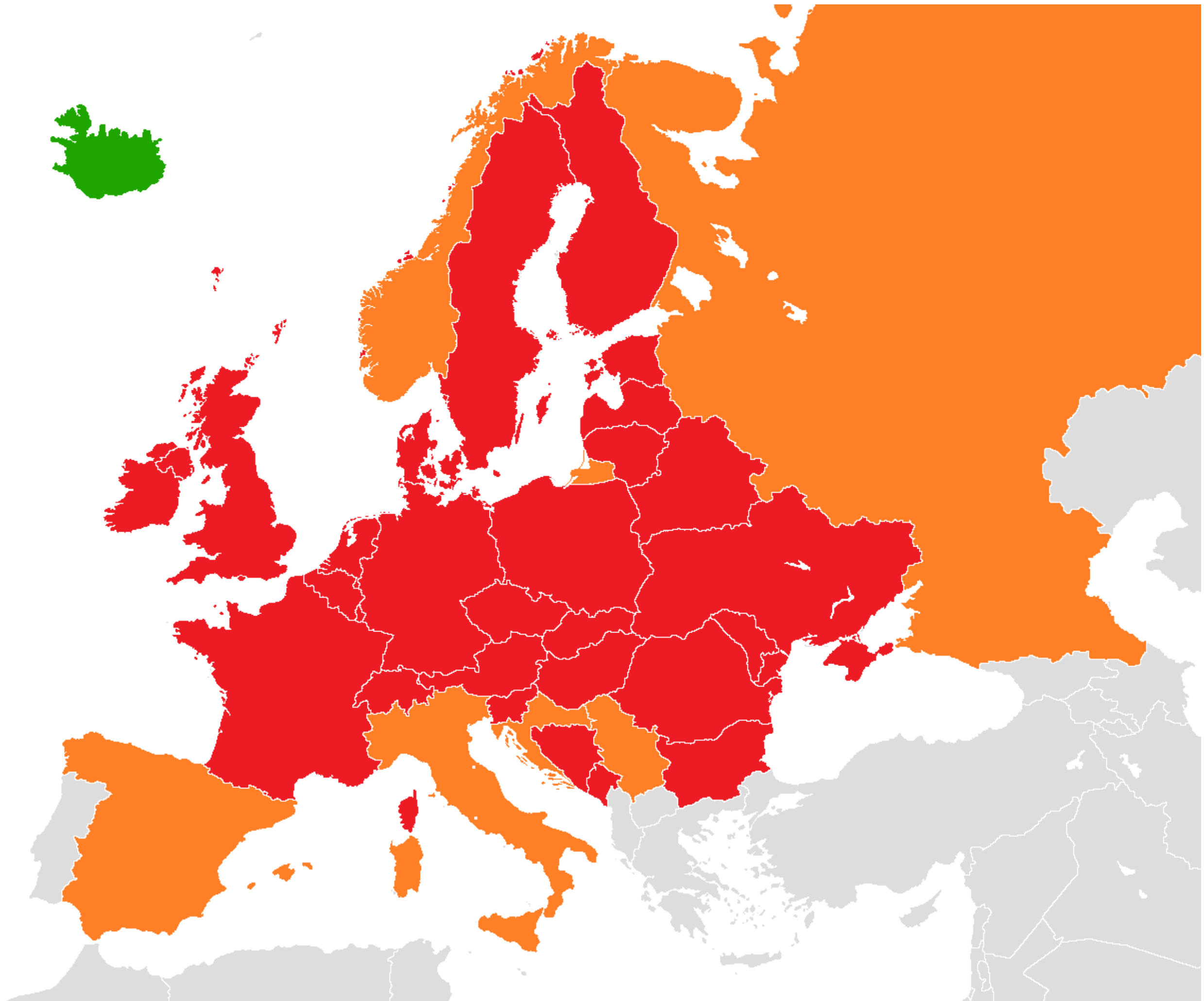


Wikipedia, Cogiati, Creative Commons

[132] BRITISH GEOLOGICAL SURVEY, 'Eyjafjallajökull Eruption, Iceland | April/May 2010'; GILL, Victoria, 'Iceland Volcano: Why a Cloud of Ash Has Grounded Flights', BBC News, 15 April 2010, http://news.bbc.co.uk/2/hi/science/nature/8621992.stm; WIKIPEDIA, '2010 Eruptions of Eyjafjallajökull'.

[133] ICELAND MAGAZINE STAFF, 'Seven Years Ago Today: Eruption in Eyjafjallajökull, the Volcano with the Un-Pronouncable Name'; WIKIPEDIA, 'Air Travel Disruption after the 2010 Eyjafjallajökull Eruption', Wikipedia, 16 March 2019, https://en.wikipedia.org/wiki/Air_travel_disruption_after_the_2010_Eyjafjallaj%C3%B6kull_eruption.

Map 5:10 Airspace completely (red) or partially (orange) closed to IFR traffic on 18th April 2010



DeltaFalcon, Originally authored by Jluisrs. Public Domain

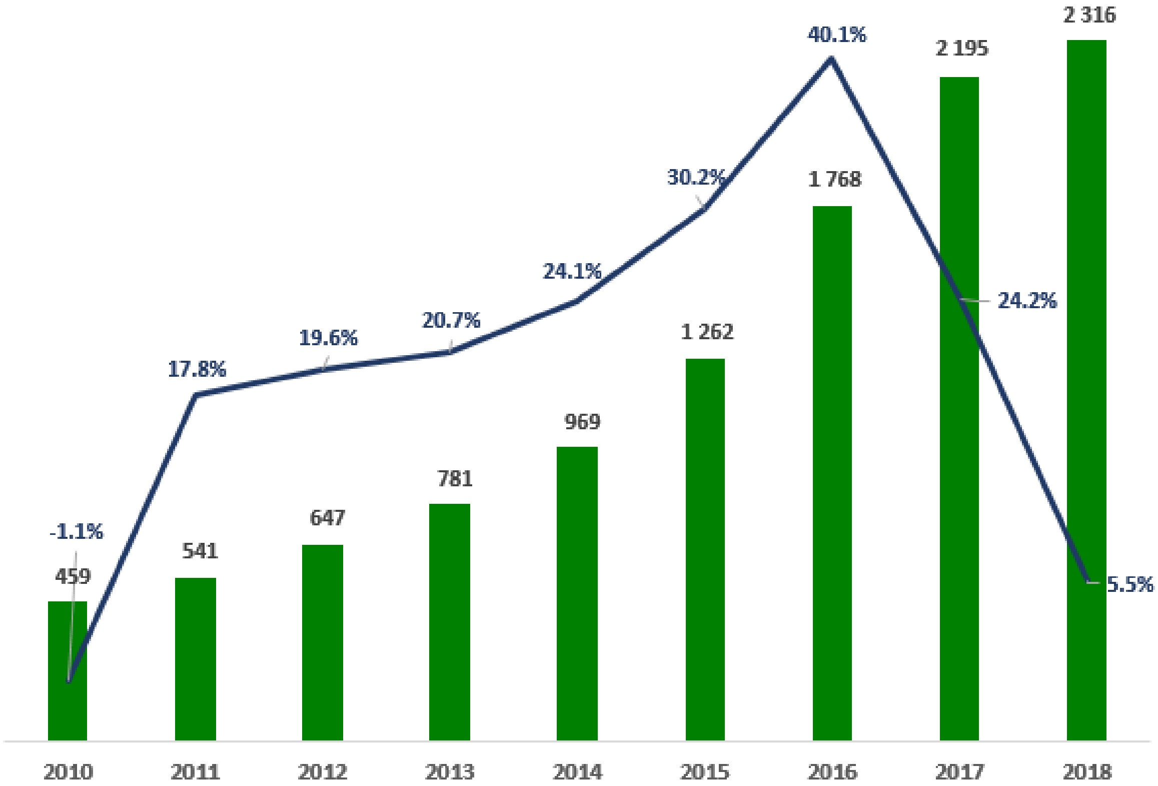
Social responses

After the eruption, many people in Iceland feared that its impact on air travel would cause the tourist industry to collapse. The government, with much perspicacity, funded an advertising campaign called, "*Inspired by Iceland*", to encourage people to visit the country. It was not realised at the time, but the eruption itself was an advertiser’s dream – free global advertising – as the media spread the news around the world of the eruption of a volcano with an unpronounceable name, that halted all air traffic in Europe.[134]

The result was that the number of foreign travellers visiting Iceland grew by 17.8% in 2011 compared to 2010 and by January 2019, the annual number of foreign visitors had risen to 2,316,000, an increase of 1,857,000. Fig. 5:12.

Figure 5:12 Changes in number of annual visitors to Iceland from 2010 to 2018

Visitors per year in thousands, green - % change from previous year, blue



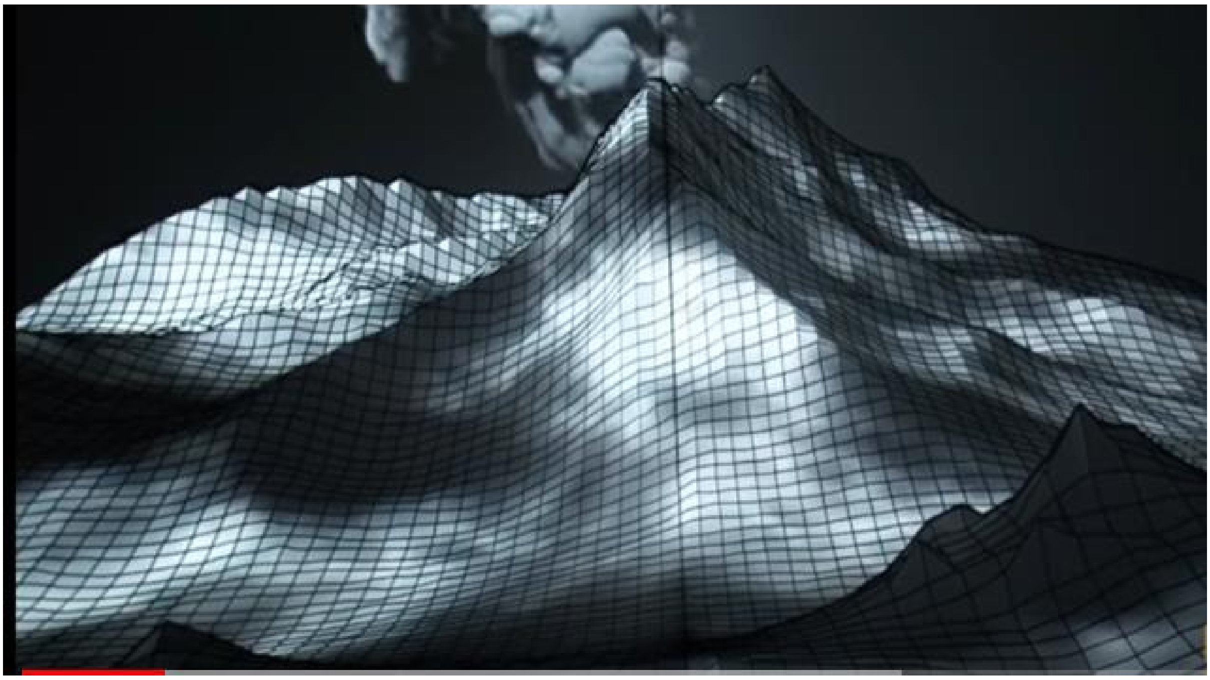
After Icelandic Tourist Board

134 ICELAND MAGAZINE STAFF, 'Seven Years Ago Today: Eruption in Eyjafjallajökull, the Volcano with the Un-Pronouncable Name'.

Artistic responses

The Eyjafjallajokull eruption inspired artists to produce some interesting work, perhaps the most unusual being the audiovisual installation by Joanie Lemercier–AntiVJ, entitled "*Eyjafjallajokull*", which won the Prix Cube 2013 International Digital Prize for Emerging Artists. '"*Eyjafjallajokull*" *is an audiovisual incarnation of mapping. Using subtle lighting effects projected on a wall directly painted by the artist, a wireframe landscape slowly emerges, making play with optical illusions that disrupt our perceptions of space'*.[135]

Figure 5:13 Screenshot from the Eyjafjallajokull audiovisual



With kind permission Joanie Lemercier

Street art is another form of artistic expression that has been used to great effect in creating a mural on one end of the Eyjafjallajokull Visitor Centre. This shows the ash and dust plume of the erupting volcano, superimposed with the name of the volcano and the word eruption, in Icelandic. Fig. 5:14 below.

[135] PRICE CUBE, 'Joanie Lemercier - Antivj (France): EYJAFJALLAJOKULL (Audiovisual Installation, 2010)', Prix Cube, 2016, http://prixcube.com/en/folio/joanie-lemercier/.

Figure 5:14 Photo of Eyjafjallajokull Visitor Centre, Hvolsvollu

Photo courtesy of TripAdvisor

Whilst the effects of dust and ash were catastrophic for air travel, the fallout produced some extremely beautiful atmospheric effects which photographers were not slow to capture. Fig. 5:15 below.

Figure 5:15 Volcanic lavender sky, Ilkley Moor, Yorkshire evening of 16th April 2010 Caused by the eruption of Eyjafjallajökull

Photograph by T. J. Blackwell. Creative Commons

5:2:6 Fogs in London and The Great Smog, 5th – 9th December 1952

London lies in the Thames basin and because of its situation has always been prone to mist. Ever since the 13th century, London has suffered from air pollution of one sort or another. This was caused mainly by the burning of sea coal for industrial purposes of which lime burning was the predominant culprit.[136] The problem had become so bad by 1285, that the following document was issued:

[136] BRIMBLECOMBE, P., 'Industrial Air Pollution in Thirteenth-Century Britain', *Weather* 30, no. 12 (December 1975): 388–96, https://doi.org/10.1002/j.1477-8696.1975.tb05276.x; BRIMBLECOMBE, Peter, 'Attitudes and Responses Towards Air Pollutionin Medieval England', *Journal of the Air Pollution Control Association* 26, no. 10 (October 1976): 941–45, https://doi.org/10.1080/00022470.1976.10470341.

> 20 May 1285
>
> Commission to Roger de Northwode, John de Cobbehain and Henry de Galleys to enquire touching certain lime kilns constructed in the city and suburbs of London and Southwerk of which it is complained that where as formerly the lime used to be burnt with wood it is now burnt with sea coal, whereby the air is infected and corrupted to the peril of those frequenting and dwelling in those parts. In executing this commission they are to associate themselves with the mayor and sherrifs of, London and the baliffs of Southwerk.[137]

This commission and later ordinances seem to have had little effect. Edward I issued a royal proclamation in 1307 prohibiting the use of sea coal in kilns owing to complaints from nobles and others of a high rank visiting the city:

> … as the King learns from the complaint of prelates and magnates of his realm, who frequently come to London for the benefit of the commonwealth by his order, and from the complaint of his citizens and all his people dwelling there and in Southwark that the workmen in the city and town aforesaid and in their confines now burn them [kilns] and construct them of sea-coal instead of brushwood and charcoal, from the use of which sea-coal an intolerable smell diffuses itself throughout the neighboring places and the air is greatly infected, to the annoyance of the magnates, citizens and others there dwelling and to the injury of their bodily health.[138]

Despite these prohibitions, sea coal continued to be imported into London, and by 1587 Elizabeth I was *"hersealfe greately greved and anoyed with the taste and smoke of the sea cooles"* used in brew houses nearest to the Palace of Westminster. Needless to

[137] BRIMBLECOMBE, P., 'Industrial Air Pollution in Thirteenth-Century Britain', 392 quoting Cal. Pat. Rolls 13 Ed I m18d.
[138] TE BRAKE, William H., 'Air Pollution and Fuel Crises in Preindustrial London, 1250-1650', *Technology and Culture* 16, no. 3 (July 1975): 340, http://www.theurbanclimatologist.com/uploads/4/4/2/5/44250401/tebrake1975medievalairpollution.pdf.

say, the brewers agreed to burn wood in future.[139] As we saw in chapter 3, John Evelyn in "*Fumifugium*" complained bitterly about the smoky atmosphere in London and thought that: … *"almost one half of them who perish in London, dye of Phthisical and Pulmonic distempers; That the Inhabitants are never free from Coughs and importunate Rheumatisms* …"[140] Indeed, by the mid-17th century, countless factories and workshops and tens of thousands of domestic fires used huge quantities of fuel which could only be satisfied by burning sea coal. Air pollution had become the norm for Londoners.[141]

By the 19th century, London was renowned for its thick yellowish, greenish, or brown fog, which earned the soubriquet, pea soup fog, pea-souper or London particular. The colour was caused by air pollution that contained sulphur dioxide and particles of soot given off by the many thousands of domestic and industrial fires burning soft coal. That some of the population at least, were aware of the deadly effects produced by fog such as this, was expressed in the following gravestone inscription: *"L. R./Who died of suffocation in the great fog of London/1814"*.[142]

The fogs worsened throughout the century. The Royal Smithfield Club cattle show which was held in December 1873 coincided with one of the worst fogs in living memory. According to one commentator, it was: *"one of the thickest and most persistent of this century so far,"* The fog which lasted for around a week until 14th December, caused untold suffering and overwhelming losses to livestock.[143] The animals began to be distressed by the atmospheric conditions on the first day of the show, and "*exhibited symptoms as if they had been inhaling a noxious gas*," and by

[139] LEMON, Robert, *Calendar of State Papers, Domestic Series, Edward VI., Mary, Elizabeth, 1547-1580* (London: Longman, Brown, Green, Longmans, & Roberts, 1856), 612, https://babel.hathitrust.org/cgi/pt?id=hvd.32044106490212;view=1up;seq=634; BRIMBLECOMBE, Peter, 'Japca J Air Waste Ma', 943.
[140] EVELYN, John, *Fumifugium or the Inconvenience of the Aer and Smoak of London Dissipated. Together with Some Remedies Humbly Proposed by J.E. Esq; to His Sacred Majestie and Parliament Now Assembled* (London: Printed by W. Godbid for Gabriel Bedel, and Thomas Collins, 1661), 13.
[141] TE BRAKE, William H., 'Technol Cult', 342.
[142] CORTON, Christine L., *London Fog : The Biography* (Cambridge, Massachusetts: The Belknap Press of Harvard University Press, 2015), 11.
[143] RUSSELL, Rollo, *London Fogs* (London: Edward Stanford, 1880), 22; CORTON, Christine L., *London Fog : The Biography*, 77.

the end of the show, many had had to be slaughtered.[144] *The Daily News* was under no apprehension as to the cause of the animals' suffering: "*That the sole ailment is suffocation is proved by an examination of the animals that have died or been slaughtered, their lungs being found gorged with black blood*."[145] The same newspaper also reported several fatalities of people falling in canals and missing persons believed to have come to the same fate, but their bodies remained to be discovered, owing to the fact that visibility was down to practically zero.[146]

Rollo Russell had this to say about the dangers of fog upon the population:

> The evil effects of smoke upon health may be roughly classed as follows: Actual suffocation of healthy persons; aggravation of lung diseases, bronchitis, and nervous disorders; prostration of convalescents and others from want of fresh air; effects similar to those produced more conspicuously by dust in grinding mills, factories of textile fabrics, etc., by the constant presence of small solid particles in the air, weakening the system and shortening life …[147]

According to the Meteorological Office, the number of London fogs had been declining since 1890. This they put down to more rigorous enforcement of the 1891 Public Health Act, which laid down regulations regarding the nuisance caused by black smoke discharged from factory chimneys;[148] the spread of gas which was replacing coal for cooking on kitchen ranges; the use of gas for domestic heating, and electric motors were gradually replacing coal powered steam engines in small industrial operations.[149]

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144 RUSSELL, Rollo, *London Fogs*, 22; HARTWIG, Georg, *The Aerial World : A Popular Account of the Phenomena and Life of the Atmosphere* (London: Longmans, Green and Co, 1874), 139.
145 ANON, 'Serious Effects of the Fog', *The Daily News*, 11 December 1873, 2, https://search.findmypast.co.uk/bna/ViewArticle?id=BL%2F0000051%2F18731211%2F003%2F0001&browse=true.
146 ANON, 2.
147 RUSSELL, Rollo, *London Fogs*, 30–31 Quoted in CORTON p. 81.
148 HOLDSWORTH, W. A., *The Public Health (London) Act 1891 (54 & 55 Vict. c. 76): With an Introduction, Notes, and an Index*. (London: George Routledge and Sons, 1891), https://archive.org/details/publichealthlond00greaiala/page/n3.
149 CORTON, Christine L., *London Fog : The Biography*, 204–5.

However, London still had its fair share of thick fogs, but had to wait until 1952 to experience the most infamous in living memory – the Great Smog – which lasted from 5th to 9th December and brought the city to a standstill for four days. This was due to a combination of high pressure, bitterly cold temperatures and light winds that failed to dissipate the fog. The virtual absence of wind produced a temperature inversion, with a layer of warm air overlying the cold air at ground level. This acted like a lid and prevented the smog from dispersing, thus trapping the smoke and other air pollutants, particularly in central London. The fog has been called the "*Killer Fog*" or "*Killer Smog*" for good reason; during the week ending 13th December 1952, the number of excess deaths in Greater London – that is the number of deaths exceeding those of the previous year – was between 4,000 to 4,500.[150] See Figure 5:16. The mortality rates did not return to normal until the end of March 1953. It is estimated that there were between 12,000 to over 13,500 more deaths than usual due to the fog. According to Dr Robert Waller who was working at St Bartholomew's Hospital in the capital in the early 1950s, "*no one really noticed that more people were dying*". The first indications that there was anything amiss was a shortage of coffins and high sales of flowers.[151]

> During the smog, both smoke and sulphur dioxide levels reached exceptional concentrations. The previous December, the mean smoke concentration across twelve sites for which data was available was between 0.12 and 0.44 milligrammes per cubic metre (mg/m^3). In 1952, the wind speed dropped on the afternoon of Thursday 4 December and patches of fog had begun to appear by 6pm. Air pollution measurements were taken by the London County Council at its headquarters, County Hall in Lambeth.

[150] MET OFFICE, 'The Great Smog of 1952', Met Office, accessed 11 March 2019, https://www.metoffice.gov.uk/weather/learn-about/weather/case-studies/great-smog; GLC, *50 Years on. The Struggle for Air Quality in London since the Great Smog of December 1952* (London: Greater London Authority, 2002), 3–9, https://web.archive.org/web/20110719204051/http://legacy.london.gov.uk/mayor/environment/air_quality/docs/50_years_on.pdf; BELL, Michelle L., DAVIS, Devra L., and FLETCHER, Tony, 'A Retrospective Assessment of Mortality from the London Smog Episode of 1952: The Role of Influenza and Pollution', *Environmental Health Perspectives* 112, no. 1 (January 2004): 6, http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1241789/.

[151] ANON, 'Historic Smog Death Toll Rises', BBC News: World Edition, 5 December 2002, http://news.bbc.co.uk/2/hi/health/2545747.stm#top; BELL, Michelle L., DAVIS, Devra L., and FLETCHER, Tony, 'A Retrospective Assessment of Mortality from the London Smog Episode of 1952: The Role of Influenza and Pollution', 6–8.

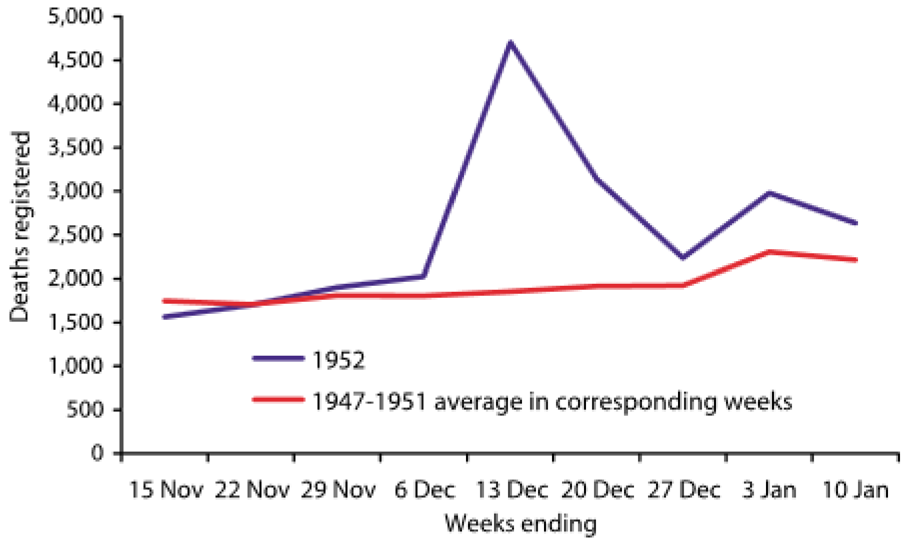
By noon the next day, smoke concentrations at County Hall had risen from 0.49 mg/m^3 to 2.46 mg/m^3. They continued to rise to 4.46 mg/m^3 on both 7 and 8 December. Sulphur dioxide (SO2) followed a similar pattern with concentrations rising from 0.41 mg/m^3 on 4 December to 2.15 mg/m^3 on the 5th and to 3.83 mg/m^3 on both the 7 and 8 December. The concentrations of both smoke and SO2 dropped sharply to 1.22 mg/m^3 and 1.35 mg/m^3 respectively as wind speeds rose and the smog cleared on Tuesday 9 December.

This rise and fall is illustrated in Figure 5:17, which also shows the average concentrations in December 1951.The peak concentration was the highest recorded at County Hall since measurements began in 1932. An indication of the generally high smoke concentration is given by comparing December 1951 with the average concentration in December 2001, which was just 2.4 per cent!

Sunday 7 December was probably the worst day, and there were few areas of Greater London that were not blanketed with a dense smog. On 8 December, a light wind cleared some areas, including Westminster but not the East End, Kent, or Essex, but the smog returned that night. On 9 December, however, a south westerly wind finally cleared the smog from all areas.[152]

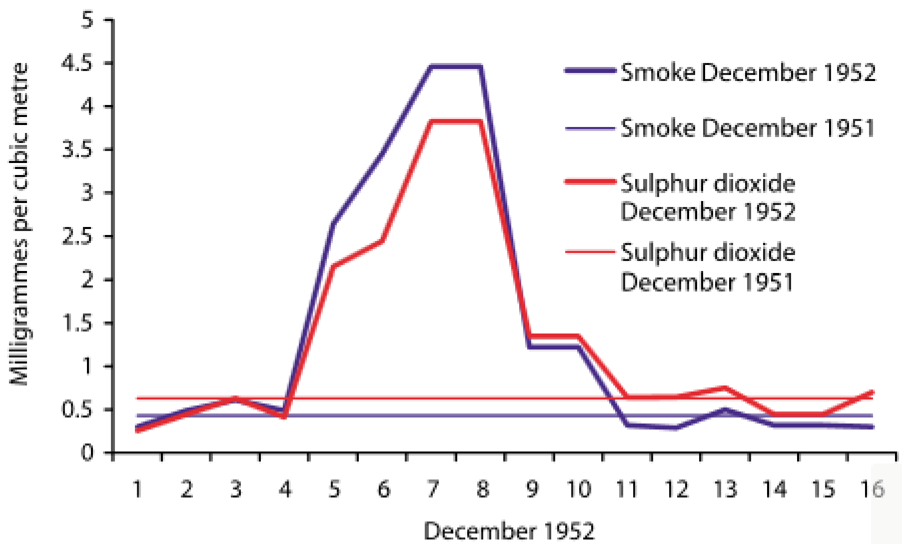
[152] GLC, *50 Years on. The Struggle for Air Quality in London since the Great Smog of December 1952*, 5–7.

Figure 5:16 Deaths registered during the London smog of December 1952



Courtesy Greater London Authority. *"50 Years on"* p. 7

Figure 5:17 Smoke and sulphur dioxide concentrations at County Hall during the London smog of December 1952 compared to the average concentrations in December 1951



Courtesy Greater London Authority. *"50 Years on"*, p. 6

The smog was caused in no small part by the extra consumption of poor-quality coal called "*nutty slack*" – a mixture of small lumps of coal (nuts) mixed with coal dust (slack). The fumes emitted from the chimneys were a mixture of soot, sulphur dioxide and nitrogen oxides which quickly formed into a thick yellowish fog.[153] As with the 1873 smog, the first casualties were the animals at the annual Smithfield show. Several newspapers carried the same news: [154]

> Beasts Die at Show from Fog. Eleven beasts at the Smithfield Show and machinery exhibition at Earls Court, London, have died or been slaughtered through being affected by fog. Penicillin and whisky-soaked respirators to filter the fog have produced a remarkable improvement in the condition of other affected animals.[155]

On 8th December, "*The Times*" reported that "*The fog belt, which still showed no sign of clearing last night, extended for about 20 miles from the centre of London in all directions. The Automobile Association said that the fog in London was as bad as had ever been known …"*[156]

British Railways Western Region had laid on a special fog service in the London area. Road traffic was virtually at a standstill. In the centre of London visibility had been reduced to 5 yards (4.5m). See Figure 5:18. The Automobile Association advised people to leave their cars at home until the fog cleared. London transport announced that all bus and trolley bus services had been suspended in the central area, but a few had been maintained in the outer areas. The visibility at London airport was down to

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153 TRIVEDI, Chirag, 'The Great Smog of London', BBC News: World Edition, 5 December 2002, http://news.bbc.co.uk/2/hi/uk_news/england/2545759.stm; DAVIS, Devra L., BELL, Michelle L., and FLETCHER, Tony, 'A Look Back at the London Smog of 1952 and the Half Century Since', *Environmental Health Perspectives* 110, no. 12 (December 2002): A734-735, https://doi.org/10.1289/ehp.110-a734; WITZE, Alexandra and KANIPE, Jeff, *Island on Fire*, 1st ed. (London: Profile Books, 2014), 180; CORTON, Christine L., *London Fog : The Biography*, 280.
154 TRIVEDI, Chirag, 'The Great Smog of London'.
155 ANON, 'Beasts Die at Show from Fog', *Coventry Evening Telegraph*, 8 December 1952, 16, https://search.findmypast.co.uk/bna/viewarticle?id=bl%2f0000769%2f19521208%2f191.
156 ANON, 'Transport Dislocated by Three Days of Fog', *The Times*, 8 December 1952, Late London edition, 8, http://gdc.galegroup.com/gdc/artemis/NewspapersDetailsPage/NewspapersDetailsWindow?disableHighlighting=false&displayGroupName=DVI-Newspapers&docIndex=&source=&prodId=&mode=view&limiter=&display-query=TX+power+cuts+AND+PU+%22The+Times%22+AND+IU+52490+AND+DA+119521209&contentModules=&action=e&sortBy=&windowstate=normal&currPage=1&dviSelectedPage=&scanId=&query=&navigationOption=issue&search_within_results=&p=TTDA&catId=&u=bright&displayGroups=&documentId=GALE%7CCS16994184&activityType=BrowseByDate&failOverType=&commentary=.

100 yards (91m) or less, whilst at Northolt in Essex it was only 22 yards (20m), leading to the cancellation of many flights. Traffic on the River Thames was also at a standstill, and Port of London police wearing Mae West life jackets patrolled the docks because at least eight people had walked off the quays and into the water. A policeman said, *"We fear that when the fog clears we shall find bodies floating in the water."* A fire engine had to be guided to a fire by an escort of firemen on foot. [157]

As could be expected, the weather severely affected sport with every first-class soccer match in the capital being postponed on Saturday (6th December).[158] Other entertainments also suffered. A performance of La Traviata had to be cancelled at the Sadler's Wells opera after the first act as the theatre was full of fog. The manager told the audience that it would be unfair to continue, and that tickets would be refunded[159]

However, there was a section of the community who used the fog to their own advantage, viz.,

> Smash-and-grab raiders took advantage of the fog in London last night. Shop windows in all parts of London were found smashed. In most recent cases the shops were lock-up premises. The fog was so dense that most police patrol cars were immobilised, and the police answered 999 calls by going on foot.[160]

[157] ANON, 8; ANON, 'Abandoned Cars', *Dundee Courier and Advertiser*, 8 December 1952, 2nd edition, 2, https://search.findmypast.co.uk/bna/viewarticle?id=bl%2f0000564%2f19521208%2f017; ANON, 'Cinemas Half Empty', *Daily Herald*, 8 December 1952, 1–2, https://search.findmypast.co.uk/bna/ViewArticle?id=BL%2F0000681%2F19521208%2F019%2F0001&browse=true; DAILY MIRROR REPORTERS, 'Patrols in Life-Jackets', *Daily Mirror*, 8 December 1952, 1, https://search.findmypast.co.uk/bna/viewarticle?id=bl%2f0000560%2f19521208%2f001.
[158] ANON, 'A "Pea-Souper" to Remember', *Dundee Courier and Advertiser*, 8 December 1952, 2nd edition, 3, https://search.findmypast.co.uk/bna/viewarticle?id=bl%2f0000564%2f19521208%2f017.
[159] ANON, 'Opera Discontinued', *The Times*, 9 December 1952, Late London Edition edition, 8, http://gdc.galegroup.com/gdc/artemis/NewspapersDetailsPage/NewspapersDetailsWindow?disableHighlighting=false&displayGroupName=DVI-Newspapers&docIndex=&source=&prodId=&mode=view&limiter=&display-query=&contentModules=&action=e&sortBy=&windowstate=normal&currPage=1&scanId=&query=&navigationOption=issue&search_within_results=&p=TTDA&catId=&u=bright&displayGroups=&documentId=GALE%7CCS16994185&activityType=BrowseByDate&failOverType=&commentary=; CORTON, Christine L., *London Fog : The Biography*, 280; GLC, *50 Years on. The Struggle for Air Quality in London since the Great Smog of December 1952*, 3.
[160] ANON, 'Smash-and-Grab Men Busy in Fog', *Evening Express*, 8 December 1952, Late Final edition, 12, https://search.findmypast.co.uk/bna/viewarticle?id=bl%2f0000445%2f19521208%2f120.

The Western Mail printed the following under the rather alarming headline: "*Bandits and Burglars Strike Under Cover of Fog*", and then went on to describe some of the robberies of which this is but one example: "*Three burglaries at Kingston House, a block of luxury flats at Princes' Gate, S.W., were believed to have been committed on Saturday night by the same man. The burglar climbed drainpipes to the flats.*"[161]

Figure 5:18 No 15 bus in London Smog

Photo ActiveHistory.ca- Creative Commons

There were, of course, many recollections of the fog and its effects. The following by Barbara Fewster, a 24-year-old dancer, is typical of many:

> It was the worst fog that I'd ever encountered. It had a yellow tinge and a strong, strong smell strongly of sulphur, because it was really pollution from coal fires that had built up. Even in daylight, it was a ghastly yellow colour

[161] ANON, 'Bandits and Burglars Strike Under Cover of Fog', *Western Mail*, 8 December 1952, Fourth Edition edition, 1, https://search.findmypast.co.uk/search/british-newspapers?date=1952-12-08&date_offsetdate=1952-12-08&keywords=fog&page=4&_=1552297347774.

… I'd gone out with my fiancé for dinner … At the end of the evening we drove off towards Kingston upon Thames … when the smog hit us like a wall. It was absolutely solid … It was a terrifying journey. The only thing to do was for me to walk in front of the car. My fiancé hung out of the window while I walked - in evening clothes, in evening shoes - in front to guide him … We eventually got to Kingston at five in the morning, absolutely black as sweeps ... I was wearing a woolly yellow scarf and that too was pitch black with soot and muck. Our faces were black, our noses were black and everything was filthy.[162]

The poor quality of air that people were breathing in is shown by the following extract in Stephen Kelly's book of 1950s reminiscences, "*You've never had it so good*!" The following is a quote by Chris Prior a London schoolboy, who used to walk to school in the smog:

My mum made me a smog mask, which was layers of muslin and cotton wool, and you tied it over your ears and you'd walk to school. As soon as you got to school, they took you inside and closed the doors quickly, and when you took the mask off it was all brown inside, like marmite. You'd have a fresh one to come home with.[163]

Artistic responses

However unhealthy and unpleasant, London fog has long been an inspiration for many artists, perhaps the most famous being Monet, Turner and James McNeill Whistler. Monet took refuge in London during the Franco-Prussian war, 1870-1871, and returned to France when it was safe to do so. He returned some 30 years later for three prolonged stays and painted many scenes of the River Thames of which Figure 5:19 is, perhaps, the most famous. It was painted from a terrace on the second floor of St

[162] FEWSTER, Barbara, 'Days of Toxic Darkness', BBC News: World Edition, 5 December 2002, http://news.bbc.co.uk/2/hi/uk_news/2542315.stm.
[163] KELLY, Stephen F., *You've Never Had It so Good!: Recollections of Life in the 1950s* (Stroud, 2012), 38 Quoted in CORTON p. 299.

Thomas Hospital and shows the Houses of Parliament in the late afternoon with the sun trying to shine through the fog.[164] Turner, whom we mentioned in the previous chapter, left unfinished a painting, "*Thames above Waterloo Bridge*", which shows the bridge through a haze of London fog. Whistler spent nearly the whole of his working life in London, and his "*Nocturnes*" are justly famous, for example, "*Nocturne in grey and gold - Piccadilly*", painted between 1881-1883. As well as painters the fog also inspired satirical cartoonists such as George Cruikshank. Fig. 5:20, and various cartoonists and illustrators working for *Punch* and the *Illustrated London News.*

<u>Figure 5:19 Claude Monet – London, Houses of Parliament. The Sun Shining through the Fog 1904</u>

Wikimedia Commons. Public domain

[164] C. MONET GALLERY, 'Houses of Parliament', Studio of the South, 2019, https://www.cmonetgallery.com/houses-of-parliament.aspx.

Figure 5:20 Foggy Weather, a hand-coloured etching by George Cruikshank, 29th December 1819

George Cruikshank was a popular satirical cartoonist and illustrator during the first half of the 19th century. This etching of a foggy day in London is full of life. To the left, in the foreground, two men are in danger of being run into by a horse. The second man in the blue jacket has his foot on a woman's neck much to her horror. It appears she has been knocked over by the tradesman wheeling a barrow, and is at risk of having her skirts caught alight by the man in the centre carrying a ladder. The ladder has caught another man - who is having his pocket picked by a link boy carrying a flaming torch - around the neck. A second link boy appears to be soliciting money from a woman in a blue coat, whilst a third boy who is looking at the scene, has dangerously lowered his torch towards a bearded man who has fallen over with a pile of books. In the middle-ground, horses and coaches are looming up out of the fog and present a menace to everyone.

Fog has been used to great effect by authors of the Victorian novel, the two most notable being, Charles Dickens and Sir Arthur Conan Doyle. Both authors use fog in several of their stories, but in Dicken's "*Bleak House"* and Conan Doyle's Sherlock Holmes short story, "*The Adventure of the Bruce-Partington Plans",* fog plays an integral part of the story as we can see from the following opening paragraphs. Firstly "*Bleak House*":

> Smoke lowering down from chimney-pots, making a soft black drizzle, with flakes of soot in it as big as full-grown snowflakes—gone into mourning, one might imagine, for the death of the sun. Dogs, undistinguishable in mire. Horses, scarcely better; splashed to their very blinkers.
>
> Fog everywhere. Fog up the river, where it flows among green aits and meadows; fog down the river, where it rolls defiled among the tiers of shipping and the waterside pollutions of a great (and dirty) city. Fog on the Essex marshes, fog on the Kentish heights. Fog creeping into the cabooses of collier-brigs; fog lying out on the yards and hovering in the rigging of great ships; fog drooping on the gunwales of barges and small boats. Fog in the eyes and throats of ancient Greenwich pensioners, wheezing by the firesides of their wards; fog in the stem and bowl of the afternoon pipe of the wrathful skipper, down in his close cabin; fog cruelly pinching the toes and fingers of his shivering little 'prentice boy on deck. Chance people on the bridges peeping over the parapets into a nether sky of fog, with fog all round them, as if they were up in a balloon and hanging in the misty clouds.[165]

The next excerpt is from "*The Adventure of the Bruce-Partington Plans"*:

> In the third week of November, in the year 1895, a dense yellow fog
>
> settled down upon London. From the Monday to the Thursday I doubt whether it was ever possible from our windows in Baker Street to see the

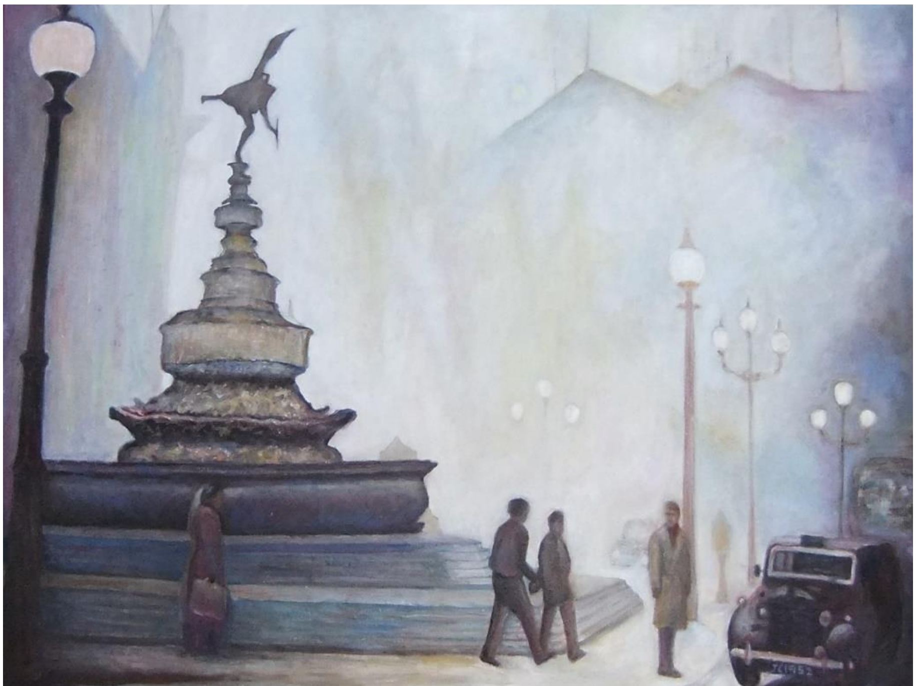
[165] DICKENS, Charles, *Bleak House* (London: Chapman & Hall, 1853), 1, https://babel.hathitrust.org/cgi/pt?id=uc2.ark:/13960/t47p8x024;view=1up;seq=801.

loom of the opposite houses … But when, for the fourth time, after pushing back our chairs from breakfast we saw the greasy, heavy brown swirl still drifting past us and condensing in oily drops upon the window-panes …[166]

Even if fogs like this are a thing of the past, both of the above passages convey to the reader a sense of reality as to what dense London fogs were really like.

The 1952 smog does not seem to have had the same artistic appeal as fogs had in the Victorian era. However, the following pictures are very evocative.

Figure 5:21 Annabel Bloxham – 1952: The Big Smog



Reproduced by kind permission of the artist and present owners

The picture shows Piccadilly Circus with the statue of Eros during the 1952 smog. A couple are standing by the statue, two men appear to have just walked past whilst a

[166] DOYLE, Arthur Conan Sir, 'The Adventure of the Bruce-Partington Plans', in *His Last Bow* (London: John Murray, 1954), 122.

third stands on the corner of the pavement, possibly waiting for the taxi which has just arrived. We see the dim outline of a bus behind the taxi and a car in the middle ground. The street lights are still shining and although it is daylight the area behind Eros is shrouded in thick fog.

Figure 5:22 Jacqueline Morreau – Killer Fog

Reproduced with kind permission of Patrick Morreau

Jacqueline Morreau's painting was commissioned by the London School of Tropical Medicine to mark the 50th anniversary of the 1952 London smog. On the left, people can be seen groping their way through the smog, covering their mouths for protection, whilst on the right a train is crossing a viaduct. A row of street lights can be seen stretching across the centre of the picture, whilst clouds of dense fog swirl over the whole scene.

A dense London fog has also been used to great effect in Lynne Reid Banks' novel, "*The L-Shaped Room*", which was published in 1960. Although unstated, the author has used her experiences of the 1952 fog as a metaphorical device to represent the "*moral uncertainties and mistakes*" of Jane the central character of the story.[167]

The year 1956, four years after the Great Smog, saw the publication of "*The Lonely Londoners*", by the Trinidadian writer, Samuel Selvon. The story, much of which is written in a creolised form of English, concerns the lives of a group of West Indians who emigrated to England in the early 1950s, and uses the fog as a background for the opening scenes of the novel.[168]

The smog is central to two films, the first, "*The Runaway Bus*", a 1954 comedy directed by Val Guest, and starring Frankie Howard, Margaret Rutherford and Petula Clark tells the story of a botched attempt to smuggle £200,000 worth of gold bullion out of the country. Unfortunately for the crooks, their plans to escape with the gold are thwarted by the dense fog.[169]

The second film, "*Midnight Lace*", was made in 1960, directed by David Miller, and starred, Doris Day and Rex Harrison. The story begins with a newlywed American heiress, Kit Preston who is living with her financier husband, Tony, in Grosvenor Square, London. One day as she is returning home in dense fog, she is startled by an eerie voice threatening to kill her. She manages to run home where her husband comforts her and tells her she is the victim of a practical joke. After many twists and turns, she is persuaded to think that she is suffering from a mental illness and contemplates suicide, but it turns out that it is her husband and his mistress who have been trying to kill her.[170]

Unfortunately, 1952 was not the last of the London fogs. Further episodes of dense fog occurred during the 1950s, the worst lasting from 4th to 6th January 1956, and caused

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167 CORTON, Christine L., *London Fog : The Biography*, 288.
168 SELVON, Samuel, *The Lonely Londoners* (London: Alan Wingate, 1956).
169 GUEST, Val, *The Runaway Bus*, Comedy, 1954, https://www.youtube.com/watch?v=JFbnerqhbKc.
170 MILLER, David, *Midnight Lace*, Neo noir mystery thriller, 1960, https://www.youtube.com/watch?v=VG0q8NupY9E&list=PLTAniXpTV_rfoa4lF2Vf3WS66GbB5eiug.

nearly 1,000 additional deaths in Greater London, due to atmospheric pollution.[171] The last serious fog in London lasted from 3rd to 7th December 1962.[172] Although at the time it was compared to the 1952 smog, the total number of deaths was, according to the Times, around 400, or one tenth of the total for 1952.[173] However, in a House of Commons debate in 1968, the estimated number of deaths was put at 750. This was, in no small measure, due to the Clean Air Act that was passed on 5th July 1956.[174] Among its various provisions, it prohibited dark smoke from chimneys and introduced smoke control areas whereby households were not allowed to burn ordinary coal or wood on domestic fires.[175]

5:2:7 Nuclear Disaster, Chernobyl, 25th-26th April 1986

As the crow flies, the Chernobyl reactor is located about 62 miles (100 km) NNW of the city of Kiev, 2 miles (3 km) SSE of the now abandoned city of Pripyat and 10 miles (16 km) NNE of the city of Chernobyl, now also abandoned.

The Disaster

The accident at the Chernobyl reactor is considered to be the worst nuclear power plant disaster in history, and is the only accident in the history of commercial nuclear power where radiation-related fatalities have occurred.[176] The following paragraph comes from UNSCEAR's assessments of the Chernobyl accident and briefly describes the events leading up to the eruption:

> The accident at the Chernobyl reactor happened during an experimental test of the electrical control system as the reactor was being shut down for

[171] LOGAN, W. P. D., 'Mortality from Fog in London, January, 1956', *British Medical Journal* 1, no. 4969 (31 March 1956): 722–25, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1979260/?page=1; CORTON, Christine L., *London Fog : The Biography*, 309.
[172] CORTON, Christine L., *London Fog : The Biography*, 321.
[173] FROM OUR CORRESPONDENT, 'Fog Deaths Only a Tenth of 1952's', *The Times*, 15 January 1963, 4, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1979260/?page=1.
[174] MAXWELL, Robert, 'Clean Air Bill', House of Commons debate (House of Commons, 2 February 1968), 1803, https://api.parliament.uk/historic-hansard/commons/1968/feb/02/clean-air-bill; CORTON, Christine L., *London Fog : The Biography*, 318.
[175] UK GOVERNMENT, 'Clean Air Act, 1956', Pub. L. No. Chapter 52 4 and 5 Eliz 2, 38, 1–38, accessed 24 March 2019, http://www.legislation.gov.uk/ukpga/1956/52/pdfs/ukpga_19560052_en.pdf.
[176] UNSCEAR SECRETARIAT, 'The Chernobyl Accident UNSCEAR's Assessments of the Radiation Effects', United Nations Scientific Committee on the Effects of Atomic Radiation, 16 July 2012, www.unscear.org/unscear/en/chernobyl.html; WORLD NUCLEAR ASSOCIATION, 'Chernobyl Accident 1986', World Nuclear Association, April 2018, http://www.world-nuclear.org/information-library/safety-and-security/safety-of-plants/chernobyl-accident.aspx.

routine maintenance. The operators, in violation of safety regulations, had switched off important control systems and allowed the reactor, which had design flaws, to reach unstable, low-power conditions. A sudden power surge caused a steam explosion that ruptured the reactor vessel, allowing further violent fuel-steam interactions that destroyed the reactor core and severely damaged the reactor building. Subsequently, an intense graphite fire burned for 10 days. Under those conditions, large releases of radioactive materials took place. At 1:23 a.m. on April 26, when extremely hot nuclear fuel rods were lowered into cooling water, an immense amount of steam was created, which — because of the RBMK reactors' design flaws — created more reactivity in the nuclear core of reactor number 4. The resultant power surge caused an immense explosion that detached the 1,000-ton plate covering the reactor core, releasing radiation into the atmosphere and cutting off the flow of coolant into the reactor.[177]

The spread of radioactivity over Europe

The reactor was destroyed in the accident and a large amount of radioactive material – at least 5% (9.6 tonnes) of the highly radioactive reactor core, some 5,200 PBq – was released into the atmosphere. Most of this was deposited as dust and debris in the close vicinity of the reactor, but the lighter material, was initially carried by the wind in a north-westerly direction on 26th April, and passed over the Baltic countries and then Scandinavia on 28th April. Thereupon, it was blown eastwards and then south carrying the radioactivity towards central Europe and the Balkans. A plume of radioactive material released on the 27th April had spread over much of western Europe by 5th May. It was then picked up by a south wind which took it to the British Isles, avoiding Spain and Portugal. Eventually, the various plumes merged to form a huge mass of contaminated air which covered most of Europe, albeit in decreasing concentrations. The radioactivity was finally carried over the whole of the northern

[177] UNSCEAR SECRETARIAT, 'The Chernobyl Accident UNSCEAR's Assessments of the Radiation Effects'.

hemisphere where it was detected in Japan and North America in exceedingly low concentrations.[178] See Map 5:11.

> According to aircraft measurements within the USSR. the plume height exceeded 1,200 m on 27 April, with the maximum radiation occurring at 600 m. On subsequent days, the plume height did not exceed 200-400 m. The volatile elements iodine and caesium, were detectable at greater altitudes (6-9 km), with traces also in the lower stratosphere.[179]

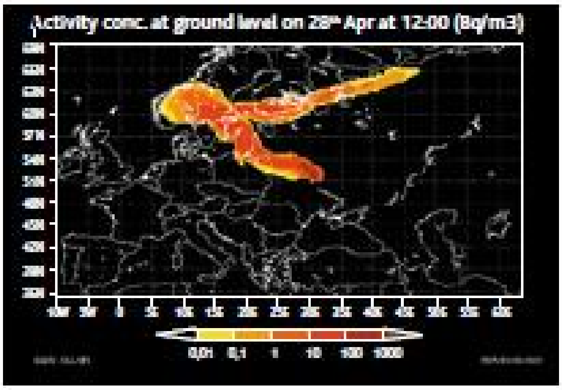
Approximately 53,000 people were evacuated from the town of Pripyat on 27th April.[180] Soon after the disaster, the Soviet Armed Forces set up an exclusion zone with a 30 km (19 mi) radius around the power plant. By 14th May, some 116,000 people who had been living within this zone had been evacuated and later relocated.[181]

During the years following the disaster, a further 220,000 people from Belarus, the Russian Federation and Ukraine were resettled into less contaminated areas, and the initial 30 km radius exclusion zone (2,800 km^2) was extended to cover 4,300 square kilometres. According to the WNA (World Nuclear Association), "*This resettlement was due to application of a criterion of 350 mSv projected lifetime radiation dose, though in*

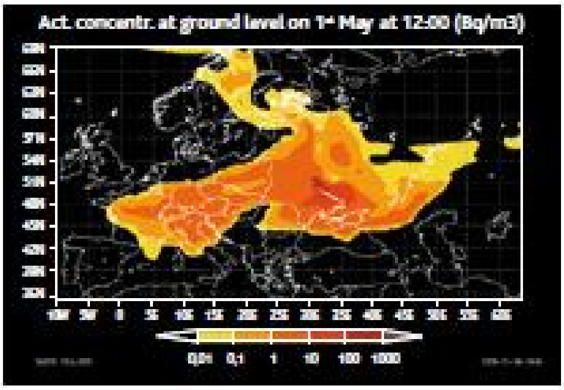
[178] UNSCEAR SECRETARIAT; WORLD NUCLEAR ASSOCIATION, 'Chernobyl Accident 1986'; IRSN, 'Chernobyl 25 Years On', Institut de radioprotection et de sûreté nucléaire, April 2011, 8–9, https://www.irsn.fr/EN/publications/thematic-safety/chernobyl/Documents/irsn_booklet_chernobyl_2011.pdf; IRSN, 'The Chernobyl Plume : Modelling Atmospheric Dispersion of Caesium-137 across Europe Following the Chernobyl Accident', Institut de radioprotection et de sûreté nucléaire, 2011, https://www.irsn.fr/EN/publications/thematic-safety/chernobyl/Pages/The-Chernobyl-Plume.aspx; UNSCEAR, *SOURCES, EFFECTS AND RISKS OF IONIZING RADIATION United Nations Scientific Committee on the Effects of Atomic Radiation 1988 Report to the General Assembly, ANNEX D* (New York: United Nations, 1988), 10, https://www.unscear.org/docs/reports/1988annexd.pdf.
[179] UNSCEAR, *SOURCES, EFFECTS AND RISKS OF IONIZING RADIATION United Nations Scientific Committee on the Effects of Atomic Radiation 1988 Report to the General Assembly, ANNEX D*, 314.
[180] WIKIPEDIA, 'Chernobyl Disaster', Wikipedia, 13 March 2016, https://en.wikipedia.org/wiki/Chernobyl_disaster from 'Валентина Шевченко: "Провести демонстрацію 1 травня 1986-го наказали з Москви"'. Istorychna Pravda (in Ukrainian). 25 April 2011.
[181] WIKIPEDIA; WORLD NUCLEAR ASSOCIATION, 'Chernobyl Accident 1986'; UNSCEAR SECRETARIAT, 'The Chernobyl Accident UNSCEAR's Assessments of the Radiation Effects'; WHO, 'Chernobyl: The True Scale of the Accident', World Health Organisation Media Centre, 5 September 2005, https://www.who.int/mediacentre/news/releases/2005/pr38/en/.

fact radiation in most of the affected area (apart from half a square kilometre) fell rapidly so that average doses were less than 50% above normal background of 2.5 mSv/yr."[182]

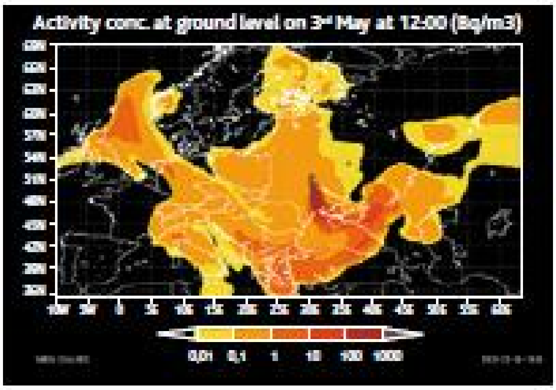
<u>Map 5:11 Computer modelling of spread of Caesium 137 released into the atmosphere by the Chernobyl accident</u>



Spread of caesium-137 released into the atmosphere by the Chernobyl accident: situation at 12:00 on 28th April 1986 (modelling: IRSN 2006).



Air contamination by caesium-137: situation at 12:00 on 1st May 1986 (modelling: IRSN 2006).



Air contamination by caesium-137: situation at 12:00 on 3rd May 1986 (modelling: IRSN 2006).

Maps courtesy IRSN www.irsn.fr.

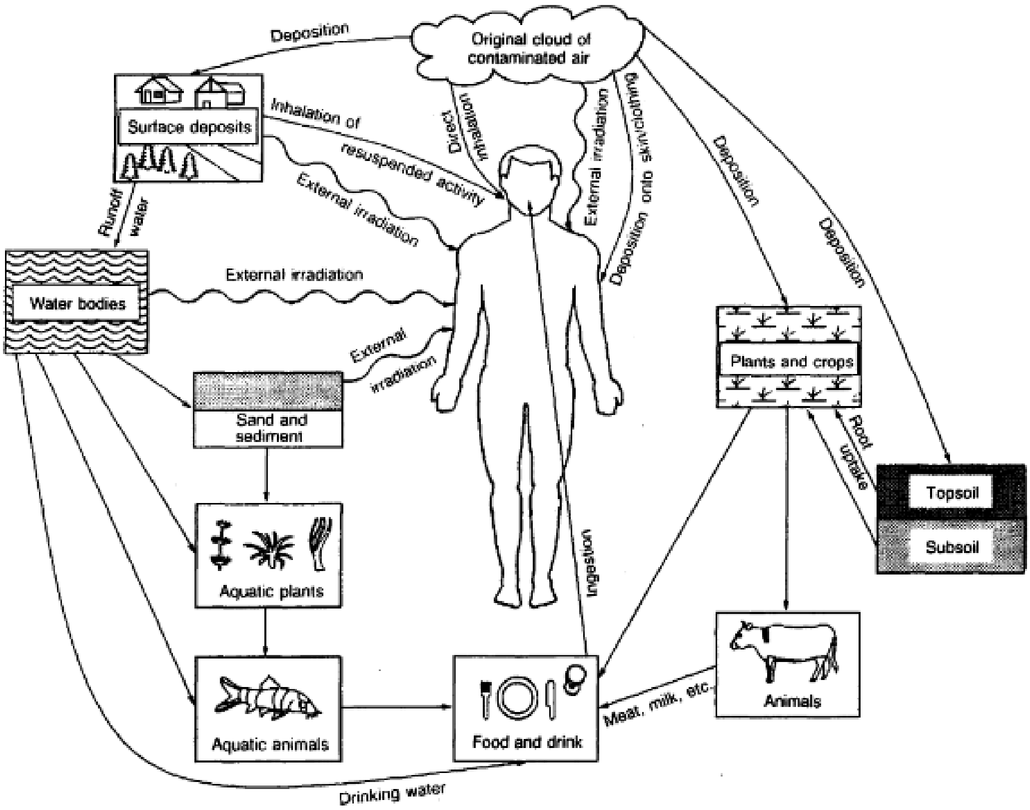
[182] UNSCEAR SECRETARIAT, 'The Chernobyl Accident UNSCEAR's Assessments of the Radiation Effects'; WORLD NUCLEAR ASSOCIATION, 'Chernobyl Accident 1986'; WIKIPEDIA, 'Chernobyl Disaster'.

> Following any release of radionuclides into the atmosphere, the radioactive cloud is dispersed and transported by the prevailing winds. Initially, people will be exposed to radiation by two principal routes, viz: external irradiation from material in the cloud and internal irradiation following inhalation of radioactive material in the air. Over time, the contents of the cloud are gradually depleted during its dispersion, as radioactive materials are transferred to the ground and bodies of surface water, such as, lakes, streams and rivers; under dry weather conditions, by precipitation or in fog. People may then be exposed, and may continue to be exposed to radiation by other routes, the three main ones being: external irradiation from the deposited material itself; the inhalation of any material resuspended into the atmosphere; the transfer of material through the terrestrial and aquatic environment to food and water, which can give rise to internal irradiation.[183]

According to UNSCEAR, most of the radiation released from the reactor was mainly iodine-131, caesium-134 and caesium-137. Iodine-131 has a short half-life of eight days, but it can be transferred to humans relatively rapidly from the air and through the consumption of contaminated milk and leafy vegetables, from whence it becomes localized in the thyroid gland, particularly of children. Isotopes of caesium have relatively longer half-lives — caesium-134 has a half-life of 2 years while that of caesium-137 is 30 years. Owing to their much longer half-lives, those who were exposed to caesium radionuclides, in particular a cohort of 530,000 Chernobyl recovery and clean-up operation workers — who received doses ranging from 20 to 500 millisievert (mSv) in 1986-1990 — is being closely followed for potential risk of cancer and other diseases, for example, cardiovascular disease and radiation-induced cataracts. [184] See Fig. 5:23

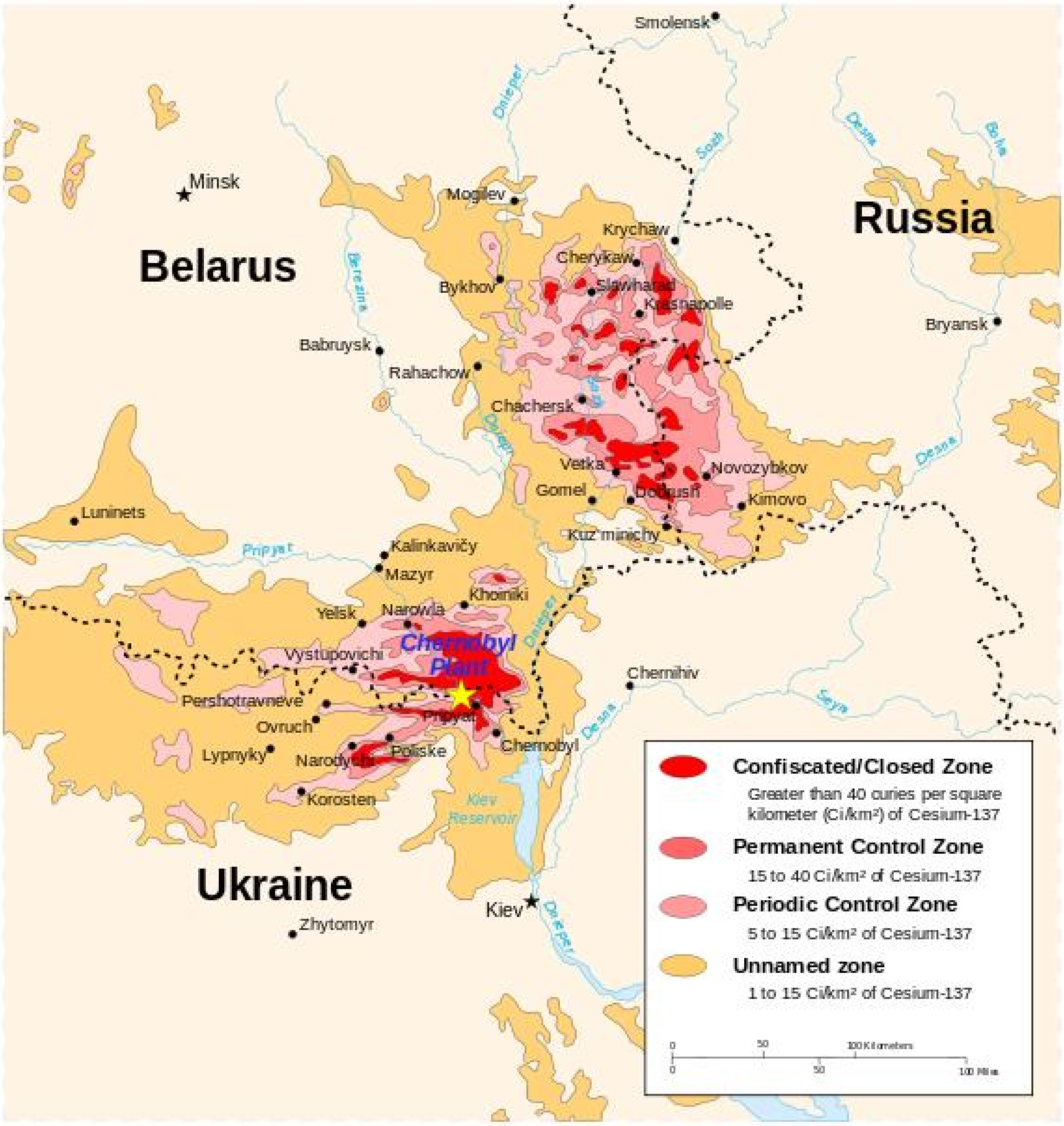
[183] INTERNATIONAL ADVISORY COMMITTEE, *The International Chernobyl Project: Technical Report. Assessment of Radiological Consequence Sand Evaluation of Protective Measures* (Vienna: IAEA, 1991), 31, https://www-pub.iaea.org/MTCD/publications/PDF/Pub885e_web.pdf.
[184] UNSCEAR SECRETARIAT, 'The Chernobyl Accident UNSCEAR's Assessments of the Radiation Effects'; LALLANILLA, Marc, 'Chernobyl: Facts About the Nuclear Disaster', livescience.com, 25 September 2013, http://www.livescience.com/39961-chernobyl.html; WHO, '1986-2016: CHERNOBYL at 30: An Update', World Health Organisation, 25 April 2016, 1–2, https://www.who.int/ionizing_radiation/chernobyl/Chernobyl-update.pdf?ua=1.

Figure 5:23 Main environmental pathways of human radiation exposure



Courtesy The International Chernobyl Project, IAEA, Vienna (1991), p. 31 Fig. 8

Map 5:12 Chernobyl radiation hotspots resulting from the accident



Wikimedia Commons

The map, which was created in 1996, shows the areas of worst contamination around the Chernobyl nuclear plant after the explosion. It is based on one from the CIA Handbook of International Economic Statistics.

Due to the secrecy and lack of transparency that the Soviet state maintained regarding its nuclear industry, nothing about the accident had been released by the authorities. The first indication that anything was amiss, was on the morning of 28th of April, when Swedish scientists detected an increase in radiation at their nuclear plant in Forsmark, on the Baltic coast, and about 60 miles north of Stockholm.[185] This led to 600 workers being evacuated from the installation. Radiation levels were also checked at other areas including Stockholm, and these all confirmed that radiation levels were higher than normal. These results, together with further tests at Forsmark, induced the Swedish authorities to believe that the radioactivity had come from the Soviet Union. After an initial denial by the Soviet atomic energy authorities, Tass finally admitted, on 28th April, that there had been an accident at the Chernobyl nuclear power station, and there had been a few casualties. The Swedish Defence Ministry said that monitoring stations in Denmark, Sweden, Norway, and Finland had all detected abnormally high levels of radioactivity.[186]

In a masterly understatement on 28th April, two days after the accident, the Soviet TV channel, BPEMR, reported the disaster in an announcement lasting 14 seconds: *"An accident has occurred at the Chernobyl Nuclear Power Plant, and one of the reactors has been damaged. Steps are being taken to deal with the situation, and aid is being given to those affected. The government has formed a commission of enquiry".*[187]

The press were quick to pick up on this the following day as reports came in from their diplomatic correspondents, agencies, and foreign staff, but they had very little to go on. The "quality" newspapers were not jumping the gun with their headlines, the Financial Times being quite sober in its comments: *"Serious accident hits nuclear power plant in Soviet Union"*. The Times was a little more animated: *"Huge nuclear*

[185] EUROPEAN PARLIAMENT, 'Forsmark: How Sweden Alerted the World about the Danger of the Chernobyl Disaster', News European Parliament, 15 May 2014, http://www.europarl.europa.eu/news/en/headlines/society/20140514STO47018/forsmark-how-sweden-alerted-the-world-about-the-danger-of-chernobyl-disaster.
[186] PRENTICE, Thomson, and MOSEY, Christopher, 'Alert 1,000 Miles Away in Sweden after Moscow Admits Casualties: Huge Nuclear Leak at Soviet Plant', *The Times*, 29 April 1986, 1, http://gdc.galegroup.com/gdc/artemis/NewspapersDetailsPage/NewspapersDetailsWindow?disableHighlighting=false&displayGroupName=DVI-Newspapers&docIndex=&source=&prodId=&mode=view&limiter=&display-query=&contentModules=&action=e&sortBy=&windowstate=normal&currPage=1&scanId=&query=&navigationOption=issue&search_within_results=&p=TTDA&catId=&u=bright&displayGroups=&documentId=GALE%7CIF0500035216&activityType=BrowseByDate&failOverType=&commentary=.
[187] McLAIN, Tim, 'Chernobyl Russian Soviet TV News Announcement', YouTube, 1 September 2012, https://www.youtube.com/watch?v=RuWIIiTLbFM.

leak at Soviet plant", "Overheating of nuclear fuel raises fear of possible meltdown", "European alarm" and "Moscow acts", whilst The Guardian was quite deadpan with the headline, *"Radioactive Russian dust cloud escapes"*

The popular press, never slow to miss out on a good story, however sparse the information, produced the following eye-catching examples: The Star, *"Atom cloud horror"*; the Daily Express, *"Nuclear disaster – radioactive cloud heads for Britain"*; The Mirror, *"Russia's cloud of death"*; the Sun, perhaps the most dramatic, headlined *"Red nuke disaster", "Scores feared dead. Thousands flee leak"*.[188]

Owing to a lack of concrete information, the Press were picking up a number of unsubstantiated rumours, some of which were reported in The Times on 30th April, viz: The Soviet Council of Ministers announced that only two people had been killed; a Soviet official in Washington quoted a figure in tens, but no more than a hundred for both dead and injured; a Scottish teacher living in Kiev had heard reports that up to 300 people had died, whilst Universal Press International reported that about 2,000 people had been killed.[189]

The following days produced some choice examples of creative writing. The tabloid Today, had discovered the reason for the reactor fire. A power station worker, it said, *"dozed off on the job"*. The Star had the patriotic headline, *"HELP! Russia's disaster plea to the West. Only our experts can save the day"*. The Daily Mail reported*, "2000 dead in atom horror"*, presumably based on The United Press report. On 1st May, most papers were reporting a claim from the US, based on satellite photographs, that a

[188] HERBERT, Roy, 'Chernobyl Disaster: How the Soviet Union's Cover Story Was Blown', *New Scientist* 114, no. 1557 (23 April 1987): 34, https://books.google.fr/books?id=S-SsDtZG5WgC&pg=PA17&lpg=PA17&dq=new+scientist+23+april+1987&source=bl&ots=uC03v3mZEa&sig=ACfU3U1bsuby8o8uvoXGRbupPfBrfQgzJw&hl=en&sa=X&ved=2ahUKEwic7cjV8ZXiAhUpBWMBHTbbDmwQ6AEwAnoECAgQAQ#v=onepage&q=new%20scientist%2023%20april%201987&f=false.

[189] PRENTICE, Thomson, 'Fears of High Death Toll in Atom Disaster', *The Times*, 30 April 1986, 1, http://gdc.galegroup.com/gdc/artemis/NewspapersDetailsPage/NewspapersDetailsWindow?disableHighlighting=false&displayGroupName=DVI-Newspapers&docIndex=&source=&prodId=&mode=view&limiter=&display-query=&contentModules=&action=e&sortBy=&windowstate=normal&currPage=1&scanId=&query=&navigationOption=issue&search_within_results=&p=TTDA&catId=&u=bright&displayGroups=&documentId=GALE%7CIF0500035607&activityType=BrowseByDate&failOverType=&commentary=.

second reactor was in trouble, The Daily Telegraph even going so far as to say – based on information from a soviet radio "ham" – that a second reactor was on fire.[190]

One thing that can be said of the press, is that although some hard things were said about the Soviet designers and technologists, there was not one word unsympathetic to the suffering of the Soviet people. The serious papers did their best with a story that frustrated them from the beginning for its absence of salient facts. Despite some lurid headlines the tabloids did the same for their readers.[191]

Health effects

The explosions killed two plant workers, one immediately, probably by explosion trauma, and the other, who died in hospital the same day, from a broken spine, broken ribs and a lethal dose of radiation. A further 28 people died within three months from ARS (Acute Radiation Syndrome) and three died later from medical complications that may have been caused by the accident. During the following 20 years, a further 15 people died from ARS, and 9 children under the age of 18 years died of thyroid cancer, out of about 6,800 who were infected; the remainder recovered.[192] See Table 5:2.

Table 5:2 People with demonstrable health effects

Health effects	**Size**	**No of deaths due to radiation**
Symptoms of acute radiation syndrome	134 confirmed cases (237 hospitalized)	28 died within 3 months 15 died within the subsequent 20 years
Childhood thyroid cancer	6,848 (1991-2005) 20,000 (1991- 2015)	9 (-15) died confirmed
Leukaemia and other solid cancers	No increase	None known
Subclinical psychological effects	Major impact	None known

190 HERBERT, Roy, 'Chernobyl Disaster: How the Soviet Union's Cover Story Was Blown', 34–36.
191 HERBERT, Roy, 36.
192 NAGATAKI, Shigenobu, 'Latest Knowledge on Radiological Effects: Radiation Health Effects of Atomic Bomb Explosions and Nuclear Power Plant Accidents', *Japanese Journal of Health Physics* 45, no. 4 (2010): 376, https://www.jstage.jst.go.jp/article/jhps/45/4/45_4_370/_pdf; WIKIPEDIA, 'Deaths Due to the Chernobyl Disaster', Wikipedia, 2 October 2018, https://en.wikipedia.org/wiki/Deaths_due_to_the_Chernobyl_disaster; WHO, 'Chernobyl: The True Scale of the Accident'; INTERNATIONAL ADVISORY COMMITTEE, *The International Chernobyl Project: Technical Report. Assessment of Radiological Consequence Sand Evaluation of Protective Measures*, 67–68; UNSCEAR, 'Evaluation of Data on Thyroid Cancer in Regions Affected by the Chernobyl Accident', United Nations Scientific Committee on the Effects of Atomic Radiation, 2018, v,1, https://www.unscear.org/docs/publications/2017/Chernobyl_WP_2017.pdf.

After Nagataki 2010, World Nuclear Association 2018 and UNSCEAR 2018

UNSCEAR says that apart from increased thyroid cancers, "there is no evidence of a major public health impact attributable to radiation exposure 20 years after the accident." [193]

At the present time, the number of deaths and other health effects related to Chernobyl is much less than initially feared, but the total number, including future deaths, is highly controversial. Estimates range from around 4,000 by the World Health Organisation, approximately 27,000 by the Union of Concerned Scientists, and between 93,000 – 200,000 by Greenpeace[194] A highly dubious report: "*Chernobyl: Consequences of the Catastrophe for People and the Environment*", published in the "*Annals of the New York Academy of Sciences",* claims that there may be a further 265,000 deaths in Europe and the rest of the world, and concludes that there were 985,000 premature deaths as a result of the radioactivity.[195] This report has subsequently been trashed in a review by M. I Balanov. He writes:

> … the authors unfortunately did not appropriately analyze the content of the Russian-language publications, for example, to separate them into those that contain scientific evidence and those based on hasty impressions and ignorant conclusions. Therefore, the main conclusions of Yablokov, Nesterenko, and Nesterenko are the odd mixture of facts (e.g., increased thyroid cancer in children in Belarus, Russia and Ukraine) and

[193] WORLD NUCLEAR ASSOCIATION, 'Chernobyl Accident 1986'; UNSCEAR, 'Evaluation of Data on Thyroid Cancer in Regions Affected by the Chernobyl Accident', v,1.
[194] BBC, 'Greenpeace Rejects Chernobyl Toll', BBC News, 18 April 2006, http://news.bbc.co.uk/2/hi/europe/4917526.stm; FAIRLIE, Ian and SUMNER, David, 'THE OTHER REPORT ON CHERNOBYL (TORCH)' (Berlin, Brussels, Kiev: Commissioned by Rebecca Harms, MEP, Greens/EFA in the European Parliament, April 2006), http://www.chernobylreport.org/torch.pdf; GREENPEACE, *The Chernobyl Catastrophe: Consequences on Human Health* (Amsterdam: Greenpeace, 2006), http://news.bbc.co.uk/2/shared/bsp/hi/pdfs/18_04_06_chernobyl.pdf; GRONLUND, Lisbeth, 'How Many Cancers Did Chernobyl Really Cause?—Updated Version', *Union of Concerned Scientists: All Things Nuclear* (blog), 17 April 2011, https://allthingsnuclear.org/lgronlund/how-many-cancers-did-chernobyl-really-cause-updated?; HAWLEY, Charles and SCHMITT, Stefan, 'Greenpeace vs. the United Nations The Chernobyl Body Count Controversy', Spiegel Online International, 18 April 2006, https://www.spiegel.de/international/greenpeace-vs-the-united-nations-the-chernobyl-body-count-controversy-a-411864.html; WIKIPEDIA, 'Chernobyl Disaster'; WIKIPEDIA, 'Deaths Due to the Chernobyl Disaster'; WHO, 'Chernobyl: The True Scale of the Accident'.
[195] YABLOKOV, Alexey et al., eds., *Chernobyl : Consequences of the Catastrophe for People and the Environment*, vol. 1181, Annals of the New York Academy of Sciences (Boston, Mass.: Blackwell on behalf of the New York Academy of Sciences, 2009); GRONLUND, Lisbeth, 'How Many Cancers Did Chernobyl Really Cause?—Updated Version'; WIKIPEDIA, 'Deaths Due to the Chernobyl Disaster'.

uncorroborated statements of mass mortality in emergency and recovery workers caused by radiation, abnormalities in newborns, etc. [196]

Following the explosion, many doctors throughout Eastern Europe and the Soviet Union systematically carried out abortions on women to avoid them bearing children with birth defects or other disorders, though the actual level of radiation exposure these women experienced was too low to cause any problems. Driven by a media panic, many women throughout Europe were also asking for abortions, and an estimated excess of about 100,000 – 200,000 unnecessary terminations were performed due to unfounded fears of deformities caused by radiation.[197]

Apart from cancers and the other diseases mentioned above, mental health and psychological disorders would seem to be a very serious problem both now and in the future.[198] The WHO said in 2005 that: "*People in the affected areas report negative assessments of their health and well-being, coupled with an exaggerated sense of the danger to their health from radiation exposure and a belief in a shorter life expectancy*."[199] In the words of one physician this is a *"Chernobyl-related health problem*."[200] Furthermore, in their report of 2006, they state that, "*The mental health impact of Chernobyl is the largest public health problem caused by the accident to date. The magnitude and scope of the disaster, the size of the affected population, and the long-term consequences make it, by far, the worst industrial disaster on record."*[201]

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[196] BALANOV, M. I., 'Chernobyl: Consequences of the Disaster for the Population and the Environment: Yablokov AV, Nesterenko VB, and Nesterenko AV Ann NY Acad Sci 1189 (2009)', *Annals of the New York Academy of Sciences* 1189 (2009): 1, https://web.archive.org/web/20120119125747/http://www.nyas.org/asset.axd?id=8b4c4bfc-3b35-434f-8a5c-ee5579d11dbb&t=634507382459270000.

[197] PLUGBEIL, Sebastian, et al., 'Health Effects Following Chernobyl: 20 Years after the Reactor Catastrophe', German Affiliate of the International Physicians forthe Prevention of Nuclear War (IPPNW)Society for Radiation Protection (GSL), April 2006, 23–24, https://www.sortirdunucleaire.org/IMG/pdf/ippnw-2006-the_health_effects_of_chernobyl-20_years_after_the_reactor_catastrophe.pdf; LALLANILLA, Marc, 'Chernobyl: Facts About the Nuclear Disaster'; WIKIPEDIA, 'Chernobyl Disaster'.

[198] WOJCIK, Andrzej, 'Psychological and Stress Effects of the Chernobyl Accident', Stockholm University KVA seminar, 25 April 2016, 1–24, http://www.crpr-su.se/chernobyl/Andrzej_Wojcik.pdf; WHO, '1986-2016: CHERNOBYL at 30: An Update', 2–3.

[199] WHO, 'Chernobyl: The True Scale of the Accident', 2.

[200] WHO, '1986-2016: CHERNOBYL at 30: An Update', 2–3.

[201] WHO, *Health Effects of the Chernobyl Accident and Special Health Care Programmes. Report of the UN Chernobyl Forum Expert Group 'Health'*, ed. BENNETT, Burton, REPACHOLI, Michael, and CARR, Zhanat (Geneva: World Health Organization, 2006), 95, https://apps.who.int/iris/bitstream/handle/10665/43447/9241594179_eng.pdf;jsessionid=35A8F567DC96369C0A6AC8FC79FAF39A?sequence=1.

Environmental impacts

Shortly after the disaster, when radiation levels were extremely high, four square kilometres of pine forest directly downwind of the reactor turned reddish-brown and died, thus earning it the name of the "Red Forest". The trees were eventually bulldozed and buried in trenches, which were covered with a thick layer of sand and then replanted with pine saplings.[202]

According to a report by the UN Chernobyl Forum:

> … vegetation and animals in forests and mountain areas have shown particularly high uptake of radiocaesium, with the highest recorded Cs^{137} activity-concentrations found in forest products due to the persistent recycling of radiocaesium in forest ecosystems. Particularly high Cs^{137} activity-concentrations have been found in mushrooms, berries and game, and these high levels have persisted for many years.[203]

In the aftermath of the eruption, many countries introduced measures in order to limit the effects of radioactive contamination to foodstuffs and livestock. These included placing restrictions or prohibitions on the marketing and consumption of fresh leafy vegetables, milk, dairy products, and some types of meat.[204] Owing to the contamination of grazing land, embargos were placed on the movement and consumption of livestock in many parts of Europe. In some parts of the UK and Northern Ireland, for example, restrictions affecting some 10,000 farms in highland areas, were placed on the movement of sheep. The last of these was finally removed on 1st June 2012 – Southern Ireland thought it unnecessary to restrict the movement

[202] LALLANILLA, Marc, ‘Chernobyl: Facts About the Nuclear Disaster’; WIKIPEDIA, ‘Chernobyl Disaster’; WIKIPEDIA, ‘Red Forest’, Wikipedia, 1 February 2019, https://en.wikipedia.org/wiki/Red_Forest.
[203] UN CHERNOBYL FORUM, ‘Environmental Consequences of the Chernobyl Accident and Their Remediation: Twenty Years of Experience Report of the UN Chernobyl Forum Expert Group “Environment” (EGE)’ (Vienna: UN Chernobyl Forum Expert Group “Environment” (EGE), August 2005), 4, https://www-ns.iaea.org/downloads/rw/meetings/environ-consequences-report-wm-08.05.pdf.
[204] OECD, *The Radiological Impact of the Chernobyl Accident in OECD Countries.* (Paris: Nuclear Energy Agency of the OECD, 1987), 9 & 170–78, https://www.oecd-nea.org/rp/pubs/1987/radiological_impact_chernobyl.pdf.

of livestock.[205] Of particular concern was the contamination of reindeer meat in Finland, Norway, Russia and Sweden, which was caused by the high absorption rate of radiocaesium by lichen and mushrooms, both staple foods of reindeer. This created significant problems for the Sami people whose livelihood depends upon these animals.[206]

In addition, constraints were also placed on the importation of foodstuffs from eastern European countries and the Soviet Union, and travel to areas affected by the accident was prohibited.[207]

Notwithstanding the above, the exclusion zone is a thriving wildlife sanctuary, and flourishing populations of wolves, deer, lynx, beaver, eagles, boar, elk, bears and other animals have been documented in the dense woodlands that now surround the silent plant.[208] As the wildlife was flourishing, Ukrainian zoologists decided in 1998, to release a herd of 30 endangered Przewalski's horses in the zone. The hope was that the horses would graze overgrowth and reduce the risk of wildfire. The horses have adapted so well that there are now – in February 2019 – about 60 of them spread in herds across Ukraine and Belarus.[209] See Appendix 5.

According to Greenpeace: "…it is reasonable to conclude that the Chernobyl accident has caused, and will continue to cause, a significant amount of morbidity and mortality

[205] MAGEE, Audrey, 'Chernobyl Radiation Persists in Ireland', The Irish Times, 20 April 1996, https://www.irishtimes.com/news/chernobyl-radiation-persists-in-ireland-1.41399; BBC, 'Chernobyl Sheep Controls Lifted in Wales and Cumbria', BBC News, 22 March 2012, https://www.bbc.com/news/uk-wales-17472698.
[206] UN CHERNOBYL FORUM, 'Environmental Consequences of the Chernobyl Accident and Their Remediation: Twenty Years of Experience Report of the UN Chernobyl Forum Expert Group "Environment" (EGE)', 3–12; WHO, 'Chernobyl: The True Scale of the Accident', 2.
[207] OECD, *The Radiological Impact of the Chernobyl Accident in OECD Countries.*, 9.
[208] MULVEY, Stephen, 'Wildlife Defies Chernobyl Radiation', BBC News, 20 April 2006, http://news.bbc.co.uk/2/hi/europe/4923342.stm; LALLANILLA, Marc, 'Chernobyl: Facts About the Nuclear Disaster'; GILL, Victoria, 'Chernobyl: The End of a Three-Decade Experiment', BBC News, 15 February 2019, https://www.bbc.com/news/science-environment-47227767.
[209] GILL, Victoria, 'Chernobyl: The End of a Three-Decade Experiment'.

across Europe, from Scandinavia, through Western Europe, south to where Turkey straddles the border between Europe and Asia, and beyond."[210]

Chernobyl has now become a popular tourist destination, especially since the screening of the TV miniseries, *"Chernobyl",* and there are many sites on the web devoted to the industry, as a brief search on Google will reveal. According to CNN travel: *"Chernobyl is one of the most popular examples of the phenomenon known as dark tourism -- a term for visiting sites associated with death and suffering, such as Nazi concentration camps in Europe or the 9/11 Memorial and Museum in New York."*[211]

Artistic responses

There has been a huge artistic response to the Chernobyl disaster, inspiring many different forms of art including the more traditional painting, sculpture, music and literature to documentary and fiction films, television series, video games and the multimedia event, "*ARTEFACT*". This was an installation by Kiev artist, Valery Korshunov which took place in the central square of Pripyat on 22 November 2018 and included, live performance, parties, sculpture and VJing[212] – *VJing (pronounced: VEE-JAY-ing) is, a broad designation for realtime visual performance. Characteristics of VJing are the creation or manipulation of imagery in realtime through technological mediation and for an audience, in synchronization to music.*[213]

Painting and sculpture

A number of painters have been motivated to produce work which has been inspired by Chernobyl, and many of these can be found on the internet. Perhaps the most evocative is a series of thirty paintings entitled *"Pripyat Lights, or Chernobyl Shadows",*

[210] GREENPEACE, *The Chernobyl Catastrophe: Consequences on Human Health*, 136.
[211] STREET, Francesca, 'Chernobyl and the Dangerous Ground of "Dark Tourism"', CNN Travel, 25 June 2019, https://edition.cnn.com/travel/article/dark-tourism-chernobyl/index.html.
[212] SEYMOUR, Tom, 'Grab Your Geiger Counter: A Trip to Chernobyl's First Rave', The Guardian, 28 November 2018, https://www.theguardian.com/artanddesign/2018/nov/28/chernobyl-art-party-nuclear-pripyat-ukraine-artefact-valery-korshunov; MILEY, Jessica, 'Chernobyl Nuclear Site Hosts First Ever Art Event Since Disaster', 1 December 2018, https://interestingengineering.com/chernobyl-nuclear-site-hosts-first-ever-art-event-since-disaster.
[213] WIKIPEDIA, 'VJing', Wikipedia, 8 April 2019, https://en.wikipedia.org/wiki/VJing.

by the Ukranian artist, Roman Gumanyuk. The pictures range from the nuclear explosion itself ("*Reactor in flames*"); the firefighters trying to contain the inferno ("*Steps to immortality*"); and the radiation symbol ("*Symbol of Pripyat*"); to visions of what can be seen today – abandoned and rusting vehicles ("*Rusty forest*"); and derelict buildings in a desolate landscape ("*Jungle of Pripyat*"). The whole series has a misty quality and a sense of gloom and foreboding. The collection can be seen at: http://www.chernobylshadows.com/Chernobyl-Shadows-Gallery.html.

There are several Chernobyl-inspired sculptures of which the Monument to the Chernobyl Firemen, pictured below, is the most striking. Fig. 5:24.

The memorial was built and funded by the surviving firemen, and illustrates the heroism of the firefighters, their bodies strained in the action of bringing the reactor under control. Their effort is symbolised by a gigantic ribbon tied around a representation of the reactor, above which hovers a globe representing the world which is supported by two tall pillars arising from the base of the monument. The top of the monument is topped by a cross representing the firefighters' degree of sacrifice.

At the base of the memorial is a plaque which reads (in translation) "To those who saved the world."[214]

[214] ODDVISER, 'Monument to the Chernobyl Liquidatorsin Chernobyl, Ukraine', Oddviser, 2019, https://oddviser.com/ukraine/chernobyl/memorial.

Figure 5:24 Monument to the Chernobyl Firemen

Creative Commons photograph by Martin Cigler

Tapestry

On the 19th September 1991, the people of Belarus presented a hand-woven Gobelin tapestry entitled "*Chernobyl*" to the United Nations. Fig. 5:25. It was designed by the Belarusian artist, Alexander Kishchenko and measures 12ft 6in x 33ft (3.8 x 10.6m). According to the UN, *"The tapestry reflects humanism displayed by representatives of various countries".*[215]

[215] UNITED NATIONS, 'Chernobyl', United Nations Gifts, n.d., https://www.un.org/ungifts/content/chernobyl.

Figure 5:25 United Nations tapestry "Chernobyl"

Copyright Boris Kester & traveladventures .org

Literature

Apart from scientific reports, theses, and articles ai the popular press, the Chernobyl tragedy has resulted in a huge volume of literature. WorldCat, for example, lists 3,243 printed books, of which 4 are in large print format and 2 in braille.

As with previous disasters, authors were quick to capitalise on the accident. In 1987, the German writer, Christa Wolf published her novel, *"Störfall Nachrichten eines Tages",* and which was later published in English as *"Accident",* tells the story of an East German writer who:

> awaits a call from the hospital where her brother is undergoing brain surgery and instead receives news of a massive nuclear accident at Chernobyl, one

> thousand miles away. In a potent, lyrical stream of thought, the narrator confronts both mortality and life and, above all, the importance of each moment lived.[216]

Another 1987 novel is Frederik Pohl's, *"Chernobyl"* which weaves a tale about the disaster from the viewpoint of the individuals involved and the impact it has on their personal lives. Not only does it explain how and why the accident occurred but also reflects on the future of the world and the effect it has had on Russian political policies.[217]

A third novel which has had very positive reviews is Markiyan Kamysh's story about illegal trips to the Chernobyl exclusion zone, *"A Stroll to the Zone"*. It has been translated from the original Ukrainian into French and released under the title *"La Zone".*[218]

If we now turn to nonfiction, we find from a search on Amazon.com, that 12 books have been, or are going to be published in this year alone (2019). First off the mark, on 31st January 2019, was the Penguin paperback version of *"Chernobyl: History of a Tragedy"* by S. M. Plokhy, the Mykhailo Hrushevsky Professor of Ukrainian History at Harvard University and winner of the 2018 Baillie Gifford prize for nonfiction. Drawing on recently declassified documents, and interviews with the personnel involved, the author gives us an interesting and well-written account of the events leading up to, during, and after the disaster. He also portrays the officials who tried, unsuccessfully, to cover up the disaster with a total disregard for the local population.[219]

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[216] WOLF, Christa, *Accident: A Day's News*, trans. SCHWARZBAUER, Heike, and TAKVORIAN, Rick, First, Phoenix Fiction (Chicago: University of Chicago Press, 2001) from blurb on back cover; WIKIPEDIA, 'Cultural Impact of the Chernobyl Disaster', Wikipedia, 29 March 2019, https://en.wikipedia.org/wiki/Cultural_impact_of_the_Chernobyl_disaster.
[217] POHL, Frederick, *Chernobyl: A Novel* (London: Bantam, 1987); WIKIPEDIA, 'Cultural Impact of the Chernobyl Disaster'.
[218] KAMYSH, Markiyan, *La Zone*, trans. IVANISHKO, Natalya (Paris: Arthaud, 2016); WIKIPEDIA, 'Cultural Impact of the Chernobyl Disaster'.
[219] PLOKHY, Serhii, *Chernobyl: History of a Tragedy*, paperback (London: Penguin Books, 2019).

Adam Higgingbotham's book, *"Midnight in Chernobyl: the untold story of the world's greatest nuclear disaster"* was published on 7th February 2019. The following extract from a review in The New York Times gives the reader a flavour of the book:

> … the real story of the accident, clouded from the beginning by secrecy, propaganda, and misinformation, has long remained in dispute.
>
> Drawing on hundreds of hours of interviews conducted over the course of more than ten years, as well as letters, unpublished memoirs, and documents from recently-declassified archives, Adam Higginbotham has written a harrowing and compelling narrative which brings the disaster to life through the eyes of the men and women who witnessed it first-hand. The result is a masterful non-fiction thriller, and the definitive account of an event that changed history: a story that is more complex, more human, and more terrifying than the Soviet myth.[220]

"Growth and Decay: Pripyat and the Chernobyl Exclusion Zone" is a book of 200 photographs taken during his 22 visits to the zone over a period of some twenty-five years – especially to the deserted town of Pripyat – by the Canadian photographer, David McMillan, together with an essay by Art History Professor, Claude Baillargeon.

McMillan has a particular fascination with the gradual decay of the buildings and discarded machinery in the area, and over the period of his visits, has been able to document their deterioration and the progressive reclamation of the site by nature.[221]

HIGGINBOTHAM, Adam, *Midnight in Chernobyl: The Story of the World's Greatest Nuclear Disaster* (London: Bantam Press, 2019); THE NEW YORK TIMES, 'Midnight in Chernobyl: The Story of the World's Greatest Nuclear Disaster', Penguin Books, February 2019, https://www.penguin.co.nz/books/midnight-in-chernobyl-9780593076842.

[221] McMILLAN, David, and BAILLARGEON, Claude, *Growth and Decay: Pripyat and the Chernobyl Exclusion Zone* (Göttingen: Steidl, 2019); ROBIN, 'Ruins Revealed', *Westread Book Reviews* (blog), 22 March 2019, http://westreadreviews.blogspot.com/2019/03/ruins-revealed_22.html.

Music

Pieces of music that were influenced by the catastrophe were many and varied, and the following small selection from around the world show how musicians interpreted the disaster.

David Bowie's 1987 song *"Time Will Crawl"* was inspired by the disaster. Bowie told the “*Mail on Sunday*” that:

> this song deals with the industrial pollution and destruction of our planet: "One Saturday afternoon in April 1986, along with some other musicians I was taking a break from recording at Montreux studios in Switzerland. It was a beautiful day and we were outside on a small piece of lawn facing the Alps and the lake. Our engineer, who had been listening to the radio, shot out of the studio, and shouted: 'There's a whole lot of s--t going on in Russia.' The Swiss news had picked up a Norwegian radio station that was screaming to anyone who would listen - that huge billowing clouds were moving over from the Motherland and they weren't rain clouds”.[222]

> Polish singer Jacek Kaczmarski wrote a song called *"Dzień Gniewu II (Czarnobyl)"* (“*Day of Wrath II (Chernobyl”)*, written in May 1986 and released a year later), about the day of the disaster in Pripyat, its citizens unaware of the unfolding tragedy. The song juxtaposes calm, ballada-like music with the perspective of imminent death (such as *"Around the well in the backyard / wet, smiley faces / a child chases wheel / it is being killed as well"*), serving as a protest song against the Soviet handling of the disaster and the secrecy that surrounded it.[223]

[222] SONGFACTS, ‘Time Will Crawl by David Bowie’, Songfacts, accessed 4 May 2019, https://www.songfacts.com/facts/david-bowie/time-will-crawl; WIKIPEDIA, ‘Cultural Impact of the Chernobyl Disaster’.
[223] WIKIPEDIA, ‘Cultural Impact of the Chernobyl Disaster’.

In July 1988 the Japanese punk band "*The Blue Hearts*" released the single *"Chernobyl".* It was written by guitarist Mashima "Marcy" Masatoshi as a protest against nuclear power.[224]

Canadian composer Larysa Kuzmenko composed the piano piece *"In memoriam: to the Victims of Chernobyl"* in 1997.[225] "*From intense rage to speechless desolation, the vast emotional range depicted in Kuzmenko's Memoriam for the Victims of Chornobyl is a eulogy to one of the worst man-made disasters in modern history*"[226]

The Catalan neo-classical band Der Blaue Reiter have dedicated an entire album, *"Nuclear Sun - Chronicle Of A Nuclear Disaster"* to the Chernobyl disaster.[227]

German Thrash Metal band "Traitor" deal with the nuclear catastrophe of 1986 in their 2015 song *"Reactor 4".*[228]

Films

The films about Chernobyl fall into two categories, fiction and documentary and the three following examples of the fictional genre are a cross-section of what is available.

"Chernobyl: The Final Warning" is a 1991 American made-for-television disaster movie starring Jon Voight, Jason Robards and Sammi Davis and directed by Anthony Page. The story is based on a book by Dr. Robert Peter Gale, and is a true account of the events which took place at Chernobyl both prior to and after the explosion. The plot focusses on a fireman, his pregnant wife, the government officials who directed rescue

[224] WIKIPEDIA; RYM, 'The Blue Hearts', Rate Your Music, 14 March 2019, https://rateyourmusic.com/artist/the_blue_hearts.
[225] WIKIPEDIA, 'Cultural Impact of the Chernobyl Disaster'.
[226] PLANGERE, 'Memoriam for the Victims of Chornobyl', Plangere Editions: Canadian Composers Series, 2019, http://store.plangere.com/index.php?main_page=product_info&cPath=2_80&products_id=208.
[227] WIKIPEDIA, 'Cultural Impact of the Chernobyl Disaster'.
[228] WIKIPEDIA.

efforts, and Dr. Robert Peter Gale, a bone-marrow specialist who led an international team that helped treat the survivors of the disaster.[229]

From the docudrama format, we next look at the 2009 science fiction action film, "*Universal Soldier: Regeneration*", from Sony Pictures Home Entertainment, starring Jean-Claude Van Damme and Dolph Lundgren and directed by John Hyams. It revolves around a band of terrorists assisted by various cyborgs, holding the world hostage by seizing control of Chernobyl, and threatening to blow up the reactor.[230]

The third film, "*Chernobyl Diaries*" is a 2012 horror monster movie directed by Brad Parker and stars, Jonathan Sadowski, Jesse McCartney, Devin Kelley, Olivia Taylor Dudley, Ingrid Bolsø Berdaland, Nathan Phillips and Dimitri Diatchenko. The story revolves around six twenty-somethings who decide to tour the town of Pripyat – abandoned some twenty-five years previously – led by their guide Uri, a hulking ex-Special Services soldier. After a brief exploration of the abandoned city, the group soon finds themselves stranded, only to discover that they are not alone … wild dogs, mutant fish and humanoid mutants all add excitement to the mix, as the body count quickly rises.[231]

"*The Bell of Chernobyl*" is a Russian documentary film directed by Rollan Sergianko and concerns the aftermath of the explosion and the attempts to lessen the impact of radiation on the surrounding area. According to the film's synopsis it is "*an indictment against the irresponsible application of nuclear technology, armament and the Cold War.*"[232]

[229] PAGE, Anthony, *Chernobyl: The Final Warning*, Docudrama. Faction disaster movie (Turner Entertainment, 1991), https://www.youtube.com/watch?v=IcbEx4H-bmc; GALE, Robert Peter, and HAUSER, Thomas, *Final Warning: The Legacy of Chernobyl* (New York: Warner Books, 1988).
[230] ANON, 'Universal Soldier: Regeneration', Rotten Tomatoes, 2009, https://www.rottentomatoes.com/m/universal_soldier_the_next_generation; WIKIPEDIA, 'Cultural Impact of the Chernobyl Disaster'.
[231] WIKIPEDIA, 'Chernobyl Diaries', Wikipedia, 19 April 2019, https://en.wikipedia.org/wiki/Chernobyl_Diaries; ANON, 'Chernobyl Diaries', Rotten Tomatoes, 2019, https://www.rottentomatoes.com/m/chernobyl_diaries.
[232] ANON, 'The Bell of Chernobyl...(1987)', Net Film, accessed 7 May 2019, https://www.net-film.eu/film-9371/; WIKIPEDIA, 'The Bell of Chernobyl', Wikipedia, 1 May 2017, https://en.wikipedia.org/wiki/The_Bell_of_Chernobyl.

The Ukrainian documentary, "*The Russian Woodpecker*", – made by Fedor Alexandrovich, directed by Chad Gracia and released in 2015 – had some very positive critical reviews and won the World Cinema Grand Jury Prize for Documentary at the Sundance Film Festival in 2015, and the Sinofsky Prize for Best Feature Documentary at the Montclair Film Festival.[233] However, as well as being a documentary about the disaster, it suffers from being a vehicle for Alexandrovich's unproven conspiracy theory that a high-ranking government official, the Soviet minister of communication – Vasily Shamshin – may have made a call from Moscow to the Chernobyl plant, and ordered a dangerous directive that caused the explosion. This, so the theory goes, was in order to cover up the failure of a huge radio-transmitter called Duga-3, a.k.a. "*The Russian Woodpecker*" which was designed to interfere with US communication systems and upon which Shamshin had staked his reputation.[234]

"*Chernobyl.3828*" is a Ukrainian documentary directed by Sergey Zabolotny. It is dedicated to the 3828 people who worked cleaning the most dangerous areas of the plant roof and uses footage taken on site.[235]The film is seen through the eyes of the protagonist, Valeriy Starodumov, a dosimetrist, who trained and took the first soldiers onto the roof in order to assist with the decontamination. The operation took more than five months, but the film only relates to two days. On the first day we see robots being used to clear away debris, although they could not function in the most contaminated areas. On the second day, the Government commission decided to use soldiers and military students to do the work, although they could only stay on the roof for a very short period of time.[236]

233 BUCKLE, Andrew, 'The Russian Woodpecker [SFF2015]', An Online Universe, June 2015, https://www.anonlineuniverse.com/2015/06/the-russian-woodpecker-sff15/.
234 DELMAN, Matt, 'Russian Woodpecker, The', Hammer to Nail, 4 February 2015, http://www.hammertonail.com/reviews/the-russian-woodpecker-film-review/; GLENN, Daniel, 'The Russian Woodpecker', Film-Forward, 15 October 2015, Film-forward.com/star-reviews/the-russian-woodpecker.
235 ZABOLOTNY, Sergey, *Chernobyl 3828*, Documentary (TeleconStudio, 2012), https://www.youtube.com/watch?v=FfDa8tR25dk.
236 ANON, 'Chernobyl. 3828', Telecon Studio, 2012, http://www.telecon.kiev.ua/eng/projects/chernobyl_3828.html; ZABOLOTNY, Sergey, *Chernobyl 3828*.

Television series

Chernobyl has been mentioned in several TV series including, amongst others, episode 9, Season 5, of the cartoon series, "*The Simpsons*", the British motoring programme "*Top Gear*" and a new mini-series, "*Chernobyl".*

"*Chernobyl*" a five-part mini-series which premiered on 6 May 2018, starring Jared Harris and directed by Johan Renck, is the first TV series to dramatize the accident. It is, according to the website Deadline:

> the true story of one of the worst man-made catastrophes in history and tells of the brave men and women who sacrificed to save Europe from unimaginable disaster. The miniseries focuses on the heart- breaking scope of the nuclear plant disaster that occurred in Ukraine in April 1986, revealing how and why it happened and telling the shocking, remarkable stories of the heroes who fought and fell.[237]

On 7th June 2019, the BBC announced that Russian state TV is working on its own version of Chernobyl.

> The NTV drama will deviate from the acclaimed HBO series - and from historical reality - by claiming that the CIA was involved in the disaster. Director Aleksey Muradov claims it will show *"what really happened back then".*

[237] PETSKI, Denise, '"Chernobyl" Miniseries Starring 'The Crown's Jared Harris', Deadline, 26 July 2017, https://deadline.com/2017/07/hbo-sky-chernobyl-miniseries-starring-the-crown-jared-harris-tca-1202136735/.

> But in an interview with Komsomolskaya Pravda, Russia's most widely-read tabloid, Mr Muradov said his version of the show *"proposes an alternative view on the tragedy in Pripyat*".
>
> "There is a theory that Americans infiltrated the Chernobyl nuclear power plant," he told the paper*. "Many historians do not rule out the possibility that on the day of the explosion, an agent of the enemy's intelligence services was working at the station."*
>
> The Hollywood Reporter reports that the Russian culture ministry has contributed 30 million roubles ($463,000; £363,000) to the show.[238]

In Season 5 Episode 9 of "*The Simpsons*", "*The Last Temptation of Homer*", there is a passing reference to Chernobyl. At the National Energy convention in Capital City, Homer, and his new colleague Mindy Simmons, are representing the Nuclear Power Plant where they work. A crowd of passers-by are shouting at the nuclear power stand, culminating in one yelling out, *"No more Chernobyls",* prompting Homer to throw a brick at him.[239]

On the British show "*Top Gear"*, presenters Jeremy Clarkson, Richard Hammond and James May have been driving around the Crimean peninsula. But to complete their journey they must face one last fearsome challenge; to drive into Chernobyl and past the reactor. Clarkson ran out of fuel and had to stop not far from the building.[240]

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[238] BBC, 'Russia to Make Its Own Show about Chernobyl That Implicates the US', BBC News, 7 June 2019, https://www.bbc.com/news/world-europe-48559289.
[239] WIKIPEDIA, 'Cultural Impact of the Chernobyl Disaster'.
[240] *Chernobyl Exclusion Zone Challenge | Top Gear | Series 21*, Motoring (BBC, 2014), https://www.youtube.com/watch?v=nf6ON6pbDDA.

Video games

Needless to say, there are several video games that use Chernobyl as a setting. The Ukrainian game developer GSC Game World has issued three entitled, "*S.T.A.L.K.E.R.: Shadow of Chernobyl"*; its prequel "*S.T.A.L.K.E.R.: Clear Sky"* and sequel, "*S.T.A.L.K.E.R.: Call of Pripyat"*, are based upon the Chernobyl plant, disaster, and the surrounding areas. In the first two games the power plant is the setting of the final stages. Although the landscape is not an exact replica of the Exclusion Zone, various landmarks, and geographic features are similar and these are based upon fieldtrips to the Zone. To add spice to the story the power plant is guarded by the "Monolith", a fanatical cult who worship an alien crystal which lies inside No 4 Reactor.[241]

The latest game, "Chernobylite", was made by the Polish video game developer, *"The Farm 51"* and released on 16th October 2019. According to its promotional website it is *"a science-fiction survival horror experience. The game is mixing free exploration of its disturbing world with challenging combat, unique crafting and non-linear storytelling. We will constantly challenge you to: Survive … Play by your own rules …Experience …".*[242]

Summary

The institutionalised paranoia of the Soviet authorities prevented them from admitting that there had been an horrific nuclear accident, until Swedish scientists working at the nuclear power plant in Forsmark on the morning of the 28th of April, detected radiation emanating from the Soviet Union, and tackled the Soviets about it. After an initial denial, Tass finally admitted that there had been an incident at Chernobyl with a few casualties. Once the news had been released, press coverage was worldwide, but with very little to go on, much was speculative, and ranged from the sober to the alarming.

241 WIKIPEDIA, 'Cultural Impact of the Chernobyl Disaster'.
242 THE Farm 51, 'Chernobylite', Chernobylite - Official Website, 2019, https://www.chernobylgame.com/.

The accident at the Chernobyl nuclear power plant on 26th of April 1986 was the worst disaster to have occurred in the nuclear industry. It was the result of flawed reactor design and fatal mistakes made by the plant operators during an experimental test of the electrical control system, prior to routine maintenance. A sudden power surge caused a steam explosion that damaged the reactor vessel and detached the 1,000-tonne cover to the reactor, thus allowing steam to come into contact with the nuclear fuel. This resulted in a further explosion that destroyed the reactor core, severely damaged the reactor building, and caused an intense graphite fire that burned for ten days, thereby releasing large quantities of radioactive material into the atmosphere.

Although the heavier part of the dust and debris was deposited near the reactor, the lighter part was carried by winds over the Baltic countries and Scandinavia, and thence over much of northern Europe and eventually over much of the northern hemisphere: radiation was even detected in Japan and North America. The radiation emitted was mainly, iodine 131, caesium 134 and caesium 137. Iodine 131 only has a half-life of 8 days, but it can be transferred to humans fairly rapidly from the air and through the consumption of contaminated milk and leafy vegetables. Those who were children and adolescents at the time in Belarus, Ukraine, and the most affected Russian regions, who drank milk with high levels of radioactive iodine, were far more likely to be infected. By 2005, more than 6,000 thyroid cancer cases had been diagnosed in this group.

The caesium radionuclides have longer half-lives (caesium-134 has a half-life of 2 years while that of caesium-137 is 30 years). They cause longer-term exposures through being ingested, by inhalation and through external exposure from their deposition on the ground. Many other radionuclides were associated with the accident, for example, Strontium-90 which has a half-life of 29 years and is linked with leukaemia.

Two workers at the plant were killed on the night of the explosion, and a further 31 people died within the next few months from ARS and other medical conditions. During the next 20 years a further 15 people died from ARS, and 9 children under the age of

15 years died of thyroid cancer. Although the number of deaths and other health effects is much less than feared, the total number, including future deaths is highly contentious, with estimates ranging from 6,000 by the WHO, to 265,000 worldwide in a highly dubious report by Yablokov, who also claimed that there had been 985,000 premature deaths due to radioactivity.

Around 170,000 residents of Pripyat and the surrounding towns and villages that were within the 30 km exclusion zone set up around the stricken reactor, were evacuated within $2^1/_2$ weeks, and a further 220,000 people from Belarus, the Russian Federation and Ukraine, were resettled into less contaminated areas within the next few years.

One positive aspect of the disaster is that without human interference, the exclusion zone has become a haven for wildlife, with flourishing populations of many different animals, including, wolves, deer and even bears and herds of Przewalski's wild horses.

Chernobyl has been an inspiration for many different artists covering all forms of media from painting and sculpture to music, films, television series and video games. But perhaps the most impressive, is the United Nations tapestry designed by Alexander Kishchenko.

5:3 Overall conclusion

Although it only measured 4 on the VEI scale, the Laki eruption which took place between June 1783 and February 1784, was one of the largest fissure eruption events in recorded history. It proved disastrous for the Icelandic population, killing around 10,000 people, mainly through starvation, and an unknown number worldwide. Despite the fact that the information regarding mortality extracted from European parish registers during this period is rather sparse, it would appear that there was a higher number of deaths than could be expected in parts of France and northern Holland, during the very hot summer of 1783.[243] Whether this can be blamed upon Laki is a matter of conjecture, but as has been stated in chapter 1, this was in all likelihood caused by a combined negative phase of the North Atlantic Oscillation and an El Niño-Southern Oscillation warm event.[244]

Laki did not kill directly. It generated no lahars or pyroclastic flows. It caused no tsunamis, and the lava moved so slowly that it allowed people to evacuate their farms before they became inundated. Instead many fields were rendered unfit for use by being covered in lava or volcanic ash or were contaminated by fluorine-rich rainfall. Consequently, some 60% of the grazing livestock – the main source of the islanders' food – was lost, thus causing widespread starvation.[245]

Apart from its impact in Europe, Laki also caused an unknown number of deaths in Egypt by disrupting – for two years running, 1783 & 1784 – the Indian Ocean monsoon which feeds the Nile, and by so doing reduced the annual Nile floods, the life-blood of the region. The resulting reduction of water had disastrous consequences by causing a massive drought that led to untold suffering in the countryside.[246] However, even though Laki disrupted the monsoon pattern, we must also take into account the internecine warfare, onerous taxation and poor administration that had dogged the country for years.[247]

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243 GRATTAN, John et al., 'Volcanic Air Pollution and Mortality in France 1783-1784', *C. R. Geoscience*, no. 337 (2005), http://www.google.fr/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&ved=0CC8QFjAB&url=http%3A%2F%2Fwww.researchgate.net%2Fprofile%2FThorvaldur_Thordarson%2Fpublication%2F37145366_Volcanic_air_pollution_and_mortality_in_France_17831784%2Flinks%2F0c96052ab09ddb2314000000.pdf&ei=XAMxVb71IofSaN6tgbgC&usg=AFQjCNEu4GPSOz-wZdzpmC2hcI5PiG9umQ&bvm=bv.91071109,d.d2s; GARNIER, Emmanuel, 'The Laki fog of 1783. Volcanic activity and health crises in Europe', *Bulletin de l'Académie nationale de médecine* 195, no. 4–5 (10 May 2011): 1043–55, https://www.researchgate.net/publication/221871315_The_Laki_fog_of_1783_Volcanic_activity_and_health_crises_in_Europe.

244 D'ARRIGO, Rosanne et al., 'The Anomalous Winter of 1783-1784: Was the Laki Eruption or an Analog of the 2009-2010 Winter to Blame?', *Geophysical Research Letters* 38 (13 March 2011): 1–4, https://doi.org/10.1029/2011GL046696.

245 JACKSON, E.L., 'The Laki Eruption of 1783: Impacts on Population and Settlement in Iceland', *Geography* 67, no. 1 (January 1982): 42–50.

246 DAMODARAN, Vinita et al., 'The 1780s: Global Climate Anomalies, Floods, Droughts, and Famines', in *The Palgrave Handbook of Climate History* (London: Palgrave Macmillan, 2018), 536–37; OMAN, Luke D. et al., 'High-Latitude Eruptions Cast Shadow over the African Monsoon and the Flow of the Nile', *Geophysical Research Letters* 33, no. L18711 (September 2006): 1–5, https://doi.org/10.1029/2006GL027665.

247 GRATTAN, John, MICHNOWICZ, Sabina, and RABARTIN, Roland, 'The Long Shadow: Understanding the Influence of the Laki Fissure Eruption on Human Mortality in Europe', in *Living Under the Shadow Cultural Impacts of Volcanic Eruptions*, ed. GRATTAN, John and TORRENCE, Robin, One World Archaeology (Walnut Creek, California: Left Coast Press, 2007), 156, https://www.researchgate.net/publication/280574292_The_Long_Shadow_Understanding_the_Influence_of_the_Laki_Fissure_Eruption_on_Human_Mortality_in_Europe.

On a more contentious basis, Laki has been blamed for disrupting the annual monsoon over parts of India; and the Great Tenmei famine in Japan. India has a long history of famines; the Chalisa famine of 1783-1784 that affected a great part of South Asia, killed an estimated 10-11 million people, and followed an unusual El Niño event that began in 1780.[248]The Great Tenmei famine was most likely caused by the eruption of Mts Iwaki and Asama.[249]

The mortality caused by Laki on a global scale is unknown, but when taken into account and compared with that caused by the eruptions mentioned in Table 5:3, we find that it probably accounts for a far greater number of deaths, with the possible exception of Samalas. Not only did Samalas cause massive devastation on the islands of Lombok, Bali, and the western part of Sumbawa killing thousands of people – and most probably leaving the land sterile and uninhabitable for generations – its reach also extended as far as Europe, and owing to a change in the weather patterns, caused widespread starvation.[250]

Of the volcanoes described in the table, it is interesting to note that both Laki and Eyjafjallajökull had by far the lowest volcanic plumes, injecting gasses, and dust from 9-13km and 9km in into the atmosphere, respectively. Whereas $^{2}/_{3}$ of Laki's ejecta remained in the troposphere, from whence it was rapidly transported by the westerly jet stream towards the high-pressure zone positioned over Europe, causing a dry fog and acid rain; the remaining $^{1}/_{3}$ remained in the stratosphere for 12 months or more. See chapter 1, 1:1 Setting the Scene.

[248] GROVE, Richard H., 'The Great El Niño of 1789–93 and Its Global Consequences: Reconstructing an Extreme Climate Event in World Environmental History', *The Medieval History Journal* 10, no. 1–2 (1 October 2006): 80, https://doi.org/10.1177/097194580701000203; DAMODARAN, Vinita et al., 'The 1780s: Global Climate Anomalies, Floods, Droughts, and Famines', 523 et seq.; THORDARSON, Thorvaldur, 'Volatile Release and Atmospheric Effects of Basaltic Fissure Eruptions' (PhD, Honolulu, University of Hawaii, 1995), 123–31.
[249] MACFARLANE, Alan, 'The Three Major Famines of Japanese History.', 2002, 2–3, http://www.alanmacfarlane.com/savage/A-JAPFAM.PDF; WIKIPEDIA, 'Great Tenmei Famine', Wikipedia, 16 February 2018, https://en.wikipedia.org/wiki/Great_Tenmei_famine.
[250] LAVIGNE, Franck et al., 'Source of the Great A.D. 1257 Mystery Eruption Unveiled, Samalas Volcano, Rinjani Volcanic Complex, Indonesia', ed. Kushiro, Ikuo, *PNAS* 110, no. 42 (15 October 2013): 16746, http://www.pnas.org/content/110/42/16742.full.pdf+html.

Eyjafjallajökull's gas and dust remained in the troposphere, and whilst not causing any human fatalities, it caused a great deal of disruption by forcing airlines to cancel flights to and from Europe. Volcanic dust can damage aircraft engines, potentially leading to a mid-air engine failure.[251] See maps 5:9 and 5:10. Farmers were asked not to let their animals drink from contaminated streams and other water sources due to the danger of fluorosis and horse owners were asked to keep their herds undercover where the ashfall was significant.[252]

The height of the plume of radioactive material released by Chernobyl was measured to >1.2km, but further measurements indicate that some caesium and iodine migrated upwards to between 6-9km, and traces had been detected in the stratosphere.[253] Eventually, the radioactivity covered most of the northern hemisphere, albeit in exceedingly low concentrations.

The large quantity of radiation released by the Chernobyl disaster puts this accident in a league of its own, as it has the potential of being complicit in many thousands of deaths in the future, unlike the volcanic eruptions, which did not release huge amounts of radionuclides into the atmosphere. However, because the accident happened well over 30 years ago, it is extremely difficult to conclusively implicate Chernobyl in any future mortality.

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[251] BRITISH GEOLOGICAL SURVEY, 'Eyjafjallajökull Eruption, Iceland | April/May 2010'; GILL, Victoria, 'Iceland Volcano: Why a Cloud of Ash Has Grounded Flights'.
[252] WIKIPEDIA, '2010 Eruptions of Eyjafjallajökull'.
[253] UNSCEAR, *SOURCES, EFFECTS AND RISKS OF IONIZING RADIATION United Nations Scientific Committee on the Effects of Atomic Radiation 1988 Report to the General Assembly, ANNEX D*, 314.

Table 5:3 Comparison of five eruptions, the London smog and Chernobyl nuclear disaster to Laki

Volcano	VEI	Date	Eruption Type	Amt. of Tephra	Amt. of SO_2	Height of plume	No of Deaths	Reason
Laki, Iceland	**4**	**8 Jun. 1783 – 8 Feb. 1784**	**Fissure**	**14.7 ± 1km^3 [1]**	**122Mt [1]**	**9-13km [2]**	**~10,000 in Iceland [3] Unknown number globally**	**Starvation [3] Respiratory diseases**
Samalas, Indonesia	7	Between May & Oct. 1257	Explosive	40km^3 [4]	158 ± 12Mt [5]	43km [4]	Unknown	Starvation [6] Pyroclastic flows
Mt.Tambora, Indonesia	7	5 – 10 April 1815	Explosive	41± 4km^3 [7]	60-80Mt [8]	43km [9]	90-117,000 locally [10] Same no globally?	Tsunami, Starvation [11] Epidemics, Pyroclastic flows
Krakatau, Indonesia	6	26 – 27 August 1883	Explosive	21km^3 [12]	20Mt [13]	40km [14]	>36,000 [12]	Tsunamis, Pyroclastic [12] flows
Mt. St Helens, Washington, USA	5	18 May 1980	Explosive	~1km^3 [15]	1±0.3Mt [16]	23-27km [17]	57 [18]	Asphyxiation, Pyroclastic [18] flows
Eyjafjallajökull, Iceland	4	14 April – 23 June 2010	Explosive	0.25km^3 [19]	0.39Mt [20]	9km [19]	None [21]	N/A
Great Smog, London	N/A	5 – 9 Dec. 1952	N/A	N/A	N/A	N/A	~12,000 [22]	Bronchitis, Influenza, [23] Pneumonia, other Respiratory diseases
Nuclear Disaster, Chernobyl	N/A	25 -26 Apr. 1986	N/A	N/A	N/A	>1.2km [24]	31 Direct [25] 19 Indirect Many Thousands in the future?	Initial blast, Radiation [25] sickness, Cancer

1. Thordarson et al 1996, Thordarson and Self 2003; **2**. Maclean 1984, Rampino, Self and Stothers 1988; **3**. Jackson 1982, Thordarson and Self 1993; **4**. Guillet et al. 2017; **5**. Vidal et al. 2016; **6**. Jones 2012, Lavigne et al. 2013; **7**. Kandlbauer and Sparks 2014; **8**. Oppenheimer 2003; **9**. Sigurdsson et al.1992; **10**. Bronnimann and Krämer 2016; **11**. Stothers 1984, Sigurdsson et al. 1992, Sutawidjaja et al. 2006, Bronnimann 2016; **12**. San Diego State University undated; Self and Rampino 1981; **13**. Rampino and Self 1982; **14**. Gruber undated; **15**. Brantley and Myers 2005; **16**. Gerlach and McGee 1994; **17**. Sarah-Wojcicki et al. 1981; **18**. Brantley and Myers 2005, Grisham 2015; **19**. Iceland Magazine 2017; **20**. Schmidt 2014; **21**. Wikipedia 2017; **22**. Bell and Davis 2001, Hunt et al. 2003, Bell et al. 2004; **23**. Hunt et al. 2003, Bell et al. 2004; **24**. IRSN 2011; **25**. Tate 2011, UNSCEAR 2012, Llanilla 2013, Wikipedia 2018, Greenpeace 2006, Gronland 2011.

The Great London Smog, only lasted from 5th to 9th December 1952, but Londoners continued to suffer from its after-effects until the end of March the following year. It has been calculated that there were more than 4,000 to 4,500 deaths during the week ending 13th December than there were in the same period for the preceding year, and an additional 12,000 to more than 13,500 up to the end of March 1953.[254]

It has been argued by Witze and Kanipe, that the Laki haze *"would have been far, far, worse than the Great Smog of 1952"*, but statistically, this is unlikely to have been the case.[255] The smog lasted for four days, whilst the Laki fog lasted for some three months – about July to September – say approximately 90 days. If we extrapolate the number of additional deaths caused by the Great Smog over four days – 4,000 to 4,500 – to cover 90 days, we find that a further 90,000 to 101,250 people would have died, and this for Greater London only. The London smog had a great deal of smoke in its composition, and when this was combined with high concentrations of sulphur dioxide, and nitrogen oxides from vehicle exhausts – particularly diesel-fuelled buses – I contend that the resultant mix would have been considerably more toxic than the Laki dry fog.

News of the Krakatau eruption was the first to be broadcast to the world by cable. Owing to a functioning telegraph system, the news was disseminated rapidly – within two or three days – by the world's press. Previously, one could only learn about these events much later, and in the case of Laki, many months after the event. See table 2:3.

The advent of inter-continental cable links enabled the near-instant reporting of events; first by telegraph; then by radio and television; and now by satellite; internet; emails; blogs; smart phones; and SMS. The eruptions of Mount St. Helens and Eyjafjallajökull were captured instantly on TV, video and by satellite, whilst news of the Great London

[254] MET OFFICE, 'The Great Smog of 1952'; GLC, *50 Years on. The Struggle for Air Quality in London since the Great Smog of December 1952*, 3–9; BELL, Michelle L., DAVIS, Devra L., and FLETCHER, Tony, 'A Retrospective Assessment of Mortality from the London Smog Episode of 1952: The Role of Influenza and Pollution', 6–8.
[255] WITZE, Alexandra and KANIPE, Jeff, *Island on Fire*, 182.

Smog was broadcast by the BBC, on both radio and television. The same cannot be said of Chernobyl as it took two days for the Soviet authorities to admit to the disaster.

Social responses to the eruptions were varied. The Laki dry fog, accompanied by severe storms, meteors, and other unusual occurrences during the summer of 1783, caused much alarm amongst the more unenlightened of the European population. This prompted various academics, including the French astronomer, de la Lande to try to assuage the populous by publishing calming and explanatory articles in the local press.

The very severe weather that followed the Tambora eruption, caused flooding and heavy rain in many parts of Europe. As well as this extreme weather, 1816 had an unusually cold spring, summer, and autumn. Consequently, crops would not ripen, which resulted in food shortages, famine, and starvation. This, in turn, led to food riots in Britain and parts of Europe. The combination of cold, wet, weather, and undernourished bodies proved ideal for the spread of epidemics, particularly typhus, dysentery, and fevers of various kinds. Hordes of beggars were to be seen throughout Europe, many of whom were ex-military personnel who had been dismissed from military service at the end of the Napoleonic wars. Food shortages combined with large-scale unemployment provided the ideal incentive for mass emigration to the Americas and Russia.

There were no food riots in Europe, or mass emigrations to America after the Krakatau eruption, but there were far-reaching political consequences in Indonesia, the ramifications of which could not have been foreseen at the time. A revolt, inspired by the teachings and prophesies of one man, Hajji Abdul Karim, culminated in the quickly-suppressed Banten Revolution against the Dutch authorities. However, the seed of nationalism had been sown, but independence was only fully achieved in 1949.

Unfortunately, mental health and stress related problems were experienced by some of the people living in the vicinity of the Mount St. Helens eruption, and programmes had to be put in place to help them. The same thing happened with a great many of the Chernobyl survivors, with the WHO reporting that mental health issues with the survivors were the biggest public health problem to date (2006).

It seems to be a truism that the sites of some disasters hold a certain fascination for people, and proof of this is to be found in the burgeoning Chernobyl tourist industry – known as black tourism. The volcanoes of the Indonesian archipelago are no exception, and there are volcano tours covering both Tambora and Krakatau. Indonesia has been a popular destination for tourists since being developed for wealthy Dutch merchants and plantation owners in the 19th century, but whether the eruptions of Tambora or Krakatau had any effect on the number of visitors is open to question.

We can be confidently certain that when the news of the Laki eruption reached the outside world, Iceland did not become a magnet for international tourism. In the 50 years from 1950-2000 only four million tourists visited Iceland.[256] Since then there had been a steady increase in the number of visitors, but after the eruption of Eyjafjallajökull there was a boom in the tourist industry with the number of annual visitors exceeding two million in 2017. See Fig. 5:11. This has provided a much-needed boost to Iceland's economy following the bank crash of 2008. The Icelanders embraced tourism wholeheartedly and the number of jobs increased substantially to cater for the increase in visitors. There are of course downsides to this; apartment prices increased by 5% to 9% from 2015 to 2017, and landlords can often make twice the amount on Airbnb that they would make renting out their properties to locals, thus undercutting incentives to provide housing for people who actually live there.[257]

Disasters have often proved irresistible to artists of all persuasions. The sunsets resulting from the eruptions of Tambora, Krakatau and Eyjafjallajökull; the thick

[256] BRYNJOLFSSON, Gretar et al., 'Tourism in Iceland: Investing in Iceland's Growth Engine', GAMMA, 2018, 8, https://www.gamma.is/media/skjol/Gamma-Tourism.pdf.
[257] FONTAINE, Paul, 'Airbnb In Iceland: Growing Fast, Driving Up Costs, Mostly Not Registered Legally', The Reykjavik Grapevine, 21 June 2018, https://grapevine.is/news/2018/06/21/airbnb-in-iceland-growing-fast-driving-up-costs-mostly-not-registered-legally/.

impenetrable London smog; the brooding landscapes of the aftermath of the Chernobyl disaster, have all made a powerful impact on painters. Other forms of art have also been influenced by the disasters. The audiovisual installation, "*Eyjafjallajokull*"; the Chernobyl tapestry in the United Nations headquarters; the multimedia event at Pripyat, being among the more unusual.

Literature is well represented. The ancient Javanese poem, the "*Babad Lombok",* describes the eruption of Mt. Samalas, whilst 1816, the "*year without a summer*", inspired Mary Shelley to write one of the most famous horror stories of all time, *"Frankenstein"*. The volcanic eruptions, from Laki to Eyjafjallajökull; the disaster at Chernobyl and the dense London fogs, have all been the inspiration for famous poems and novels, whilst film and television documentaries have been made about Krakatau and Chernobyl.

And finally, we see that press coverage of the events varies between the sober reporting of known facts, to creative reporting of mere rumour and conjecture.

CHAPTER 6 – Villain or Fall Guy?

In this, the final chapter of the thesis, we have brought together the conclusions from the previous chapters with the object of reappraising and reinterpreting the consequences of the Laki eruption in Europe. We have placed the eruption within the context of the other strange and unusual events that took place in that year, thereby earning it the name of the Annus Mirabilis, or year of wonders. We have also presented a detailed overview of the different categories of literature – contemporary, academic, and popular – that these extraordinary events have generated.

Eyewitness accounts of the eruption have been analysed in great detail by Thordarson, and his findings have been summarised in Table 2:2. Great use has been made in the thesis of eyewitness accounts relating to the other events occurring in the year of wonders, notably, those concerning the Calabrian earthquakes; the dry sulphurous fog; the abnormally hot summer followed by an unbearably cold winter; massive flooding the ensuing spring; the Great Meteor, and many other remarkable events.

In this thesis, we have made a detailed examination of living conditions during the latter part of the 18th century, with the objective of establishing whether the Laki dry fog was responsible for causing any, if not all, the deaths attributed to it, or was just one factor among many, influencing the health of a population already stressed by frequent outbreaks of disease. Quotes from contemporary sources have been carefully scrutinised, and in this context, we have explored the state of housing vis à vis fresh air, cleanliness, access to clean water and sanitation. We have seen that in big cities like London and Paris, fresh air was at a premium, the more opulent citizens moving out to the western suburbs to escape the all-pervading smells that emanated from the privies, dung heaps, over-flowing graveyards, slaughter houses and various industrial enterprises.

Body odour was a problem for all classes as fresh water was in short supply for washing, unless one had access to a river or parish pump. Consequently, the majority of people were, by today's standards, exceedingly dirty, only washing their hands and faces on a regular basis, if that, and their bodies seldom. Washing clothes was a problem, and they were often worn unwashed until they were in rags.

There was a large selection of food available for those able to afford it, but generally speaking, the diet eaten by both rich and poor was, by today's standards, extremely unhealthy. The rich probably suffered from vitamin deficiency by eating a high protein meat diet with little fruit and vegetables, but for many of the poor, it meant subsisting on a diet of bread, very little meat, and seasonal fruit and vegetables.

From birth onwards, people were challenged by a whole battery of different diseases, and a close analysis has been made of many of these, and their modes of transmission. However, without the benefit of modern antibiotics, even a cut finger could lead to certain death through sepsis or tetanus. The most feared disease was, perhaps, smallpox, but there were many just as deadly, for example, summer diarrhoea, typhus, influenza, and in the marshy regions, malaria. It is no wonder then, considering the distance that a cloud of pathogens can be expelled by coughs and sneezes, that infectious diseases spread like wildfire, especially when one considers the living conditions that many people had to endure. Social distancing was an unknown. We have also looked at occupational diseases, such as grinder's lung or silicosis, caused by the inhalation of metal or stone dust, and mad hatter disease due to inhaling mercury vapour.

Volcanic eruptions can be the cause of three kinds of disease, namely, irritant, noxious, or inert. The Laki dry fog was an irritant, and because it consisted mainly of SO_2 and much smaller amounts of HCl, HF and NH_3, inhaling it could have affected the health of those with existing respiratory conditions.

The high incidence of infant deaths has been discussed with particular reference to the excessive rate of mortality in lying-in hospitals and the suggestion that many deaths were the result of infanticide.

Unfortunately, the medical profession was unable to cope with most infections, which is hardly unsurprising, as the germ theory of disease had not yet been developed. Epidemic diseases such as smallpox, dysentery, fevers of various kinds and influenza were very common, and a large part of the population preferred to put their trust in tried and tested folk remedies, either because they could not afford doctors, or preferred not to trust them. Quacks and charlatans abounded, and then as now, the patent medicine industry did a roaring trade.

Thirty years-worth of burial data collected from nearly 1,500 parish registers in Britain, Jersey and the I.O.M., enabled their rates of mortality to be studied in great detail. From these records it appears that the Laki eruption did not have the dire effect attributed to it, of causing many thousands of additional deaths above the expected annual average.

As the French data was only based on a small sample of 53 parish registers, the population statistics produced by INED were utilised as well, and the number of additional deaths – 48.5k – that may have been due to Laki, was calculated. This, however, may be a false presumption, as the mortality rate in 1782 was 18,500 higher than that for 1783.

We were only able to obtain the national figures for 30 years of burials relating to Norway and Sweden, and these show that there was a major spike in the mortality rate in 1773, due to a wave of acute epidemic diseases that struck central Europe and Scandinavia. There were also elevated mortality levels in 1789 which were most likely due to one of the epidemic fevers circulating in Europe at the time. The data obtained from the limited number of parishes in the Netherlands, Norway and Sweden shows that the burial rate for 1783 and 1784 falls within the normal parameters that could be expected.

We looked at the role that Laki played in three other major disasters, namely, famines in Egypt, India and Japan that occurred at around the same time as Laki was erupting.

It was found that the eruption caused a failure in the annual monsoons that fed the Nile, thus causing severe droughts which, in turn, led to a disastrous famine and the death of an untold number of people in Egypt. It is tempting to blame Laki for the Indian Chalisa famine, but that was caused by an unusual El Niño event which began in 1780; and the Great Tenmei famine in Japan was most likely due to bad weather caused by the eruption of Mts Iwaki and Asama.

Finally, in Chapter 5, the Laki eruption was compared to five other eruptions of VEI 4 or greater, and two other non-volcanic disasters, one of which had the potential of causing a catastrophe of global proportions. Unlike the other eruptions – apart from Eyjafjallajokull that caused no deaths at all – Laki killed indirectly by starvation, whilst the others mainly killed directly, by pyroclastic flows, lahars, or tsunamis. Although Laki's was by no means the largest eruption scrutinised in this thesis, it probably killed more people indirectly, worldwide, than all the other eruptions combined, with the possible exception of Samalas.

Moreover, mention must be made of the "year without a summer" caused in part by the Tambora eruption. This helped to change global weather patterns, thus resulting in lower summer temperatures and heightened rainfall over large parts of central and western Europe. The bad weather resulted in the failure of grain harvests, thereby causing severe food shortages and ultimately starvation and disease. The cold weather reached as far as Canada and New England, leading to the New England saying, *"eighteen hundred and froze to death".*

The disasters produced a range of differing social responses, for example: fear of the unknown generated by the strange and unusual phenomena of the Annus Mirabilis; the shortage of food throughout much of Europe after the eruption of Tambora prompted food riots, and encouraged emigration to the Americas and Russia; religious fanaticism spread by an anonymous Italian astronomer appeared during 1816 – the Bologna Prophecy; the prophecies of the charismatic teacher, Abdul Karim, who fanned the flames of Indonesian independence after the Krakatau eruption, that ultimately led to the Banten Rebellion of 1888; psychological and emotional problems after the Mt St Helens eruption and the Chernobyl nuclear disaster; wearing face masks during the London Smog.

Apart from comparing the number of people killed and the havoc caused by these catastrophes, this thesis examines some of the positive aspects that accrued. There has been no lack of artistic response, and the disasters mentioned in the thesis have inspired some impressive works of art, which cover a wide range of media, including amongst other things, paintings; sculpture; literature; film; audio-visual installations; and video games.

One interesting and unexpected outcome of these catastrophes was the advent of disaster tourism. It seems to be a truism, that people like a good disaster as long as it doesn't happen to them. Apart from the Samalas eruption and the London smog, all those mentioned in this thesis have generated lucrative tourist industries.

The dissemination of news has speeded up unimaginably since the end of the 18th century. The news of the Laki eruption took several weeks to reach the rest of Europe, but the advent of the inter-continental cable link during the first half of the 19th century meant that news of the Krakatau eruption reached the outside world within a few hours, and the other later disasters discussed here, almost if not immediately. However, there was one exception. Due to the obduracy of the Soviet authorities, it took 48 hours before the news of the Chernobyl disaster was admitted.

Was Laki the villain or the fall guy? On the evidence presented in this thesis, it can be said that on the world stage, Laki was definitely the villain. However, on the current evidence, in Britain certainly, and Continental Europe possibly, Laki was, without doubt, the fall guy.

APPENDIX 1 List of plants affected by a sulphur dioxide mist as listed by S. J. Brugmans

I Plants that have suffered the most
II Plants that suffered less
III Plants that suffered a little
IV Plants with no damage

I Plants that have suffered the most

Acorus calamus	Sweet flag or calamus
Apium petroselinum	Parsley
Asphodelus lutens	Yellow asphodel
Asphodelus ramosus	Branched asphodel
Calendula officinalis	Common marigold
Carthamus lanatus	Saffron thistle
Carpinus ostrya	Hop-hornbeam
Centaurea cyanus	Cornflower
Centaurea scabiosa	Greater knapweed
Centaurea lacea	Brown knapweed
Centaurea benedicta	Blessed thistle or holy thistle
Corylus avellana	Hazel
Cytisus laburnum	Laburnum
Dictamnus albus	Burning bush or dittany
Dipsacus fullonum	Teasel
Fragaria vesca	Wild strawberry
Fraxinus excelsior	Ash
Gentiana lutea	Yellow gentian
Hypericum spp.	St. John's wort
Juglans regia	Walnut
Ligusticum levisticum	Lovage
Linum usitatissimum	Flax
Oenothera biennis	Evening primrose
Ononis spinosa	Restharrow
Paeonia officinalis	European or common peony
Pinus silvestris	Scots pine
Pinus strobus	White pine
Pinus cedrus	Cedar
Pinus abies	Norway spruce
Platanus orientalis	Oriental plane
Populus alba	White poplar
Populus nigra	Black poplar
Prunus domestica	Plum
Ribes rubrum	Redcurrant
Ribes album	Whitecurrant
Ribes Uva crispa	Gooseberry
Rosa	Rose
Salix	Willow
Scabiosa	Scabious
Spiraea ulmaria	Meadowsweet
Vicia faba	Broad bean

II Plants that suffered less

Alcea rosea	Hollyhock
Alfine media	Common chickweed
Amygdalus communis	Almond
Anagallis arvensis	Scarlet pimpernel
Aquilegia vulgaris	Columbine
Asarum europaeum	Hazelwort or asarabacca
Avena sativa	Wild oats
Berberis vulgaris	Barberry
Betula alba	Birch or white birch
Betula alnus	Alder
Botomus umbellatus	Flowering rush
Clematis erecta	Clematis
Daucus carota	Wild carrot
Delphinium	Delphinium
Fagus castanea	Sweet chestnut
Fagus sylvatica	European beech
Geranium	Geranium or cranesbill
Gramina	Grass (ordinary Meadow Grass)
Helianthus annuus	Sunflower
Hordeum vulgare	Barley
Humulus lupulus	Hop
Indigofera tinctoria	Indigo
Iris pseudacorus	Yellow flag or yellow iris
Iris xiphium	Spanish iris
Mimosa sensitiva	Mimosa
Morus nigra	Black mulberry
Oxalis acetofella	Wood sorrel
Papava	Poppy
Phlox	Phlox
Polygonum fagopyrum	Buckwheat
Primula veris	Cowslip
Pyrus communis	Pear
Pyrus malus	Apple
Rheum rhaponticum	False rhubarb
Rheum undulatum	Rhubarb
Rheum palmatum	Turkish or Chinese rhubarb
Rheum compactum	No common name
Ribes nigrum	Blackcurrant
Rubia tinctorum	Common madder
Rubus idaeus	Raspberry
Rubus fruticosus	Blackberry
Rumex	Dock & sorrel family
Sagittaria fagittifolia	Arrowhead
Sium latifolium	Great water parsnip
Spinacia oleracea	Spinach
Spiraea filipendula	Dropwort
Stratiotes aloides	Water soldier
Vitis vinifera	Common grape vine

III Plants that suffered a little

Acer	Maple
Aegopodium podagraria	Ground elder
Alisma plantago aquatica	Common water plantain
Allium	Onion family
Amarantus tricolor	Joseph's coat
Amygdalus persica	Peach
Antirrhinum linaria	Antirrhinum or snapdragon
Apium petroselinum	Parsley, especially young shoots
Arctium lappa	Greater burdock
Artemisia (most species inc.)	Wormwood, tarragon
Aster	Aster
Cannabis sativa	Cannabis
Chenopodium	Goosefoot
Conium maculatum	Hemlock
Crataegus Oxyacantha	Hawthorn
Datura	Angel's trumpet or moonflower
Dianthus	inc. Pink, Carnation, Sweet William
Epilobium	Willowherb
Equisetum arvense	Common horsetail
Erica (most varieties)	Heather
Euphorbia	Spurge
Geranium moschatum	Musk stork's-bill
Hissopus officinalis	Hyssop
Impatiens chinensis	Chinese balsam
Inula helenium	Elecampane
Iunci	Rush
Lactuca sativa	Lettuce
Lathurus (most varieties)	Sweet pea
Ligustrum vulgare	Privet
Lotus Iacobaeus	Black-flowered lotus
Lupulus	Hop
Mercurialis annua	Annual mercury
Myrica gale	Bog myrtle
Phellandrium aquaticum	Water dropwort
Philadelphus coronarius	Sweet mock-orange
Pinus larix	Larch
Plantago major	Greater or broadleaf plantain
Plantago media	Hoary plantain
Plantago lanceolata	English plantain
Prunus armeniaca	Armenium plum
Prunus cerasus	Sour or wild cherry
Ranunculus	Buttercup fam.
Salvia	Sage
Sanguisorba officinalis	Great burnet
Saponaria officinalis	Soapwort
Scirpi	Rush
Secale cereale	Rye
Serratula arvensis	Creeping thistle
Sparganium erectum	Bur-reed

Tilia europaea	Lime
Trifolium melilotus officinalis	Yellow sweet clover
Trifolium repens	White or Dutch clover
Trifolium pratense	Red clover
Trifolium arvense	Haresfoot clover
Triticum aestivum	Wheat
Triticum hybernum	Wheat
Tussilago farfara	Coltsfoot
Tussilago petasites	Butterbur
Ulmus campestris	Common elm

IV Plants with no damage

Achillaea Millefolium	Yarrow
Aloe	Aloe
Apium graveolens	Celery
Asparagus officinalis	Asparagus
Brassica napus	Oilseed rape
Brassica rapa	Turnip
Brassica oleracea	Cabbage
(includes white-head, red, savoy, curled, kale and brown coal cabbages)	
Canna indica	Indian shot or canna
Carduus marianus	St. Mary's Thistle
Citrus aurantium	Bitter orange
Citrus medica	Citron
Cucumis sativus	Cucumber
Digitalis purpurea	Foxglove
Erysimum officinale	Hedge mustard
Ficoides	Ficoides
Hedera arborea	Common Ivy
Heracleum spondylium	Hogweed
Ilex aquifolium	Holly
Impatiens balsamina	Garden balsam
Impatiens noli me tangere	Touch-me-not balsam
Ipomaea	Morning glory spp.
Jucca	Yucca
Juniperus communis	Common juniper
Lathyrus tuberosus	Tuberous pea
Laurus nobilis	Bay
Lavandula spica	Lavender
Lemna trisulca	Star or ivy duckweed
Lemna minor	Common or lesser duckweed
Lemna gibba	Gibbous or swollen duckweed
Lilium canadense	Canada or meadow lily
Liriodendron tulipifera	Tulip tree
Lonicera periclymenum	Honeysuckle
Lotus corniculatus	Bird's-foot trefoil
Lysimachia nummularia	Creeping jenny
Orchis maculata	Heath spotted orchid
Orchis bifolia	Lesser butterfly orchid
Passiflora	Passion flower
Phaseolus vulgaris	French bean

Polygonum amphibium	Water knotweed
Polygonum hydropiper	Water pepper
Polygonum aviculare	Common knotgrass or knotweed
Portulaca oleracea	Common purslane
Potentilla anserina	Common silverweed
Prunus laurocerasus	Common or cherry laurel
Queldergras	Marsh grass
Quercus robur	English or pedunculate oak
Sambucus ebelus	Danewort
Sambucus nigra	Elder
Saxifraga	Saxifrage
Sempervivum	Houseleek
Solanum tuberosum	Potato
Spiraea trifoliata	Bowman's root
Tagetes patula	French marigold
Tanacetum vulgare	Tansy
Taxus cacata (sic)	Yew
Thlaspi bursa-pastoris	Shepherd's purse
Thuja occidentalis	Swamp cedar
Tropaeolum nasturtium indicum	Nasturtium
Urtica urens	Dwarf nettle
Verbascum	Mullein
Veronica officinalis	Heath or common speedwell
Veronica chamaedrys	Germander speedwell
Veronica arvensis	Wall speedwell
Viburnum tinus	Viburnum

APPENDIX 2 Tobias Smollett , Travels through France and Italy

I have likewise two small gardens, well stocked with oranges, lemons, peaches, figs, grapes, corinths, sallad, and pot-herbs. It is supplied with a draw-well of good water, and there is another in the vestibule of the house, which is cool, large, and magnificent. You may hire furniture for such a tenement for about two guineas a month: but I chose rather to buy what was necessary; and this cost me about sixty pounds. I suppose it will fetch me about half the money when I leave the place. It is very difficult to find a tolerable cook at Nice. A common maid, who serves the people of the country, for three or four livres a month, will not live with an English family under eight or ten. They are all slovenly, slothful, and unconscionable cheats. The markets at Nice are tolerably well supplied.Their beef, which comes from Piedmont, is pretty good, and we have it all the year. In the winter we have likewise excellent pork, and delicate lamb; but the mutton is indifferent. Piedmont, also, affords us delicious capons, fed with maize; and this country produces excellent turkeys, but very few geese. Chickens and pullets are extremely meagre. I have tried to fatten them, without success. In summer they are subject to the pip, and die in great numbers. Autumn and winter are the seasons for game; hares, partridges, quails, wild-pigeons, woodcocks, snipes, thrushes, beccaficas, and ortolans. Wild-boar is sometimes found in the mountains: it has a delicious taste, not unlike that of the wild hog in Jamaica; and would make an excellent barbecue, about the beginning of winter, when it is in good case: but, when meagre, the head only is presented at tables. Pheasants are very scarce. As for the heath-game, I never saw but one cock, which my servant bought in the market, and brought home; but the commandant's cook came into my kitchen, and carried it of, after it was half plucked, saying, his master had company to dinner. The hares are large, plump, and juicy. The partridges are generally of the red sort; large as pullets, and of a good flavour: there are also some grey partridges in the mountains; and another sort of a white colour, that weigh four or five pounds each. Beccaficas are smaller than sparrows, but very fat, and they are generally eaten half raw. The best way of dressing them is to stuff them into a roll scooped of it's crum; to baste them well with butter, and roast them, until they are brown and crisp. The ortolans are kept in cages, and crammed, until they die of fat, then eaten as dainties. The thrush is presented with the trail, because the bird feeds on olives. They may as well eat the trail of a sheep, because it feeds on the aromatic herbs of the mountain. In the summer, we have beef, veal, and mutton, chicken, and ducks; which last are very fat, and very flabby. All the meat is tough in this season, because the excessive heat, and great number of flies, will not admit of its being kept any time after it is killed. Butter and milk, though not very delicate, we have all the year. Our tea and fine sugar come from Marseilles, at a very reasonable price.

Nice is not without variety of fish; though they are not counted so good in their kinds as those of the ocean. Soals, and flat-fish in general, are scarce. Here are some mullets, both grey and red. We sometimes see the dory, which is called St Pierre; with rock-fish, bonita, and mackarel. The gurnard appears pretty often; and there is plenty of a kind of large whiting, which eats pretty well; but has not the delicacy of that which is caught on our coast. One of the best fish of this country, is called Le Loup, about two or three pounds in weight; white, firm, and well-flavoured. Another, no-way inferior to it, is the Moustel, about the same size; of a dark-grey colour, and short, blunt snout; growing thinner and flatter from the shoulders downwards, so as to resemble a soal at the tail. This cannot be the mustela of the antients, which is supposed to be the sea lamprey. Here too are found the vyvre, or, as we call it, weaver; remarkable for its long, sharp spines, so dangerous to the fingers of the fishermen. We have abundance of the saepia, or cuttle-fish, of which the people in this country make a delicate ragout; as also of the polype de mer, which is an ugly animal, with long feelers, like tails, which they often wind about the legs of the fishermen. They are stewed with onions, and eat something like cow-heel. The market sometimes affords the ecrivisse de mer, which is a lobster without claws, of a sweetish taste; and there are a few rock oysters, very small and very rank. Sometimes the fishermen find under water, pieces of a very hard cement, like plaister of Paris, which contain a kind of muscle, called la datte, from its resemblance to a date. These petrifactions are commonly of a triangular form and may weigh about twelve or fifteen pounds each and one of them may contain a dozen of these muscles which have nothing extraordinary in the taste or flavour, though extremely curious, as found alive and juicy, in the heart of a rock, almost as hard as marble, without any visible communication with the air or water.[1]

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[1] SMOLLETT, Tobias, *Travels through France and Italy*, The world's classics reprint (London, Edinburgh, Glasgow: O.U.P., 1919), 156-58,1st ed. 1766.

APPENDIX 3 Germ, miasma, and contagion theories of disease

1. Germ theory: This idea was first mooted by the Italian physician, poet and mathematician, Girolamo Fracastoro in his book *De contagione et contagiosis morbis et curatione* which was published in 1546. He proposed that epidemic diseases are caused by transferable tiny particles or "spores" that could transmit infection by direct or indirect contact or even without contact over long distances. In his writing, the "spores" of diseases may refer to chemicals rather than to any living entities.[2] From then on, various authors had similar ideas. Richard Bradley writing during the years 1714 - 1721 **"**proposed a unified, unique, living agent theory of the cause of infectious diseases of plants and animals and the plague of humans."[3] Benjamin Marten, wrote a "New Theory of Consumptions" in 1720, which also suggested the germ theory.[4]

Agostino Bassi an Italian entomologist. preceded Louis Pasteur in the discovery that microorganisms can be the cause of disease He discovered that the muscardine disease of silkworms was caused by a living, very small, parasitic organism, a fungus that would be named eventually *Beauveria bassiana* in his honour. In 1844, he stated

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[2] WIKIPEDIA, 'Girolamo Fracastoro', 5 October 2015, https://en.wikipedia.org/wiki/Girolamo_Fracastoro; ZANOBIO, Bruno, 'Fracastoro, Girolamo', Encyclopedia.com, 2008, http://www.encyclopedia.com/doc/1G2-2830901495.html.

[3] SANTER, Melvin, 'Richard Bradley: A Unified, Living Agent Theory of the Cause of Infectious Diseases of Plants, Animals, and Humans in the First Decades of the 18th Century', *Perspectives in Biology and Medicine* 52, no. 4 (Autumn 2009): 566–78, https://doi.org/10.1353/pbm.0.0124.

[4] MARTEN, Benjamin, *A New Theory of Consumptions, More Especially of a Phthisis, or Consumption of the Lungs : Wherein, after a Brief History of the Distemper, Its Various Symptoms throughout Its Several Degrees, and Every Minute Step It Takes, from Its First Invading the Patient, to Its Final Termination, Enquiry Is Made Concerning the Prime, Essential, and Hitherto Accounted Inexplicable Cause of That Disease, so Very Endemick to This Nation, and Generally Fatal to Those It Seizes on : With an Account of the Great Number of Medicines, and Various Methods of Cure Recommended for Consumptions; and the Different Opinions of Authors Concerning Them : Also the Possibility of Healing Ulcers in the Lungs Asserted, the Strongest Objections against It Answered, and a Different and More Probable Method of Cure Advanced, than Commonly Practised : Likewise Directions about Eating, Drinking, Sleeping, Exercise, and Way of Living in General, Proper for Consumptive Persons*, 1st ed. (London: R. Knaplock; A. Bell; J. Hooke; C. King, 1720), 51–62, https://books.google.fr/books?id=QQG1kPqyoTkC&pg=PA190&dq=Benjamin+Marten+New+theory+of+Consumptions&source=gbs_selected_pages&cad=2#v=onepage&q=Benjamin%20Marten%20New%20theory%20of%20Consumptions&f=false; DOETSCH, Raymond N., 'Benjamin Marten and His "New Theory of Consumptions"', *Microbiological Reviews* 42, no. 3 (September 1978): 521–28.

the idea that not only animal (insect), but also human diseases are caused by other living microorganisms; for example, measles, syphilis, and the plague.[5]

Ignaz Semmelweis was a Hungarian born physician who, in 1847, was given a 2-year appointment as an assistant in obstetrics with responsibility for the First Division of the maternity service of the Allgemeine Krankenhaus teaching hospital in Vienna. Whilst there, he concluded that the rate of puerperal or childbed fever (13-18%) in a ward where the patients were treated by physicians and students who had come straight from autopsies was much higher than the ward where patients were treated by midwives who did not attend them (2%). This, he reasoned, was due to the fact that none of the physicians or their students washed their hands after dissecting the dead bodies After a controlled trial using a chloride of lime solution, the mortality rate fell to about 2%—down to the same level as the midwives. Later he started washing the medical instruments in the same solution and the rate decreased to about 1%.[6]

John Snow is considered as the “Father of Modern Epidemiology” owing to his discovery that a cholera outbreak in Soho, London, was transmitted through contaminated water. For a detailed description see: David Vachon, *Father of Epidemiology*.[7]

Louis Pasteur was a French chemist who disproved the theory that life appeared spontaneously, for example, fleas grew from dust or maggots from dead flesh. In a series of ground-breaking experiments, he showed that microorganisms cause both fermentation and disease, thus supporting the germ theory of disease. He also developed the earliest vaccines against anthrax, chicken cholera and rabies, and by

[5] WIKIPEDIA, ‘Agostino Bassi’, Wikipedia, 16 September 2015, https://en.wikipedia.org/wiki/Agostino_Bassi; PORTER, J. R., ‘Agostino Bassi Bicentennial (1773-1973)’, *Bacteriological Reviews* 37, no. 3 (September 1973): 284–88.

[6] BEST, M and NEUHAUSER, D, ‘Ignaz Semmelweis and the Birth of Infection Control’, *BMJ Quality & Safety* 13 (2004): 233–34, https://doi.org/10.1136/qshc.2004.010918; WIKIPEDIA, ‘Ignaz Semmelweis’, Wikipedia, 13 October 2015, https://en.wikipedia.org/wiki/Ignaz_Semmelweis.

[7] VACHON, David, ‘Father of Modern Epidemiology’, *Old News*, June 2005, 8–10.

proving that a disease of silkworms called pebrine, was caused by two species of microsporidia, saved the French silk industry.[8]

Robert Koch is considered as the founder of bacteriology. Building on Pasteur's work, he proved that the bacterium, Bacillus anthracis was the cause of anthrax. He and his team also discovered the causes of, tuberculosis and cholera.[9]

2. <u>Miasma theory</u>: A theory that originated in classical Greece, at least as far back as Hippocrates (c.400 BC), and had a considerable following from the Medieval period up to the 18th and 19th centuries, as a way to explain the origin and propagation of some epidemic diseases, particularly plague, cholera and malaria. The theory said that the cause was miasma, an ill-defined emanation from rotting organic matter, both vegetable and animal, especially the noxious effluvia given off from graveyards, and the exhalations from marshes and stagnant water.[10]

3. <u>Contagion theory</u>: Belief that disease was passed from one person to another either through personal contact or contact with articles, such as clothing, which had been handled by them. John Fothergill in his book, "*Account of the sore throat attended with ulcers*" said this about contagion, "*That the Cause of this Tendency is a putrid Virus, or Miasma sui generis, introduced into the habit by contagion; principally by means of the Breath of the Person affected. That this Virus or contagious matter, produces*

[8] WIKIPEDIA, 'Louis Pasteur', Wikipedia, 22 October 2015, https://en.wikipedia.org/wiki/Louis_Pasteur; CHEMICAL HERITAGE FOUNDATION, 'Louis Pasteur', CHF Chemical Heritage Foundation, accessed 29 October 2015, http://www.chemheritage.org/discover/online-resources/chemistry-in-history/themes/pharmaceuticals/preventing-and-treating-infectious-diseases/pasteur.aspx; WIKIPEDIA, 'Microsporidia', Wikipedia, 26 October 2015, https://en.wikipedia.org/wiki/Microsporidia.
[9] SCIENCE MUSEUM, 'Robert Koch (1843-1910)', Exploring the History of Medicine, accessed 29 October 2015, http://www.sciencemuseum.org.uk/broughttolife/people/robertkoch.aspx; WIKIPEDIA, 'Robert Koch', Wikipedia, 27 October 2015, https://en.wikipedia.org/wiki/Robert_Koch.
[10] A DICTIONARY of PUBLIC HEALTH, 'Miasma Theory', Oxford Reference, 2007, http://www.oxfordreference.com/view/10.1093/acref/9780195160901.001.0001/acref-9780195160901-e-2851?rskey=pnl0pn&result=2851; HARVARD UNIVERSITY, 'Concepts of Contagion and Epidemics', Contagion Historical Views of Diseases and Epidemics, 2015, http://ocp.hul.harvard.edu/contagion/concepts.html.

Effects more or less pernicious, according to the Quantity and Nature of the Infection...”[11]

[11] FOTHERGILL, John, *An Account of the Sore Throat Attended with Ulcers*, 3rd ed. (London: C. Davis, 1751), 71, http://babel.hathitrust.org/cgi/pt?id=ucm.5327248747;view=1up;seq=86; MACMICHAEL, William, ‘A Brief Sketch of the Progress of Opinion on the Subject of Contagion: With Some Remarks on Quarantine’, in *The Pamphleteer*, vol. 25, 50 (London: John Murray, 1825), 519–31, http://babel.hathitrust.org/cgi/pt?id=mdp.39015028026816;view=1up;seq=411; GRANVILLE, A. B., ‘A Letter to the Right Hon. W. Huskisson, M.P., President of the Board of Trade, on the Quarantine Bill.’, in *The Pamphleteer*, vol. 25, 50 (London: John Murray, 1825), 393–403, http://babel.hathitrust.org/cgi/pt?id=mdp.39015028026816;view=1up;seq=411.

APPENDIX 4 List of parishes used in this thesis

Bedfordshire			
Ampthill	St Andrew	Wootton	St Mary
Barton-le Clay	St Nicholas	Yelden	St Mary the Virgin
Bedford	Moravian	**Berkshire**	
Bedford	St Cuthbert	Abingdon	St Nicholas
Bedford	St John	Aldermaston	St Mary the Virgin
Bedford	St Mary	Arborfield	St Bartholomew
Bedford	St Paul	Basildon	St Bartholomew
Bedford	St Peter	Bisham	All Saints
Biggleswade	St Andrew	Boxford	St Andrew
Blunham	St Edmund or St James	Bradfield	St Andrew
Bolnhurst	St Dunstan	Denchworth	St James
Campton	All Saints	Harwell	St Matthew
Cardington	St Mary	Lambourn	St Michael and All Angels
Chalgrave	All Saints	Longworth	St Mary
Clophill	St Mary	New Windsor	St John the Baptist
Cranfield	St Peter & St Paul	Newbury	St Nicolas
Dunstable	St Peter	Old Windsor	St Peter and St Andrew
Elstow	St Mary and St Helena	Pangbourne	St James the Less
Felmersham	St Mary	Radley	St James the Great
Flitton & Silsoe	St John the Baptist	Reading	St Giles
Flitwick	St Peter and St Paul	Reading	St Laurence
Harlington	St Mary the Virgin	Reading	St Mary
Haynes	St Mary	Sonning	St Andrew
Houghton Regis	All Saints	Sparsholt	Holy Cross
Kempston	All Saints	Sulham	St Nicholas
Maulden	St Mary	Tilehurst	St Michael
Millbrook	St Michael & All Angels	Uffington	St Mary
Milton Ernest	All Saints	West Hendred	Holy Trinity
Northill	St Mary the Virgin	Yattendon	St Peter and St Paul
Pavenham	St Peter	**Cambridgeshire**	
Pulloxhill	St James the Apostle	Abington Pigotts	St Michael and All Saints
Sandy	St Swithin	Arrington	St Nicholas
Souldrop	All Saints	Babraham	St Peter
Southill	All Saints	Bassingbourn	St Peter and St Paul
Stevington	St Mary the Virgin	Bottisham	Holy Trinity
Studham	St Mary the Virgin	Bourn	St Helena and St Mary
Swinehead	St Nicholas	Boxworth	St Peter
Thurleigh	St Peter	Brinkley	St Mary
Toddington	St George	Burrough Green	St Augustine
Whipsnade	St Mary Magdalene	Caldecote	St Michael and All Angels
Woburn	St Mary	Cambridge	All Saints

Cambridge	Holy Trinity	Congleton	St Peter
Cambridge	St Andrew the Great	Coppenhall	St Lawrence
Cambridge	St Andrew the Less	Gawsworth	St James
Cambridge	St Benedict	Grappenhall	St Wilfrid
Cambridge	St Giles	Harthill	All Saints
Cambridge	St. Mary the Less	Heswall	St Peter
Cambridge	St Botolph	Lymm	St Mary the Virgin
Cambridge	St Clements	Malpas	St Oswald
Cambridge	St Edward	Marbury	St Michael
Cambridge	St Mary the Great	Nantwich	St Mary
Cambridge	St Michael	Over	St Chad
Cambridge	St Peter	Runcorn	All Saints
Caxton	St Andrew	Sandbach	St Mary
Chatteris	St Peter	Stockport	St Mary
Cherry Hinton	St Andrew	Stockport, Heaton Norris	St Thomas
Chesterton	St Andrew	Tarporley	St Helen
Cheveley	St Mary	Tarvin	St Andrew
Comberton	St Mary	Upton in Overchurch	St Mary
Conington	St Mary	Waverton	St Peter
Cottenham	All Saints	Weaverham	St Mary
Coveney	St Peter Ad Vincula	Whitegate	St Mary
Doddington	St Mary	Wilmslow	St Bartholomew
Dry Drayton	St Peter and St Paul	Wrenbury	St Margaret
East Hatley	St Denis	**Cornwall**	
Fowlmere	St Mary	Altarnun	St Nonna
Girton	St Andrew	Blisland	St Protus and St Hyacinth
Haddenham	Holy Trinity	Breage	St Breaca
Leverington	St Leonard	Calstock	St Andrew
Linton	St Mary	Camborne	St Martin and St Meriadoc
Little Abington	St Mary	Cardinham	St Meubredus the Martyr
Little Shelford	All Saints	Constantine	St Constantinus
Melbourn	All Saints	Cornelly	St Cornelius
Milton	All Saints	Creed	St Crida
Orwell	St Andrew	Cuby with Tregony	St Cuby and St James
Sawston	St Mary	Duloe	St Cubys
Waterbeach	St John the Evangelist	Egloshayle	St Petroc
Willingham	St Mary and All Saints	Falmouth	King Charles the Martyr
Witchford	St Andrew	Feock	St Feoca
Cheshire		Gerrans	St Gerent
Bowdon	St Mary the Virgin	Gulval	St Wolvela (St Gulval)
Bunbury	St Boniface	Kenwyn	St Keyne
Carrington	St George	Launcells	St Swithin
Chester	Holy Trinity	Lewannick	St Martin
Chester	St John & St Mary	Liskeard	St Martin

Lostwithiel	St Bartholomew	Wirksworth	St Mary
Ludgvan	Sts Ludgvan and Paul the Apostle	**Devonshire**	
Manaccan	St Manaccus and St Dunston	Alverdiscott	All Saints
Mylor	St Melorus	Ashreigney or Ring's Ash	St James
Roche	St Gonand of the Rock	Beaford	St George and All Saints
St Austell	Holy Trinity	Berry Pomeroy	St Mary
St Clement	St Clement	Blackawton	St Michael
St Columb Major	Parish Church of St Columba	Branscombe	St Winifred
St Columb Minor	St Columba	Clovelly	All Saints
St Ives	St Ia	Colyton	St Andrew
Truro	St Mary	Dolton	St Edmund
Wendron	St Wendron	Exeter	Cathedral
Zennor	St Senara	Exeter	Holy Trinity
Cumberland		Exeter	St David
Bootle	St Michael	Exeter	St Edmund
Crosthwaite	St Kentigern	Exeter	St George
Dalston	St Michael	Exeter	St John
Great Orton	St Giles	Exeter	St Leonard
Kirkoswald	St Oswald	Exeter	St Kerrian
Lamplugh	St Michael	Exeter	St Mary Arches
Lanercost	St Mary Magdalene	Exeter	St Mary Major
Millom	Holy Trinity	Exeter	St Mary Steps
Penrith	St Andrew	Exeter	St Olave
Skelton	St Mary and St Michael	Exeter	St Petrock
Derbyshire		Exeter	St Thomas
Alfreton	St Martin	Great Torrington	St Michael
Ashover	All Saints	Harberton	St Andrew
Blackwell nr. Alfreton	St Werburgh	Hartland	St Nectan
Breadsall	All Saints	Huntshaw	St Mary
Chelmorton	St John	Northam and Appledore	St Margaret
Clowne	St John the Baptist	Offwell	St Mary
Darley	St Helen	Parkham	St James
Duffield	St Alkmund	Plymouth	St Andrew
Hayfield	St Matthew	Plymouth	Charles the Martyr
Heanor	St Lawrence	Roborough	St Peter
Heath	All Saints	Staverton	St Paul de Leon
Matlock	St Giles	Stoke Gabriel	St Gabriel
Morton	Holy Cross	Topsham	St Margaret
Ockbrook	Moravian	Upottery	St Mary
Pentrich	St Matthew	Walkhampton	No dedication
Pinxton	St Helen	West Woolfardisworthy	All Hallows
Shirland	St Leonard	Widecombe-in-the-Moor	St Pancras
Tibshelf	St John the Baptist	**Dorset**	
Whitwell	St Lawrence	Abbotsbury	St Nicholas

Affpuddle	St Lawrence	Dorchester	All Saints
Almer	St Mary	Dorchester	St Peter
Alton Pancras	St Pancras	Dorchester	Holy Trinity
Arne	St Nicholas	East Lulworth	St Andrew
Ashmore	St Nicholas	East Stour	Christ Church
Askerswell	St Michael	Gillingham	St Mary the Virgin
Athelhampton	St John	Godmanstone	Holy Trinity
Beaminster	St Mary	Halstock	St Mary
Beer Hackett	St Michael	Holnest	St Mary
Bere Regis	St John the Baptist	Hooke	St Giles
Bettiscombe	St Stephen	Horton	St Wolfrida
Bincombe	Holy Trinity	Langton Herring	St Peter
Bishop's Caundle	St Peter and St Paul	Litton Cheney	St Mary
Blandford Forum	St Peter and St Paul	Loders	St Mary Magdalene
Blandford St Mary	St Mary	Lydlinch	St Thomas a Becket
Bloxworth	St Andrew	Lyme Regis	St Michael
Bothenhampton	Holy Trinity	Lytchett Minster	Parish Church
Bradpole	Holy Trinity	Maiden Newton	St Mary
Bridport	St Mary	Manston	St Nicholas
Broadmayne	St Martin	Mappowder	St Peter and St Paul
Buckland Newton	The Holy Rood	Marnhull	St Gregory
Burstock	St Andrew	Melbury Abbas	St Thomas
Burton Bradstock & Shipton	St Mary C	Melbury Bubb	St Mary
Castleton	St Mary Magdalene	Melbury Osmond	St Osmond
Cattistock	St Peter and St Paul	Melcombe Horsey	St Andrew
Cerne Abbas	St Mary the Virgin	Milton Abbas	St James
Chalbury	All Saints	Morden	St Mary
Chaldon Herring	St Nicholas	Mosterton	St Mary
Charlton Marshall	St Mary the Virgin	Netherbury	All Saints
Charminster	St Mary the Virgin	North Wootton	St Mary Magdalen
Charmouth	St Andrew	Portesham	St Peter
Chettle	St Mary	Portland	St George
Chickerell	St Mary	Powerstock	St Mary
Chideock	St Giles	Preston	St Andrew
Child Okeford	St Nicholas	Rampisham	St Michael
Chilfrome	Holy Trinity	Ryme Intrinseca	St Hypolite
Church Knowle	St Peter	Shaftesbury	Holy Trinity
Compton Abbas	St Mary the Virgin	Shaftesbury	St James
Compton Valence	St Thomas a Beckett	Shaftesbury	St Peter
Coombe Keynes	Holy Rood	Sherborne	Blessed Virgin Mary
Corfe Castle	St Edward the Martyr	Stalbridge	St Mary
Corfe Mullen	St Hubert	Steeple	St Michael and All Angels
Corscombe	St Mary	Stourpaine	Holy Trinity
Cranborne	St Mary & St Bartholomew	Sturminster Marshall	St Mary
Dewlish	All Saints	Swanage	All Saints

Symondsbury	St John the Baptist	Whitburn	St Mary
Thorncombe	The Blessed Virgin Mary	Witton Gilbert	St Michael
Toller Fratrum	St Basil	**Essex**	
Turners Puddle	Holy Trinity	Aldham	St Margaret and St Catherine
Turnworth	St Mary the Virgin	Alresford	St Peter
Walditch	St Mary	Ardleigh	St Mary the Virgin
Wareham	St Martin C	Ashdon	All Saints
West Lulworth	Holy Trinity	Aveley	St Michael
Whitchurch Canonicorum	St Candida and the Holy Cross	Barling	All Saints
Whitcombe	Not Dedicated	Belchamp St Paul	St Andrew
Winterborne Anderson	St Michael	Belchamp Walter	St Mary the Virgin
Woodsford	St John the Baptist	Bocking	St Mary the Virgin
Wootton Fitzpaine	Not Dedicated	Bradwell juxta Mare	St Thomas
Durham		Brightlingsea	All Saints
Bishop Middleham	St Michael	Chelmsford	St Mary
Bishopwearmouth	St Michael	Colchester	All Saints
Boldon	St Nicholas	Colchester	St Botolph
Chester-le-Street	St Mary and St Cuthbert	Colchester	St Giles
Dalton-le-Dale	St Andrew	Dedham	St Mary the Virgin
Durham	Cathedral	Foulness	St Mary the Virgin
Durham	St Giles	Great Burstead	St Mary Magdalen
Durham	St Margaret	Halstead	St Andrew
Durham	St Mary in the South Bailey	Harwich	St Nicholas
Durham	St Mary le Bow	Maldon	All Saints and St Peter
Durham	St Nicholas	Maldon	St Mary the Virgin
Durham	St Oswald	Stow Maries	St Mary and St Margaret
Easington	St Mary the Virgin	Thaxted	St John the Baptist
Esh	St Michael	Tollesbury	St Mary
Hamsterley	St James	Wakes Colne	All Saints
Houghton-le-Spring	St Michael and All Angels	Widdington	St Mary the Virgin
Hunstanworth	St James	**Gloucestershire**	
Kelloe	St Helen	Avening	St Mary
Lanchester	All Saints	Bishops Cleeve	St Michael and All Angels
Middleton St George	St George	Cam	St George
Penshaw	All Saints	Deerhurst	St Mary
Pittington	St Lawrence	Dymock	St Mary
Ryton	Holy Cross	Eastington (Stonehouse)	St Michael and All Angels
Seaham	St Mary the Virgin	Fairford	St Mary
Sherburn Hospital	St Nicholas	Forthampton	St Mary
South Shields	St Hilda	Gloucester	St Aldate
Sunderland	Holy Trinity	Gloucester	St John the Baptist
Tanfield	St Margaret of Antioch	Gloucester	St Mary de Crypt

Gloucester	St Mary de Lode	Hemel Hempstead	St Mary
Gloucester	St Nicholas	Hertford	St Andrew
Horsley	St Martin	Hitchin	St Mary
Mickleton	St Lawrence	Hunsdon	St Dunstan
Minchinhampton	Holy Trinity	Northchurch	St Mary
North Nibley	St Martin	Norton	St Nicholas
Painswick	St Mary	Rickmansworth	St Mary the Virgin
Pebworth	St Peter	St Albans	Abbey
Shortwood	Baptist	St Albans	St Michael
Slimbridge	St John the Evangelist	St Albans	St Peter
Stroud	St Lawrence	Stevenage	St Nicholas
Tetbury	St Mary	Tring	St Peter and St Paul
Wotton under Edge	St Mary the Virgin	Watford	St Mary
Hampshire		Willian	All Saints
Aldershot	St Michael	**Kent**	
Alverstoke	St Mary | St Faith Mission	Ash-next-Ridley	St Peter and St Paul
Bedhampton	St Thomas	Beakesbourne	St Peter
Blendworth	St Mary	Benenden	St George & St Margaret
Catherington	All Saints	Bredhurst	St Peter
Chalton with Idsworth	St Michael and All Angels	Burham	St Mary
Clanfield	St James	Canterbury	Christ Church Cathedral
Farlington	St Andrew	Chalk	St Mary
Gosport	Holy Trinity	Charlton	St Luke
Havant	St Faith	Chatham	St Mary the Virgin
North Hayling	St Peter	Chilham	St Mary
Portchester	St Mary	Cliffe-at-Hoo	St Helen
Portsea	St Mary	Cobham	St Mary Magdalene
Portsmouth	Royal Garrison Church	Cooling	St James
Portsmouth	St Thomas	Cuxton	St Michael and All Angels
Rowner	St Mary	Darenth	St Margaret of Antioch
Selborne	St Mary the Virgin	Dartford	Holy Trinity
South Hayling	St Mary	Ebony	St Mary
Warblington	St Thomas à Becket	Frindsbury	All Saints
Widley	St Mary Magdalene	Gillingham	St Mary Magdalene
Wymering	St Peter and St Paul	Grain	St James
Hertfordshire		Gravesend	St George
Aldbury	St John the Baptist	Halling	St John the Baptist
Aldenham	St John the Baptist	Hartley	All Saints
Ardeley	St Lawrence	High Halstow	St Margaret
Barley	St Margaret of Antioch	Higham	St John | St Mary
Berkhamsted	St Peter	Horton Kirby	St Mary
Bushey	St James	Longfield	St Mary Magdalene
Elstree	St Nicholas	Meopham	St John the Baptist
Furneux Pelham	St Mary	Milton next Gravesend	St Peter and St Paul

Northfleet	St Botolph	Desford	St Martin
Nurstead	St Mildred	Enderby	St John the Baptist
Rainham	St Margaret of Antioch	Great Bowden	St Peter and St Paul
Ridley	St Peter and St Paul	Hallaton	St Michael
Rochester	Cathedral	Hinckley	St Mary
Rochester	St. Margaretof Antioch	Humberstone	St Mary
Rochester	St Nicholas of Myra	Husbands Bosworth	All Saints
Rolvenden	St Mary the Virgin	Kibworth Beauchamp	St Wilfrid
Snodland	All Saints	Kirby Muxloe	St Bartholomew
Southfleet	St Nicholas of Myra	Kirkby Mallory	All Saints
Speldhurst	St Mary	Leicester	All Saints
Stoke	St Peter and St Paul	Leicester	St Leonard's
Stone-next-Dartford	St Mary the Virgin	Leicester	St Margaret's
Strood	St Nicholas of Myra	Leicester	St Martin's
Sutton at Hone	St John the Baptist	Leicester	St Mary de Castro
Swanscombe	St Peter and St Paul	Leicester	St Nicholas
Wilmington	St Michael and All Angels	Little Bowden	St Nicholas
Wouldham	All Saints	Long Clawson	St Remigius
Lancashire		Loughborough	All Saints
Aughton (Ormskirk)	St Michael	Market Bosworth	St Peter
Chorley	St Laurence	Market Harborough	St Dionysius
Croston	St Michael and All Angels	Medbourne	St Giles
Eccleston	St Mary the Virgin	Melton Mowbray	St Mary
Finsthwaite	St Peter	Oadby	St Peter and St Paul
Kirkham	St Michael	Packington	Holy Rood
Lancaster	St John	Prestwold	St Andrew
Lancaster	St Mary	Saddington	St Helen
Liverpool	St John	Shepshed	St Botolph
Manchester	Manchester Cathedral	Sileby	St Mary
Mitton	All Hallows	Thrussington	Holy Trinity
North Meols	St Cuthbert	Wigston Magna	All Saints and St Wistans
Oldham	St Mary	Wymondham	Abbey
Ormskirk	St Peter and St Paul	**Lincolnshire**	
Poulton le Fylde	St Chad	Addlethorpe	St Nicholas
Rainford	All Saints	Alford	St Wilfrid
Urswick	St Mary the Virgin and St Michael	Algarkirk	St Peter and St Paul
Leicestershire		Aslackby	St James
Ashby de la Zouche	St Helen	Barrow on Humber	Holy Trinity
Barkestone-le-Vale	St Peter and St Paul	Barrowby	All Saints
Barwell	St Mary	Boston	St Botolph
Belton	St John the Baptist	Candlesby	St Benedict
Bottesford	St Mary the Virgin	Carlby	St Stephen
Breedon on the Hill	St Mary and St Hardulph	Castle Bytham	St James
Coleorton	St Mary and St John	Crowland	Crowland Abbey

Fillingham	St Andrew	Haydon Bridge	St Cuthbert
Fishtoft	St Guthlac	Heddon on the Wall	St Andrew
Folkingham	St Andrew	Hexham	St Andrew
Frodingham	St Lawrence	Ingram	St Michael
Gainsborough	All Saints	Kirkwhelpington	St Bartholomew
Gosberton	St Peter and St Paul	Knarsdale	St Jude
Grantham	St Wulfrum	Longbenton	St Bartholomew
Grimsby	St James	Mitford	St Mary Magdalene
Haxey	St Nicholas	Morpeth	St Mary the Virgin
Heckington	St Andrew	Newbiggin by the sea	St Bartholomew
Irby on Humber	St Andrew	Newcastle upon Tyne	All Saints
Leasingham	St Andrew	Newcastle upon Tyne	St Andrew
Old Clee	Holy Trinity & St Mary the Virgin	Newcastle upon Tyne	St John
Quarrington & Old Sleaford	St Botolph	Newcastle upon Tyne	St Nicholas
Ropsley	St Peter	Ovingham	St Mary
Scartho	St Giles	St John Lee	St John of Beverley
Winteringham	All Saints	Tweedmouth	St Bartholomew
Witham on the Hill	St Andrew	Wallsend	St Peter
Wrangle	St Mary and St Nicholas	Whitley	St Helen
Wrawby	St Mary	Woodhorn	St Mary the Virgin
Wyberton	St Leodgar	Wooler	St Mary
Northumberland		**Norfolk**	
Allendale	St Cuthbert	Barford	St Botolph
Alnwick	St Michael	Barnham Broom	St Peter
Alwinton	St Michael	Bodham	All Saints
Bamburgh	St Aidan	Brisley	St Bartholomew
Beadnell	St Ebba	Colton	St Andrew
Bedlington	St Cuthbert	Cranworth	St Mary
Belford	St Mary	Denton	Independent Chapel | St Mary
Bellingham	St Cuthbert	Denver	St Mary
Berwick upon Tweed	Holy Trinity	Diss	St Mary
Bywell	St Andrew	Ditchingham	St Mary
Bywell	St Peter	Downham Market	St Edmund
Carham	St Cuthbert	East Dereham	St Nicholas
Chollerton	St Giles	Fincham	St Martin
Corbridge	St Andrew	Great Dunham	St Andrew
Earsdon	St Alban	Great Ryburgh	St Andrew
Elsdon	St Cuthbert	Griston	St Peter and St Paul
Gosforth	St Nicholas	Guist	St Andrew
Haltwhistle	Holy Cross	Hardingham	St George
Hartburn	St Andrew	Heigham	St Bartholomew

Hempnall	St Margaret	Wymondham	St Mary and St Thomas Becket
Kenninghall	St Mary	**Oxfordshire**	
Little Massingham	St Andrew	Banbury	St Mary the Virgin
Mileham	St John the Baptist	Chinnor	St Andrew
North Tuddenham	St Mary	Chipping Norton	St Mary
Norwich	St Andrew	Deddington	St Peter and St Paul
Norwich	St Augustine	Henley-on-Thames	St Mary
Norwich	St Benedict	Kidlington	St Mary
Norwich	St Clement & St Edmund	Mixbury	All Saints
Norwich	St Ethelreda	Oxford	All Saints
Norwich	St George Colegate	Oxford	Christchurch
Norwich	St George Tombland & St Simon & St Jude	Oxford	Holywell
Norwich	St Giles	Oxford	St Aldate
Norwich	St Gregory	Oxford	St Ebbe
Norwich	St Helen	Oxford	St Giles
Norwich	St James with Pockthorpe	Oxford	St Michael
Norwich	St John de Sepulchre	Oxford	St John the Baptist
Norwich	St John the Baptist at Maddermarket	Standlake	St Giles
Norwich	St John Timberhill with All Saints & St Michael at Thorn	Stonor	R.C.Chapel
Norwich	St Julian	Thame	St Mary the Virgin
Norwich	St Lawrence	Witney	St Mary the Virgin
Norwich	St Margaret & St Swithin	Woodstock	St Mary Magdalene
Norwich	St Martin at Oak	**Rutland**	
Norwich	St Martin at Palace	Barrowden	St Peter
Norwich	St Mary Coslany	Belton	St Peter
Norwich	St Mary in the Marsh	Bisbrooke	St John the Baptist
Norwich	St Michael at Plea	Braunston	All Saints
Norwich	St Paul	Burley	Holy Cross
Norwich	St Peter Hungate	Cottesmore	St Nicholas
Norwich	St Peter Mancroft	Egleton	St Edmund
Norwich	St Peter Parmentergate	Empingham	St Peter
Norwich	St Peter Southgate	Exton	St Peter and St Paul
Norwich	St Saviour	Greetham	St Mary the Virgin
Norwich	St Stephen	Hambleton	St Andrew
Norwich	St Swithin	Ketton	St Mary the Virgin
Saham Toney	St George	Langham	St Peter and St Paul
Sculthorpe	St Mary and All Saints	Lyndon	St Martin of Tours
Sedgeford	St Mary the Virgin	Manton	St Mary
Shipdham	All Saints	Morcott	St Mary the Virgin
Swaffham	St Peter and St Paul	North Luffenham	St John the Baptist
Wells-next-the-Sea	St Nicholas	Preston	St Peter and St Paul

Ridlington	St Mary and Magdalene	Checkley	St Mary and All Saints
Ryhall	St John the Evangelist	Edingale	Holy Trinity
Stretton	St Nicholas	Ellastone	St Peter
Uppingham	St Peter and St Paul	Newcastle-under-Lyme	St Giles
Whissendine	St Andrew	Rocester	St Michael
Wing	St Peter and St Paul	Stafford	St Chad
Shropshire		Stafford	St Mary
Alberbury	St Michael	Stone	St Michael and St Wulfad
Atcham	St Eata	Stowe by Chartley	St John the Baptist
Benthall	St Bartholomew	Tatenhill	St Michael and All Angels
Berrington	All Saints	Uttoxeter	St Mary
Bitterley	St Mary | The Chapel of Michlleton	Suffolk	
Bromfield	St Mary the Virgin	Acton	All Saints
Clive	All Saints	Brandon	St Peter
Diddlebury	St Peter	Cavendish	St Mary
Edgmond	St Peter	Debenham	St Mary
Greete	St James	East Bergholt	St Mary
Kinlet	St John the Baptist	Eye	St Peter and St Paul
Lee Brockhurst	St Peter	Framlingham	St Michael
Meole Brace	Holy Trinity	Fressingfield	St Peter and St Paul
Moreton Corbet	St Bartholomew	Hollesley	All Saints
Munslow	St Michael	Horringer	St Leonard
Neen Savage	St Mary	Ipswich	St Clement
Neenton	All Saints	Ipswich	St Helen
Shipton	St James	Ipswich	St Lawrence
Shrewsbury	St Chad	Ipswich	St Margaret
Shrewsbury	St Mary	Ipswich	St Mary at Elms
Wem	St Peter and St Paul	Ipswich	St Mary Quay
Wroxeter	St Andrew	Ipswich	St Mary Stoke
Staffordshire		Ipswich	St Mary le Tower
Aldridge	St Mary the Virgin	Ipswich	St Matthew
Alrewas	All Saints	Ipswich	St Nicholas
Alstonefield	St Peter	Ipswich	St Peter
Alton	St Peter	Ipswich	St Stephen
Audley	St James the Great	Lakenheath	All Saints
Barton-under-Needwood	St James	Lavenham	St Peter and St Paul
Bilston	St Leonard	Laxfield	All Saints
Bloxwich	All Saints St Thomas the Apostle	Lowestoft	St Margaret
Burslem	St John the Baptist	Marlesford	St Andrew
Cannock	St Luke	Mendlesham	St Mary the Virgin
Cheadle	St Giles	Mildenhall	St Mary

Peasenhall	St Michael	**Sussex**	
Rattlesden	St Nicholas	Alfriston	St Andrew
Saxmundham	St John the Baptist	Alfriston	Non-conformist
Sibton	St Peter	Arundel	St Nicholas
Stradbroke	All Saints	Barcombe	St Mary
Wickhambrook	All Saints	Barnham	St Mary the Virgin
Woodbridge	St Mary	Battle	St Mary
Wortham	St Mary	Bolney	St Mary Magdalene
Yaxley	St Mary	Climping	St Mary the Virgin
Yoxford	St Peter	Cocking	St Catherine of Siena
Surrey		Cowfold	St Peter
Abinger	St James	Easebourne	St Mary
Addington	St Mary	Eastbourne	St Mary
Albury	St Peter and St Paul	East Grinstead	St Swithun
Alfold	St Nicholas	Etchingham	St Mary and St Nicholas
Ash	St Peter	Fernhurst	St Margaret of Antioch
Banstead	All Saints	Findon	St John the Baptist
Beddington	St Mary	Glynde	St Mary the Virgin
Betchworth	St Michael	Herstmonceux	All Saints
Bisley	St John the Baptist	Heyshott	St James
Bramley	Holy Trinity	Hove	St Andrew
Carshalton	All Saints	Lewes	All Saints
Caterham	St Lawrence	Lewes	St Anne
Cheam	St Dunstan	Lewes	St Michael
Chipstead	St Margaret	Lewes	St Thomas a Becket
Cobham	St Andrew	Mayfield	St Dunstan
Coulsdon	St John the Evangelist	Petworth	St Mary
Cranleigh	St Nicolas	Preston	St Peter
Farnham	St Andrew	Ringmer	St Mary the Virgin
Gatton	St Andrew	Rogate	St Bartholomew
Haslemere	St Bartholomew	Rottingdean	St Margaret
Ickworth	St Mary	South Bersted	St Mary Magdalene
Kingston Upon Thames	All Saints	Whatlington	St Mary Magdalene
Morden	St Lawrence	Winchelsea	St Thomas the Martyr
Putney	St Mary	**Warwickshire**	
Stoke D'Abernon	St Mary	Alcester	St Nicholas
Sutton	St Nicholas	Ansley	St Lawrence
Tatsfield	St Mary	Arley	St Wilfred
Titsey	St James	Arrow	Holy Trinity
Walton-on-Thames	St Mary	Bickenhill	St Peter
Warlingham	All Saints	Bishops Itchington	St Michael
Wotton	St John the Evangelist	Bishops Tachbrook	St Chad

Budbrooke	St Michael	Beechingstoke	St Stephen
Claverdon	St Michael and All Angels	Bemerton	St Andrew
Coventry	Holy Trinity	Bishops Cannings	St Mary the Virgin
Fenny Compton	St Peter and St Clare	Bulford	St Leonard
Fillongley	St Mary and All Saints	Charlton nr. Malmesbury	St John the Baptist
Foleshill	St Laurence	Clyffe Pypard	St Peter
Grandborough	St Peter	Collingbourne Ducis	St Andrew
Great Packington	St James	Crudwell	All Saints
Hampton Lucy	St Peter	Devizes	St Mary
Hunningham	St Margaret	Dilton	St Mary
Nuneaton	St Nicholas	East Knoyle	St Mary the Virgin
Priors Marston	St Leonard	Etchilhampton	St Andrew
Ryton upon Dunsmore	St Leonard	Fugglestone St Peter	St Peter
Southam	St James	Great Somerford	St Peter and St Paul
Stockton	St Michael and All Angels	Horningsham	St John the Baptist
Stoke	St Michael	Kington St Michael	St Michael
Stretton on the Fosse	St Peter	Landford	St Andrew
Stretton upon Dunsmore	All Saints	Latton	St John the Baptist
Sutton Coldfield	Holy Trinity	Maiden Bradley	All Saints
Temple Grafton	St Andrew	Marlborough	St Mary the Virgin
Tredington	St Gregory	Marlborough	St Peter and St Paul
Ufton	St Michael	Mere	St Michael the Archangel
Warwick	St Mary	Monkton Deverill	King Alfred the Great
Warwick	St Nicholas	North Bradley	St Nicholas
Whitnash	St Chad	Salisbury	Cathedral
Westmorland		Salisbury	St Thomas
Askham	St Peter	Stratford Subcastle	St Lawrence
Bampton	St Patrick	Urchfont	St Michael and All Angels
Barton	St Michael and All Angels	West Knoyle	St Mary the Virgin
Brough under Stainmore	St Michael	Woodborough	St Mary Magdalene
Brougham	St Ninian	Yatton Keynell	St Margaret
Cliburn	St Cuthbert	**Worcestershire**	
Crosby Garrett	St Andrew	Abberley	St Mary
Crosby Ravensworth	St Lawrence	Alfrick	St Mary Magdalen
Crosthwaite cum Lyth	St Mary	Badsey	St James
Lowther	St Michael	Berrow	St Faith
Middleton-in-Lonsdale	Holy Ghost	Bredon	St Giles
Milburn	St Cuthbert	Bromsgrove	St John the Baptist
Shap	St Michael	Bushley	St Peter
Wiltshire		Droitwich	St Andrew
Alderbury	St Mary	Droitwich	St Peter
All Cannings	All Saints	Eastham	St Peter and St Paul

Eldersfield	St John the Baptist	**Yorkshire West Riding**	
Halesowen	St John the Baptist	Ackworth	St Cuthbert
Hanley William	All Saints	Adel	St John the Baptist
Kidderminster	St Mary	Allerton Mauleverer	St Martin
Leigh	St Edburga	Baildon	St John the Evangelist
Longdon	St Mary	Batley	All Saints
Norton juxta Kempsey	St James	Birstall	St Peter
Pershore	Holy Cross	Bradford	St Peter
Pershore	St Andrew	Bradford	Wibsey Chapel
Redmarley D'Abitot	St Bartholomew	Braithwell	St James
Ripple	St James or St Mary	Bramley (Leeds)	St Peter
Wickhamford	St John the Baptist	Brodsworth	St Michael
Worcester	St Alban	Brotherton	St Edward
Worcester	St Clement	Burghwallis	St Helen
Worcester	St John	Burnsall	St Wilfred
Worcester	St Martin	Calverley	St Wilfrid
Worcester	St Nicholas	Campsall	St Mary Magdalen
Worcester	St Oswalds Hospital	Carleton in Craven	St Mary
Worcester	St Peter the Great	Cawthorne	All Saints
Worcester	St Swithin	Clayton West with High Hoyland	All Saints
Yorkshire East Riding	Collingham	St Oswald	
Atwick	St Lawrence	Coniston (Burnsall)	St Mary Chapel
Aughton	All Saints	Cowthorpe	St Michael
Beverley	St John	Crofton	All Saints
Beverley	St Mary	Cross Stone Todmorden	St Paul
Brantingham	All Saints	Cumberworth	St Nicholas
Bridlington	St Mary	Darrington	St Luke and All Saints
Bubwith	All Saints	Darton	All Saints
Burton Fleming	St Cuthbert	Dewsbury	All Saints
Etton	St Mary	East Ardsley	St Michael
Flamborough	St Oswald	Elland	St Mary the Virgin
Holme on Spalding Moor	All Saints	Emley	St Michael the Archangel
Huggate	St Mary	Farnham	St Oswald
Hull	Holy Trinity	Ferry Fryston	St Andrew
Hull	St Mary Lowgate	Halifax	St John the Baptist
Owthorne	St Peter	Hampsthwaite	St Thomas a Becket
Rillington	St Andrew	Harewood	All Saints
Scorborough	St Leonard	Harrogate	Christ Church
Settrington	All Saints	Harrogate	St Mark
Weaverthorpe	St Andrew	Hartshead	St Peter
Winestead	St Germain	Haworth	St Michael and All Angels
Wintringham	St Peter	Hemsworth	St Helen

Heptonstall	St Thomas	Walton (Thorpe Arch)	St Peter
Holbeck	St Matthew	Wath Upon Dearne	All Saints
Holmfirth	Holy Trinity	Wentworth	Holy Trinity
Horbury	St Peter and St Leonard	Weston	All Saints
Horsforth	St Margaret	Whitkirk	St Mary
Huddersfield	Almondbury All Hallows	Womersley	St Martin
Huddersfield	St Peter	Woodkirk	St Mary
Hunslet Moor	St Cuthbert	**Yorkshire North Riding**	
Ilkley	All Saints	Ainderby Steeple	St Helen
Keighley	St Andrew	Askrigg	St Oswald
Kellington	St Edmund	Aysgarth	St Andrew
Kirk Deighton	All Saints	Brompton by Northallerton	St Thomas
Kirkburton	All Hallows	Danby (Guisborough)	St Hilda
Kirkheaton	St John the Baptist	Gilling East	The Church of the Holy Cross
Leeds	St Peter	Gilling West	St Agatha
Lightcliffe	St Matthew	Great Ayton	All Saints
Linton in Craven	St Michael	Great Edstone	St Michael and All Angels
Luddenden	St Mary	Grinton	St Andrew
Marsden	St Bartholomew	Hawes	St Margaret
Mirfield	St Mary	Hornby (Catterick)	St Mary
Monk Fryston	St Wilfred	Hovingham	All Saints
Penistone	St John the Baptist	Hutton Magna	St Mary
Pontefract	St Giles	Ingleby Greenhow	St Andrew
Ripon	St Peter & St Wilfrid Cathedral & Chapelries	Kilburn	St Mary
Ripponden with Rishworth	St Bartholomew & St John	Kirkby in Cleveland	St Augustine
Rotherham	All Saints	Kirkdale	St Gregory
Royston	St John the Baptist	Kirkleatham	St Cuthbert
Saddleworth	St Chad	Leake	St Mary the Virgin
Sandal Magna	St Helen	Marrick	St Andrew
Silkstone	All Saints	Marske in Cleveland	St Germain and St Mark
Silsden	St James	Melsonby	St James the Great
Skipton	Holy Trinity	Middleham	St Mary and St Alkelda
Slaithwaite with E. Scammonden	St James	Northallerton	All Saints
Sowerby	St Peter & others	Osmotherley	St Peter
Spofforth	All Saints	Pickhill	All Saints
Thorner	St Peter	Redmire	St Mary
Thornhill	St Michael and All Angels	Richmond	St Mary
Tong	St James	Sessay	St Cuthbert
Wakefield	Cathedral All Saints	Stalling Busk	St Margaret | St Matthew

Startforth	Holy Trinity	Llansanffraid	St Bridget
Terrington	All Saints | All Saints Ot	Llyswen	St Gwendoline
Wensley	Holy Trinity	Maesmynys	St David
West Witton	St Bartholomew	Talgarth	St Gwendoline
Yarm	St Mary Magdalene	Vaynor	Parish Church
York	All Saints, North Street	Ystradgynlais	St Cynog
York	All Saints, Pavement	**Caernarfonshire**	
York	Holy Trinity, Goodramgate	Aberech	St Cawrdaf
York	Holy Trinity, King's Court	Betws-y-Coed	St Michael
York	Holy Trinity, Micklegate	Bodfuan	St Buan
York	St Crux	Capel Curig	St Curig
York	St Cuthbert	Conwy	St Mary and All Saints
York	St Denys and St George	Dolwyddelan	St Gwyddelan
York	St Helen	Gyffin	St Benedict
York	St John Micklegate	Llanberis	St Peris
York	St Lawrence	Llandudno	St Tudno
York	St Margaret	Llanllyfni	St Rhedyw
York	St Martin, Coney Street	Llanrug	St Michael
York	St Martin cum Gregory	Ynyscynhaern	St Cynhaearn
York	St Mary Bishophill Junior	**Cardiganshire**	
York	St Mary Bishophill Senior	Aberporth	St Cynwyl
York	St Mary Castlegate	Blaenporth	St David
York	St Maurice	Cardigan	St Mary
York	St Olave with St Giles	Cilcennin	Holy Trinity
York	St Sampson	Lampeter	St Peter
		Llanafan	St Afan
Wales - Anglesey		Llanbadarn Trefeglwys	St Padarn
Aberffraw	St Beuno	Llanddewi Aber-Arth	St David
Cerrigceinwen	St Ceinwen	Llandygwydd	St Tygwydd
Holyhead	St Cybi	Llandysiliogogo	St Tysilio
Llanddanielfab	St Deiniol	Llanfair Clydogau	St Mary
Llandyfrydog	St Tyfrydog	Llangeitho	St Ceitho
Llanfihangel Ysceifiog	St Michael	Llangoedmor	St Cynllo
Llangadwaladr	St Cadwaladr	Llangwyryfon	St Ursula
Brecknockshire		Llangynfelyn	St Cynfelyn
Brecon	St David	Llangynllo	St Cynllo
Brecon	St John the Evangelist	Llanilar	St Hilary
Builth	St Mary	Llanina	St Ina
Glasbury	St Peter	Llanllwchaearn	St Llwchaearn
Hay	St Mary	Llanrhystud	St Rhystud
Llanbedr Ystrad Yw	St Peter	Llanwenog	St Gwenog
Llanddewi'r cwm	St David	Nancwnlle	St Cynllo
Llanfeugan	St Meugan	Penbryn	St Michael
Llanfihangel Bryn Pabuan	St Michael and All Angels	Trefilan	St Hilary

Tregaron	St Caron	Ewenny	St Michael
Troed-Yr-Aur	St Michael	Llanblethian	St John the Baptist
Denbighshire		Llandaff	Cathedral
Abergele	St Michael	Llanddewi	St David
Capel Garmon	St Garmon	Llandeilo Talybont	St Teilo
Cerrigydrudion	St Mary Magdalene	Llangyfelach	St David and St Cyfelach
Clocaenog	St Foddhyd (Meddvyth)	Llansamlet	St Samlet
Denbigh	St Marcella	Llansannor	St Senwyr
Derwen	St Mary	Llantrithyd	St Illtyd
Efenechtyd	St Michael and All Angels	Llantwit Fardre	St Illtyd
Eglwysbach	St Martin	Llantwit Major	St Illtud
Henllan	St. Sadwrn	Merthyr Tydfil	St Tydfil
Holt	St Chad	Neath	St Thomas
Llanarmon-yn-Ial	St Garmon	Pen-tyrch	St Catwg
Llanddoget	St Doged	Penmaen	St John the Baptist
Llanddulas	St Cynbryd	Penmark	St Mary
Llandrynog	St Tyrnog	Peterston-Super-Ely	St Peter
Llanelian-yn-Rhos	St Elian	Peterston-Super-Montem	St Peter
Llanfair Talhaearn	St Mary	Pyle and Kenfig	St James and St Mary Magdalene
Llanferres	St Berres	Rhossili	St Mary the Virgin
Llansannan	St Sannan	Roath	St Margaret
Llansanffraid Glan Conwy	St Ffraid	Rudry	St James
Ysbyty Ifan	St John the Baptist	St Athan	St Tathan
Flintshire		St Brides Major	St Bridget
Cilcain	St Mary	St Fagans	St Mary
Flint	St Mary	Swansea	St Mary
Hawarden	Parish Church	Ystradyfodwg	St John the Baptist
Holywell	Parish Church		
Hope	St Cynfarch and St Cyngar	**Isle of Man**	
Nercwys	Parish Church | Zoar	Andreas	St Andrew
Northop	Parish Church	Arbory	St Cairpre of Coleraine & St Columba
Glamorgan		Ballaugh	St Mary
Aberavon	St Mary	Braddan	St Braddan
Aberdare	St John the Baptist	Bride	St Bridget
Baglan	St Baglan	Douglas	No dedication
Bonvilston	St Mary	German	St Peter
Briton Ferry	St Mary	Jurby	St Patrick
Cadoxton-Juxta-Neath	St Catwg	Lezayre	Holy Trinity
Cadoxton-Juxta-Barry	St Nicholas	Lonan	St Adaman
Cardiff	St John	Malew	St Lua
Cowbridge	Holy Cross	Marown	St Runius
Eglwysilan	St Ilan	Maughold	St Maughold

Michael	St Michael	Sandar (Sandeherred)	
Onchan	St Peter	Nannestad	
Patrick	Holy Trinity	Skedsmo	
Rushen	Holy Trinity	Vinger	
Santon	St Sanctain	Ofoten	
Jersey		**Sweden**	
St Brelade	St Brelade	Stockholm, Stockholm City	
St Clement	St Clement	Stockholm, Danderyd	
St Helier	St Helier	Stockholm, Edebo	
St John	St John	Stockholms Garnisonsförsamlingar Svea Artilleriregemente	
St Lawrence	St Lawrence the Martyr	Stockholm, Hedvig Eleonora	
St Martin	St Martin le Vieux	Stockholm, Jakob	
St Mary	St Mary	Stockholm, Lovö	
St Ouen	St Ouen	Stockholm, Österåker	
St Peter	St Peter	Stockholm, Singö	
St Saviour	St Saviour of the Thorn	Stockholm, Solna	
Trinity	Holy Trinity	Stockholm, Täby	
Grouville	St Martin de Grouville	Kristianstad, Angelholm	
		Kristianstad, Gustaf Adolf	
The Netherlands		Kristianstad, Horup	
Delft		Kristianstad, Osby	
Leiden		Vasterbotten County	
Aalten		Burträsk	
Arnhem			
Batenburg			
Oirlo			
Swolgen			
Venray			
Wanssum			
Alkmaar			
Den Helder			
Norway			
Haltdalen			
Hemne			
Hitra			
Melhus			
Oslo			
Borge			
Idd			
Kristiansand			
Nøtterøy			

Parishes listed in the London Bills of Mortality 1783 and 1784

The 97 Parishes within the Walls (Original spelling has been retained)	
St Alban in Wood-street	St Laurence Pountney
Allhallows, Barking	St Leonard in Eastcheap
Allhallows in Bread-street	St Leonard in Foster-lane
Allhallows the Great	St Magnus by London-Bridge
Allhallows in Honey-lane	St Margaret in Lothbury
Allhallows the Less	St Margaret Moses
Allhallows in Lombard-street	St Margaret in New Fish-street
Allhallows Staining	St Margaret Pattens
Allhallows on London Wall	St Martin in Ironmonger-lane
St Alphage near Sion College	St Martin within Ludgate
St Andrew Hubbard	St Martin Orgars
St Andrew Undershaft	St Martin Outwich
St Andrew by the Wardrobe	St Martin Vintrey
St Ann within Aldersgate	St Mary Abchurch
St Ann in Black Friars	St Mary Aldermanbury
St Anthony (Antholin)	St Mary Aldermary
St Augustin (Austin)	St Mary Le-Bow in Cheapside
St Bartholomew by Exchange	St Mary Bothaw at Dowgate
St Benedict (Bennet Fink)	St Mary Colechurch
St Bennet Gracechurch	St Mary Hill near Billingsgate
St Bennet at Paul's Wharf	St Mary Magd. in Milk-street
St Bennet Sherehog	St Mary Magd. Old Fish-street
St Botolph at Billingsgate	St Mary Mounthaw
Christ Church Parish	St Mary Somerset
St Christopher's Parish	St Mary Staining
St Clement near Eastcheap	St Mary Woolchurch
St Dionis Backchurch	St Mary Woolnoth
St Dunstan in the East	St Matthew in Friday-street
St Edmund the King	St Michael Bassishaw
St Ethelburga's Parish	St Michael in Cornhill
St Faith under St Paul's	St Michael in Crooked-lane
St Gabriel in Fenchurch street	St Michael in Queenhith
St George in Botolph lane	St Michael Le-Quern
St Gregory by St Paul's	St Michael Royal
St Helen near Bishopsgate	St Michael in Wood-street
St James in Duke's-Place	St Mildred in Bread-street
St James in Garlickhith	St Mildred in the Poultry
St John Baptist by Dowgate	St Nicholas Acons
St John the Evangelist	St Nicholas Coleabby
St John Zachary	St Nicholas Olave
St Katherine Coleman	St Olave in Hart Street
St Katherine Creechurch	St Olave in the Old Jewry
St Laurence Jewry	St Olave in Silver-street

St Pancras in Pancras-lane	St Katherine near the Tower
St Peter in Cheapside	St Leonard in Shoreditch
St Peter in Cornhill	St Luke in Middlesex
St Peter near Paul's Wharf	St Mary at Islington
St Peter in Broad-street	St Mary at Lambeth
St Stephen in Coleman-street	St Mary Magd. Bermondsey
St Stephen in Walbrook	St Mary at Newington
St Swithin at London Stone	St Mary at Rotherhith
St Thomas the Apostle	St Mary at Whitechapel
Trinity Parish	St Matthew at Bethnal Green
St Vedast, alias Foster	St Paul at Shadwell
The 17 Parishes without the Walls	**The 10 Parishes in the City and Liberties of Westminster**
St Andrew in Holborn	St Ann in Westminster
St Bartholomew the Great	St Clement Danes
St Bartholomew the Less	St George by Hanover-square
St Botolph by Aldersgate	St James in Westminster
St Botolph by Aldgate	St John Evangelist in Westm.
St Botolph without Bishopsgate	St Margaret in Westminster
Bridewell Precinct	St Martin in the Fields
St Bridget, vulgarly St Brides	St Mary Le Strand
St Dunstan in the West	The Precinct of the Savoy
St George in Southwark	St Paul in Covent-Garden
St Giles by Cripplegate	
St John in Southwark	
St Olave in Southwark	
St Saviour in Southwark	
St Sepulchre's Parish	
St Thomas in Southwark	
Trinity in the Minories	
The 23 Out-Parishes in Middlesex and Surrey	
St Ann in Middlesex	
Christ Church in Surry	
Christ Church in Middlesex	
St Dunstan at Stepney	
St George in Bloomsbury	
St George in Middlesex	
St George by Queen's-square	
St Giles in the Fields	
St James at Clerkenwell	
St John at Clerkenwell	
St John at Hackney	
St John at Wapping	

APPENDIX 5 - Animals known to inhabit the Chernobyl exclusion zones

MAMMALS

Przewalski's wild horse – Equus ferus przewalskii

American mink – Neovison vison

Badger – Meles meles

Bank vole – Clethrionomys glareolus

Beaver – Castor fiber

Birch mouse – Sicista betulina

Black rat – Rattus rattus

Brown bear – Ursus arctos

Common shrew – Sorex araneus

Common vole – Microtus arvalis

Common weasel – Mustela nivalis

Elk – Alces alces

Eurasian lynx – Lynx lynx

Eurasian Otter – Lutra lutra

European bison – Bison bonasus

European hedgehog – Erinaceus europaeus

Field mouse – Apodemus agrarius

Grey wolf – Canis lupus

Hare – Lepus (2 species)

Harvest mouse – Micromys minutus

House mouse – Mus musculus

Mole – Talpa europaea

Elk – Alces alces

Musk rat – Ondatra zibethicus

Pine martin – Martes martes

Rabbit – Oryctolagus cuniculus

Racoon dog – Nyctereutes procyonoides

Red deer – Cervus elaphus

Red fox – Vulpes vulpes

Roe deer – Capreolus capreolus

Southern vole – Microtus levis/rossiaemeridionalis

Tundra vole – Microtus oeconomus

Water shrew – Neomys fodiens

Wild boar – Sus scrofa

Wood mouse – Apodemus sylvaticus

Yellow-necked mouse – Apodemus flavicollis

BIRDS

Barred Warbler – Sylvia nisoria

Blackbird – Turdus merula

Blackcap – Sylvia atricapilla

Black Redstart – Phoenicurus ochruros

Black Stork – Ciconia nigra

Chaffinch – Fringilla coelebs

Common magpie – Pica pica

Cuckoo – Cuculus canorus

Eurasian eagle owl – Bubo bubo

Eurasian jay – Garrulus glandarius

Great Tit – Parus major

Hawfinch – Coccothraustes coccothraustes

Mistle Thrush – Turdus viscivorus

Pigeon – Columba sp.

Raven – Corvus corax

Red-backed Shrike – Lanius collurio

Redstart – Phoenicurus phoenicurus

Robin – Erithacus rubecula

Song Thrush – Turdus philomelos

Starling – Sturnus vulgaris

Swallow – Hirundo rustica

Tawny Owl – Strix aluco

Thrush Nightingale – Luscinia luscinia

Tree Pipit –- Anthus trivialis

White Stork – Ciconia ciconia

White-tailed Eagle – Haliarrtus albicilla

Whitethroat – Sylvia communis

Wood Warbler – Phylloscopus sibilatrix

The above information has been obtained from the following websites:

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RÉSUMÉ

L'éruption du volcan Laki en 1783-1784 : une réappréciation et réinterprétation des conséquences de l'événement en Europe.

L'objet de cette thèse est d'entreprendre une réappréciation et réinterprétation des conséquences de l'éruption du volcan Laki de 1783-1784 en Europe. Le chapitre 1 commence par placer le Laki dans le contexte de la géologie islandaise et des différents types de volcans qui s'y trouvent. Il est bien établi que ce que le monde connait sous le nom d'éruption du Laki – mais que le peuple islandais appelle Lakagígar (l'éruption des cratères du Laki) ou Skaftáreldar (feux de Skaftá), d'après le fleuve voisin Skaftá – allait s'avérer l'une des plus grandes éruptions de fissures volcaniques dans l'histoire documentée de l'Islande, la plus importante étant l'éruption de l'Eldgia qui a démarré au printemps 939 pour durer au moins 18 mois, jusqu'à l'automne 940.[1]

L'année 1783 a été marquée par une quantité exceptionnelle d'activités sismiques en Europe. Le nombre de catastrophes naturelles et autres événements atmosphériques inhabituels à grande échelle qui ont eu lieu a suscité une grande inquiétude dans l'opinion publique et cette année a été souvent qualifiée d'« Annus Mirabilis » (l'année de l'émerveillement).[2] Ces évènements ont fait l'objet d'une étude minutieuse via un large éventail de documents contemporains comme récents.

1:1 La géologie de l'Islande

L'Islande est une île volcanique située dans l'océan atlantique nord entre le Groenland et la Norvège. L'île fait partie d'une masse terrestre beaucoup plus vaste située au croisement de deux structures physiographiques sous-marines, la Dorsale médio-

[1] OPPENHEIMER, Clive, et al., 'The Eldgjá Eruption: Timing, Long-Range Impacts and Influence on the Christianisation of Iceland', *Climatic Change* 147 (19 March 2018): 369, https://doi.org/10.1007/s10584-018-2171-9.

[1] STEINTHORSSON, S, 'Annus Mirabilis: 1783 I Erlendum Heimildum (Annus Mirabilis: The Year 1783 according to Contemporary Accounts outside of Iceland)', *Skirnir* 166 (1992) : 133–59 ; THORDARSON, Thorvaldur et SELF, Stephen, 'Atmospheric and Environmental Effects of the 1783-1784 Laki Eruption: A Review and Reassessment', *J. Geophys. Res.* 108, no. D1, 4011 (8 janvier 2003): 1–29, doi:10.1029/2001JD002042; CHENET, Anne-Lise, FLUTEAU, Frédéric, et COURTILLOT, Vincent, 'Modelling Massive Sulphate Aerosol Pollution, Following the Large 1783 Laki Basaltic Eruption', *Earth and Planetary Science Letters* 236, no. 3–4 (2005) : 721–31; PAYNE, Richard J., 'Meteors and Perceptions of Environmental Change in the Annus Mirabilis AD1783-4', *North West Geography* 11, no. 1 (2011), http://www.mangeogsoc.org.uk/pdfs/payne_11_1.pdf.

atlantique et la crête Groenland-Islande-Féroé. C'est un pays géologiquement jeune et on pense qu'il a été formé il y a près de 24 millions d'années à partir d'une formation de magma dans la dorsale médio-atlantique, c'est également le seul endroit sur terre où la dorsale s'élève au-dessus du niveau de la mer.

L'Islande se trouve à la croisée des plaques nord-américaines et eurasiennes, à savoir sur la dorsale médio-atlantique, et est lentement démantelée par ces plaques à hauteur d'environ 2 cm par an, soit 1 cm dans chaque direction. Cependant, elle repose également sur le panache mantellique ou point chaud de l'Islande qui n'a cessé de faire remonter le magma de l'intérieur de la terre depuis 65 millions d'années et qui alimente les volcans de l'île.[3]

Près de 11.05% de la surface terrestre de l'île (environ 11,400 km² sur une surface totale de 103 125 km²) est couverte de glaciers. La majorité du paysage actuel s'est pleinement développée au début de l'Holocène il y a environ 9 700 ans, à l'exception des cours d'eau et des canyons qui se sont formés après la fonte du Dryas récent, il y a environ 10 000-11 000 ans, et des zones volcaniques actives qui sont modifiées par l'activité volcanique actuelle[4].

Il y a 30 zones volcaniques actives et 20 volcans centraux qui ont été en action dans le passé géologique récent.[5] Les zones volcaniques sont constituées d'un volcan central, d'un essaim de fissures ou d'une combinaison des deux. Les essaims de fissures, des bandes allongées de 5 à 20 km de large, peuvent s'étendre entre 50 et 200 km, tandis que les éruptions produites peuvent être courtes (jours ou semaines) ou longues (mois ou années).[6]

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[3] THORDARSON, Thor, 'Outline of Geology of Iceland Chapman Conference 2012', Thordarson Chapman 2012, accès le 6 mai 2016, http://www.agu.org/meetings/chapman/2012/bcall/pdf/Chapman_Outline_of_Geology_of_Iceland.pdf; THORNHILL, Ted, 'Incredible Aerial Pictures Show US and European Tectonic Plates in Iceland Pulling Apart Leaving Dramatic 200ft Water-Filled Crevices That Divers Can Explore', Courrier en ligne, 23 aout 2015, http://www.dailymail.co.uk/travel/article-3207774/Incredible-aerial-pictures-European-tectonic-plates-Iceland-pulling-apart-leaving-dramatic-200ft-water-filled-crevices-divers-explore.html.

[4] THORDARSON, Thor, 'Outline of Geology of Iceland Chapman Conference 2012'; WIKIPEDIA, 'List of Glaciers of Iceland', Wikipedia, 31 décembre 2015, https://en.wikipedia.org/wiki/List_of_glaciers_of_Iceland. http://www.agu.org/meetings/chapman/2012/bcall/pdf/Chapman_Outline_of_Geology_of_Iceland.pdf (accès le 6.5.2016)

[5] THORDARSON, Thor, 'Outline of Geology of Iceland Chapman Conference 2012', 7.(accès le 6.5.2016)

[6] THORDARSON, T. et LARSEN, G, 'Volcanism in Iceland in Historical Time: Volcano Types, Eruption Styles and Eruptive History', *Journal of Geodynamics* 43 (2007): 121–23, https://doi.org/10.1016/j.jog.2006.09.005.

Le Laki n'est pas un cône volcanique unique mais un système de ventilation de 27 km de long composé de 10 fissures ou cônes volcaniques et de plus 140 cheminées qui s'étendent en direction du nord-est, de la vallée d'Ulfarsdalur à l'ouest vers le glacier de Sidujökull à l'est.[7]

Les éruptions volcaniques peuvent être divisées en 3 catégories : explosives, avec peu ou pas de lave mais une grande quantité de téphra (tous les fragments de pierre, y compris les cendres, éjectés dans l'air par une éruption) ; effusives, qui sont principalement des coulées de lave ; et mixtes, qui, comme l'indique leur nom, ont les propriétés des deux types décrits ci-dessus.[8]

1:2 Contexte

Le Laki est entré en éruption le 8 juin 1783, à la suite d'une série de légers tremblements de terre le mois précédant et de puissants séismes début juin. L'éruption a duré jusqu'au 7 février de l'année suivante. Durant cette période, elle a libéré une quantité estimée à 122 tonnes de dioxyde de souffre, avec des millions de tonnes de vapeur d'eau, de fluor et de chlore[9] et près de 14.7 km^3 de lave sur une surface d'environ 580 km^2. [10]

Le résultat a été catastrophique pour le peuple islandais. Les champs utilisés pour le pâturage ont été tellement contaminés par les cendres volcaniques et les pluies polluées par le fluor que plus de 60% du bétail en pâturage, qui constituait la colonne vertébrale de l'économie islandaise, a péri en contractant une fluorose chronique en ingérant de l'herbe empoisonnée. Cela a entrainé une famine dévastatrice qui a causé

[7]THORDARSON, Thorvaldur et al., 'The 1783–1785 A.D. Laki-Grímsvötn Eruptions II: Appraisal Based on Contemporary Accounts', *Jokull* 53 (janvier 2003): 11–48.
[8] THORARINSSON, Sigurdur, 'On the Damage Caused by Volcanic Eruptions with Special Reference to Tephra and Gasses', dans *Volcanic Activity and Uuman Ecology*, ed. SHEETS, Payson, D. et GRAYSON, Donald K. (New York: Academic Press, 1980), 125–26, http://cidbimena.desastres.hn/pdf/eng/doc13631/doc13631-1.pdf.
[9] THORDARSON, T. et al., 'Sulfur, Chlorine, and Fluorine Degassing and Atmospheric Loading by the 1783–1784 AD Laki (Skaftár Fires) Eruption in Iceland.', *Bulletin of Volcanology* 58 (1996): 205–25, http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.476.5278&rep=rep1&type=pdf; THORDARSON, Thorvaldur et SELF, Stephen, 'Atmospheric and Environmental Effects of the 1783-1784 Laki Eruption: A Review and Reassessment', 1–6.
[10] THORDARSON, Thor et SELF, Stephen, 'The Laki (Skaftár Fires) and Grímsvötn Eruptions in 1783–1785', *Bulletin of Volcanology* 55, no. 4 (mai 1993): 233–63, https://doi.org/10.1007/BF00624353; THORDARSON, Thorvaldur et SELF, Stephen, 'Atmospheric and Environmental Effects of the 1783-1784 Laki Eruption: A Review and Reassessment'.

la mort d'environ 10 000 personnes, soit 20% de la population.[11] En Islande, cette catastrophe a été appelée Móðuharðindin, ou « Famine de la brume ».[12]

1:3 L'Annus Mirabilis

Les séismes, en Italie et ailleurs

La série de séismes qui a frappé la Calabre et Messine entre le 5 février et le 28 mars 1783 a été la plus sévère que l'Italie a connu en 90 ans. Pendant près de deux mois, une série de cinq secousses en Sicile et dans la région de Calabre a tué 35 000 à 50 000 personnes d'après les estimations et a dévasté un grand nombre de villes et villages. Plus de 1 500 de ces décès étaient dus à un tsunami provoqué par le grand effondrement du Monte Paci dans la mer près de la ville de Scila le 6 février. Beaucoup de ses habitants ont cherché refuge sur la plage, où ils ont été submergés par le déluge.[13]

Plusieurs autres séismes et tremblements de moindre importance sont survenus au cours de l'été et en décembre. Le 6 juillet, il y a eu un tremblement de terre dans les régions du Jura, de Franche-Comté, de Bourgogne et de Genève ainsi que de légers séismes à Maastricht et Aix-la-Chapelle le 8 aout, et des tremblements dans le nord de la France le 23 décembre.[14]

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[11] JACKSON, E.L., 'The Laki Eruption of 1783: Impacts on Population and Settlement in Iceland', *Geography* 67, no. 1 (janvier 1982): 42–50; THORDARSON, Thor et SELF, Stephen, 'The Laki (Skaftár Fires) and Grímsvötn Eruptions in 1783–1785'; THORDARSON, Thorvaldur, 'Volatile Release and Atmospheric Effects of Basaltic Fissure Eruptions' (PhD, Honolulu, Université d'Hawai, 1995); THORDARSON, Thorvaldur et SELF, Stephen, 'Atmospheric and Environmental Effects of the 1783-1784 Laki Eruption: A Review and Reassessment'.

[12] DAMODARAN, Vinita et al., 'The 1780s: Global Climate Anomalies, Floods, Droughts, and Famines', dans *The Palgrave Handbook of Climate History* (London: Palgrave Macmillan, 2018), 520.

[13] HAMILTON, Sir William, 'Account of the Earthquakes in Calabria, and Various Parts of Sicily', *The London Magazine: Or Gentleman's Monthly Intelligencer* 52, no. Sep&Oct (1783): 220–28; 295–304, http://babel.hathitrust.org/cgi/pt?id=nyp.33433081682779;view=1up;seq=443; DEMAREE, Gaston R. et OGILVIE, Astrid E. J., 'Bons Baisers d'Island: Climatic, Environmental, and Human Dimensions Impacts of the Lakagigar Eruption (1783-1784) in Iceland', dans *History and Climate: Memories of the Future* (New York, Boston, Dordrecht, London, Moscow: Kluwer Academic/Plenum, 2001), 219–46; WIKIPEDIA, '1783 Calabrian Earthquakes', Wikipedia, 23 novembre 2016, https://en.wikipedia.org/wiki/1783_Calabrian_earthquakes; ANON, 'Foreigh Affairs: Earthquakes in Calabria', *The London Magazine: Or Gentleman's Monthly Intelligencer* 52, no. mai (1783): 256.

[14] DEMAREE, Gaston R. et OGILVIE, Astrid E. J., 'Bons Baisers d'Island: Climatic, Environmental, and Human Dimensions Impacts of the Lakagigar Eruption (1783-1784) dans Iceland'; PAYNE, Richard J., 'Meteors and Perceptions of Environmental Change in the Annus Mirabilis AD1783-4'; DEMAREE, Gaston R. et OGILVIE, Astrid E. J., 'L'éruption Du Lakagigar En Islande Ou "Annus Mirabilis 1783". Chronique d'une Année Extraordinaire En Belgique et Ailleurs', dans *Etudes et Bibliographies d'histoire Environnementale*, Collections Autres Futurs 5 (Namur: Presses universitaires de Namur, 2016), 297.

Les éruptions volcaniques Europe

Bien que l'éruption du Laki soit la plus célèbre, ce n'est pas la seule qui a eu lieu en 1783. Vers la fin du mois de février, une éruption sous-marine est survenue à Fuglasker, au large de la péninsule de Reykjanes Peninsula au sud-ouest de l'Islande. Cet événement s'est poursuivi jusqu'à l'été et a formé l'île éphémère de Nýey (Nouvelle île), qui a disparu peu après.[15]

En plus des tremblements de terre, l'Italie dû faire face à une succession d'éruptions volcaniques. Le 17 février, l'éruption de l'Etna a été signalée puis, dans les jours qui ont suivi, celle du Stromboli et probablement de Vulcano, ajoutant ainsi à la destruction causée par les séismes de la Calabre et la Sicile.[16] Six mois plus tard, le 18 aout, il y a eu une légère éruption sans grande conséquence au Vésuve, qui a amorcé le sous cycle éruptif de ce volcan de 1783-1794.[17]

Une activité volcanique aurait également eu lieu au début de l'été dans la montagne de Gleichberg dans la Thuringe en Allemagne, mais les preuves tangibles font singulièrement défaut et il pourrait s'agir là d'un canular élaboré.[18]

Le brouillard chaud et sec et le soleil rouge sang

L'effet le plus remarquable de l'éruption du Laki est sans doute l'arrivée d'un brouillard chaud, sec et sulfureux qui s'est répandu sur la plus grande partie de l'hémisphère nord de l'Amérique du nord à l'ouest à la Chine à l'est. Il a fait sa première apparition en dehors de l'Islande vers le 10 juin dans les îles Féroé, à Bergen et à Trondheim,

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[15] FRANKLIN, Benjamin, 'Meteorological Imaginations and Conjectures', dans *Memoirs of the Literary and Philosophical Society of Manchester*, 2nd ed. (London: J. Cadwell, 1789), 377, https://www.dartmouth.edu/~volcano/Fr373p77.html; WOOD, Charles A., 'Climatic Effects of the 1783 Laki Eruption', dans *The Year Without a Summer? World Climate in 1816*, ed. HARRINGTON, C.R. (Ottawa, Canada: Canadian Museum of Nature, 1992), 576; STOTHERS, Richard B, 'The Great Dry Fog of 1783', *Climate Change* 32, no. 1 (1996): 79–89, https://doi.org/10.1007/BF00141279; DEMAREE, Gaston R. et OGILVIE, Astrid E. J., 'Bons Baisers d'Island: Climatic, Environmental, and Human Dimensions Impacts of the Lakagigar Eruption (1783-1784) in Iceland'.

[16] GRATTAN, John, BRAYSHAY, Mark, and SADLER, Jon, 'Modelling the Distal Impacts of Past Volcanic Gas Emissions. Evidence of Europe-Wide Environmental Impacts from Gases Emitted during the Eruption of Italian and Icelandic Volcanoes in 1783', *Quaternaire* 9, no. 1 (1998): 25–35, https://doi.org/doi : 10.3406/quate.1998.2103.

[17] BEHENCKE, Boris, 'Vesuvio Volcano, Italy The Activity between 1632 and 1794', Italy's Volcanoes: The Cradle of Volcanology, 12 juin 1996, http://www.geo.mtu.edu/volcanoes/boris/mirror/mirrored_html/VESUVIO_1632-1794.html.

[18] GRATTAN, J. P., GILBERTSON, D. D., and DILL, A, '"A Fire Spitting Volcano in Our Dear Germany": Documentary Evidence for a Low-Intensity Volcanic Eruption of the Gleichberg in 1783?', *Geological Society, London, Special Publications* 171, no. 1 (janvier 2000): 307–15, https://doi.org/10.1144/GSL.SP.2000.171.01.22.

quand il y a eu une chute de cendres volcaniques et de pluies acides. Il a également été rapporté que des bateaux naviguant entre le Danemark et l'Islande ont vu une chute de cendres qui a coloré ponts et voiles en noir.[19]

Au 26, presque toute l'Europe était recouverte d'un brouillard épais et malodorant qui brûlait les yeux, déclenchait des maux de tête et qui suscitait une grande détresse chez ceux qui souffraient d'asthme ou de troubles similaires.[20]

Au 30 juin, il avait atteint Moscou, et le lendemain les montagnes de l'Altaï en Asie centrale, à environ 7 000 km de l'Islande.[21]

Il y avait plusieurs explications contemporaines pour le brouillard, les plus étranges étant : les séismes de la Calabre, des évaporations du sol, l'électricité atmosphérique, des météores, et les débris de la queue d'une comète.[22] Cependant, le professeur Kratzenstein de l'université de Copenhague et le naturaliste français Mr Mourgue de Montredon ont correctement identifié son origine comme étant une éruption volcanique en Islande.[23]

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[19] THORDARSON, Thorvaldur, 'Volatile Release and Atmospheric Effects of Basaltic Fissure Eruptions'.
[20] de LAMANON, 'Observations on the Nature of the Fog of 1783', dans *The Philosophical Magazine: Comprehending the Various Branches of Science, the Liberal Arts, Agriculture, Manufactures and Commerce by Alexander Tilloch*, vol. 5 (London: J. Davis, 1799), 439, http://babel.hathitrust.org/cgi/pt?id=hvd.hxh3j3;view=1up;seq=92; GRATTAN, John, BRAYSHAY, Mark, et SADLER, Jon, 'Modelling the Distal Impacts of Past Volcanic Gas Emissions. Evidence of Europe-Wide Environmental Impacts from Gases Emitted during the Eruption of Italian and Icelandic Volcanoes in 1783'; DEMAREE, Gaston R. et OGILVIE, Astrid E. J., 'Bons Baisers d'Island: Climatic, Environmental, and Human Dimensions Impacts of the Lakagigar Eruption (1783-1784) in Iceland'; THORDARSON, Thorvaldur et SELF, Stephen, 'Atmospheric and Environmental Effects of the 1783-1784 Laki Eruption: A Review and Reassessment'; VAN SWINDEN, S.P., 'Observations on the Cloud (Dry Fog) Which Appeared in June 1783', ed. THORDARSON, Thorvaldur, trad. LINTLEMAN, Susan, *Jokull* 50 (janvier 2001): 73–80, https://www.researchgate.net/publication/280527027_Lintleman_and_Thordarson_2001._van_Swinden_contemporary_description.
[21] THORDARSON, Thorvaldur et SELF, Stephen, 'Atmospheric and Environmental Effects of the 1783-1784 Laki Eruption: A Review and Reassessment'.
[22] THORDARSON, Thorvaldur, 'Volatile Release and Atmospheric Effects of Basaltic Fissure Eruptions'; STOTHERS, Richard B, 'The Great Dry Fog of 1783'; THORDARSON, Thorvaldur et SELF, Stephen, 'Atmospheric and Environmental Effects of the 1783-1784 Laki Eruption: A Review and Reassessment'; de LAMANON, 'Observations on the Nature of the Fog of 1783', 80–89.
[23] HOLM, S.M., 'Account of a Remarkable Fiery Eruption from the Earth in Iceland, in the Year 1783', dans *The Philosophical Magazine: Comprehending the Various Branches of Science, the Liberal Arts, Agriculture, Manufactures and Commerce by Alexander Tilloch*, vol. 3 (London: J. Davis, 1799), 113–20, http://babel.hathitrust.org/cgi/pt?id=pst.000068485061;view=1up;seq=132; STOTHERS, Richard B, 'The Great Dry Fog of 1783', 79–89; DE MONTREDON, Mourgue, 'Recherches sur l'origine et sur la nature des vapeurs qui ont régné dans l'Atmosphère pendant l'été de 1783', dans *Histoire et Mémoires de l'Académie Royale des Sciences, Paris, Imprimerie Royale* (Paris: l'Académie Royale des Sciences, 1784), 773, http://gallica.bnf.fr/ark:/12148/bpt6k35800/f888.item.zoom; THORDARSON, Thorvaldur et SELF, Stephen, 'Atmospheric and Environmental Effects of the 1783-1784 Laki Eruption: A Review and Reassessment'.

Il y a eu beaucoup de rapports sur la chaleur qui accompagnait la brume et, dans « *Histoire naturelle de Selborne »,* Gilbert White offre une vive impression de son expérience du brouillard. [24]

Comme si le brouillard ne suffisait pas, il était souvent interrompu par de violents orages accompagnés de tonnerre et d'éclairs intenses qui dans bien des cas prenaient des vies parmi les humains comme parmi le bétail et causaient des dégâts considérables aux cultures et aux biens.

Les violents orages et les grandes boules de feu

Entre juin et septembre, il y a eu de nombreux rapports dans les journaux locaux de tempêtes de pluie torrentielles d'une violence inhabituelle accompagnées de tonnerre, de foudre, de vent de la force d'un ouragan, de grêle et parfois de boules de feu. La cause en était le niveau élevé d'évaporation de la surface du sol provoquée par les brouillards chauds qui chargeaient l'atmosphère de vapeur d'eau en abondance. L'air était lui aussi chargé de quantités considérables de fine poussière volcanique, il constituait une source de noyaux de condensation extrêmement performants.

La foudre n'était pas à l'origine des boules de feu mentionnées dans les journaux. Le soir du 18 aout 1783, un météore extraordinairement lumineux a été aperçu au-dessus de la Grande-Bretagne et du nord-ouest de l'Europe et plusieurs correspondants l'ont rapporté à la Royal Society à Londres[25].

Les insectes et les poissons morts, et les feuilles tombantes

Au-delà de l'Islande, beaucoup d'endroits en Europe, notamment au bord de la mer

[24] WHITE, Gilbert, *The Natural History and Antiquities of Selborne in the County of Southampton: With Engravings and an Appendix* (London: T. Bensley, 1789), 301–2, https://ia800504.us.archive.org/12/items/naturalhistorya04whitgoog/naturalhistorya04whitgoog.pdf.

[25] CAVALLO, Tiberius, 'Description of a Meteor, Observed Aug. 18, 1783. By Mr. Tiberius Cavallo, F.R.S.', *Philosophical Transactions of the Royal Society* 74 (1 janvier 1784): 108–11, http://rstl.royalsocietypublishing.org/content/74/108.

du nord et dans les régions baltiques, ont vu leur végétation souffrir des effets du brouillard sec et des pluies acides. Ce fut tellement marqué qu'aux Pays-Bas, en 1783, le botaniste néerlandais Sebald Justinus Brugmans a publié un ouvrage listant plus de 200 plantes qui avaient été affectées.[26]

Tous les effets du brouillard n'étaient cependant pas mauvais. Par exemple, des récoltes de raisin record ont été rapportées en Europe centrale et orientale ; en Pologne, le maïs a été récolté début juillet, un événement sans précédent ; et il y a eu une profusion de fruits dans la région du Banat.[27]

Néanmoins, il n'y a pas que la végétation qui a subi les effets néfastes du brouillard : des myriades d'insectes ont semblé avoir été tués par l'absorption de particules d'acide par les feuilles. [28] D'autres animaux que les insectes auraient souffert du brouillard. D'après le journal « *The Caledonian Mercury* » daté du 5 juillet 1783, après un gros orage, plusieurs poissons morts ont été trouvés flottant au-dessus d'un barrage à Leith ; il semblerait que le plan d'eau dans lequel ils se trouvaient ait été frappé par la foudre ou que de l'acide séché, déposé et accumulé sur la terre pendant un certain temps ait été empoté dans l'eau par l'orage, faisant ainsi baisser son pH pour la rendre toxique.[29]

1:4 Les réponses sociales

Le brouillard sec et les tempêtes et autres phénomènes inhabituels qui l'ont accompagné ont causé beaucoup d'inquiétude parmi les personnes les moins éclairées ; à tel point que l'astronome français de la Lande a même publié un article

[26] BRUGMANS, Sebald Justinus, *Natuurkundige Verhandeling over Een Zwavelagtigen Nevel Den 24 Juni 1783 in de Provintie van Stad En Lande En Naburige Landen Waargenomen* (Groningen: Petrus Doekema, 1783), 7, 15–25.
[27] DEMAREE, G. R. et OGILVIE, A. E. J., 'Bon Baisers d'Islande: Climatic, Environmental and Human Dimensions, Impacts of the Lakagigar Eruption (1783-1784) in Iceland.', in *History and Climate: Memories of the Future?* (New York: Kluwer, 2001), 312, https://books.google.fr/books?id=-cgnFsLkIAYC&pg=PA219&dq=demaree,+ogilvie+bon+baisers+d%27islande&hl=en&sa=X&ei=IBh2VdT3MMvkUczsgIAF&ved=0CCkQ6AEwAA#v=onepage&q=demaree%2C%20ogilvie%20bon%20baisers%20d%27islande&f=false.
[28] VAN SWINDEN, S.P., 'Observations on the Cloud (Dry Fog) Which Appeared in June 1783'.
[29] GRATTAN, J. P. et PYATT, F. B., 'Acid Damage to Vegetation Following the Laki Fissure Eruption in 1783 - an Historical Review', *The Science of the Total Environment* 151 (1994): 241–47.

dans la presse populaire pour tenter de calmer les rumeurs et les spéculations qui avaient été répandues par les ignorants. [30]

Comme on pouvait s'y attendre, le météore qui est apparu le 18 aout a suscité autant de consternation parmi la *« foule ignorante »* que le brouillard sec. Un article publié dans le « *Cumberland Pacquet and Whitehaven Advertiser* » a aussi essayé de calmer la population, concluant avec une fin appropriée : … avec « *peuples ignorants et superstitieux : dans ces curiosités peu communes, ils perçoivent clairement guerre, famine, rébellion, séismes, voire même la fin du monde ! »* [31]

1:5 Les hivers rigoureux, les inondations printanières

L'hiver 1783-1784 s'est avéré long et difficile, avec des records de chutes de neige et de températures basses dans de nombreux endroits. La Tamise à Londres était gelée, comme les canaux néerlandais et beaucoup de fleuves européens. Au dégel, les fleuves ont débordé de leur lit sous la surcharge de la neige et de la glace fondues que le sol gelé ou gorgé d'eau ne pouvait pas absorber et il y a eu des inondations dans beaucoup d'endroits. Selon Brazdil et al, 2009, « *Les inondations de l'hiver 1783/1784 comptent parmi les plus spectaculaires couvertes par des données instrumentales et documentaires à l'échelle européenne la plus large et apportent des informations précieuses sur la gravité et l'ampleur de ces événements.* »[32] Dans ce rapport nous nous sommes penchés sur les marqueurs épigraphiques qui ont été utilisés pour enregistrer ces événements et nous pouvons voir qu'ils sont utiles même aujourd'hui pour comparer des inondations récentes à des inondations passées ou futures éventuelles.

[30] BRAYSHAY, Mark et GRATTAN, John, 'Environmental and Social Responses in Europe to the 1783 Eruption of the Laki Fissure Volcano in Iceland: A Consideration of Contemporary Evidence', *Geological Society, London, Special Publications* 161 (1999): 173–87.
[31] L'AMI DES HOMMES, 'On Meteors in General; Their Causes and Effects', *Cumberland Pacquet, and Ware's Whitehaven Advertiser*, 26 aout 1783, 3, https://search.findmypast.co.uk/bna/ViewArticle?id=BL%2F0000950%2F17830826%2F010%2F0003&browse=true.
[32] BRAZDIL, Rudolf et al., 'European Floods during the Winter 1783/1784: Scenarios of an Extreme Event during the Little Ice Age', *Theoretical and Applied Climatology* 100, no. 1 (29 juillet 2009): 163–89, https://doi.org/10.1007/s00704-009-0170-5.

Outre l'Europe, le long hiver 1783-1784 a affecté l'est des Etats-Unis, où il a été décrit comme l'un des trois pires hivers du 18ème siècle,[33] et le sud-est du Canada où des ponts de glace se sont formés sur le fleuve St. Laurent. [34]

Il convient maintenant de se demander si l'éruption du Laki a été le moteur de la gravité de l'hiver 1783-1784 ou s'il y avait d'autres raisons. Cette idée était généralement acceptée jusqu'à ce qu'un article de D'Arrigo et al, 2011, suggère de manière convaincante que l'extrême sévérité de l'hiver avait été causée par une phase négative combinée de l'oscillation nord-atlantique (ONA) et une phase de réchauffement de l'oscillation australe El Niño (ENSO), [35] alors que l'avis de Brazdil et al, 2009, était que : « *L'hiver 1783-1787 peut être considéré comme un hiver typique, bien que rigoureux, durant le 'petit âge glaciaire' ».*[36]

Dans le chapitre 2, la documentation populaire et universitaire fait l'objet d'une analyse approfondie. En utilisant une grande variété d'archives modernes et contemporaines, le chapitre examine les conséquences de l'éruption et la nature et les réponses de la population aux événements historiques de l'année qui lui ont valu son nom d'« Annus Mirabilis ».

2:1 Les archives contemporaines et proches du contemporain

Elles se présentent sous de nombreuses formes : témoignages oculaires rapportés dans des carnets ou lettres privées, rapports de journaux, rapports officiels, journaux de bord de bateaux et journaux météorologiques, pour n'en citer que quelques-unes. Il faut rappeler que nous ne pouvons pas considérer des témoignages oculaires comme fiables ou même utiles, sauf s'il peut être prouvé que l'informateur se trouvait

[33] THORDARSON, Thorvaldur et SELF, Stephen, 'Atmospheric and Environmental Effects of the 1783-1784 Laki Eruption: A Review and Reassessment'; WOOD, Charles A., 'Climatic Effects of the 1783 Laki Eruption'.
[34] HOULE, Daniel, MOORE, Jean-David, et PROVENCHER, Jean, 'Ice Bridges on the St. Lawrence River as an Index of Winter Severity from 1620 to 1910', *Journal of Climate* 20 (15 février 2007): 757–64, https://doi.org/10.1175/JCLI4025.1.
[35] D'ARRIGO, Rosanne et al., 'The Anomalous Winter of 1783-1784: Was the Laki Eruption or an Analog of the 2009-2010 Winter to Blame?', *Geophysical Research Letters* 38 (13 mars 2011): 1–4, https://doi.org/10.1029/2011GL046696.
[36] SADLER, J. P. et GRATTAN, J. P., 'Volcanoes as Agents of Past Environmental Change', *Global and Planetary Change* 21 (1999): 181–96, http://cadair.aber.ac.uk/dspace/bitstream/handle/2160/236/Volcanoes%20as%20agents%20of%20past%20environmental%20change.pdf?sequence=1&isAllowed=y; BRAZDIL, Rudolf et al., 'European Floods during the Winter 1783/1784: Scenarios of an Extreme Event during the Little Ice Age'.

sur la scène des événements décrits et que les témoignages ont été enregistré peu de temps après ; même dans ce cas des témoignages oculaires simultanés peuvent différer considérablement.

Une vingtaine de récits contemporains de l'éruption du Laki ont été écrits et ils ont fait l'objet d'une analyse critique par Thordarson. Les plus connus sont les trois Eldrits (Livres de feu) écrits par le curé, le révérend Jón Steingrímsson. Le dernier et le plus complet des trois a été écrit pour informer le public. Heureusement, même s'il contient quelques erreurs, d'autres témoignages apportent des informations supplémentaires permettant de les corriger. Plusieurs autres rapports contiennent des déclarations trompeuses puisqu'ils reposent sur des rumeurs, ils sont donc peu utiles.[37]

Il y a eu une forte expansion de l'industrie de la presse au 18ème siècle. En Angleterre, par exemple, les ventes annuelles ont rapidement augmenté, passant d'environ 2,5 millions en 1713 à 16 millions en 1801.[38] Les journaux, en Grande-Bretagne et en Europe, ont rapidement publié des lettres et articles concernant la météo inhabituelle qu'il y a eu durant l'été 1783 et l'hiver suivant ; les dégâts causés par les violents orages ; et l'étrange phénomène qui a eu lieu. Cependant, au 18ème siècle, la diffusion des informations prenait souvent des semaines voire des mois pour atteindre les journaux. Par exemple, les nouvelles relatives à l'éruption du Laki ont atteint La Haye le 18 septembre et Barcelone le 25 octobre 1783, soit trois ou quatre mois plus tard.[39]

Les rapports officiels, journaux, journaux de bord de navires, journaux météo et livres contemporains relatifs à un événement particulier – comme celui de Steingrímsson – constituent des sources d'informations tout aussi importantes. Les revues savantes rédigées au même moment ou juste après, qui peuvent avoir publié des informations détaillées qui ne sont pas disponibles ailleurs, par exemple le papier de Swinden :

[37] THORDARSON, Thorvaldur, 'The 1783–1785 A.D. Laki-Grímsvötn Eruptions I: A Critical Look at the Contemporary Chronicles', *Jokull* 53 (janvier 2003): 1–10; STEINGRIMSSON, Jón, *Fires of the Earth: The Laki Eruption1783-1784*, trad. KUNZ, Keneva (Reykjavik: Nordic Volcanological Institute and the University of Iceland Press, 1998).
[38] BLACK, Jeremy, *Eighteenth-Century Britain : 1688-1783* (Basingstoke, Hampshire; New York: Palgrave, 2001), 122; BLACK, Jeremy, 'From Woodcuts to Steam Press', *BBC History Magazine Supplement*, May 2002, 13.
[39] DEMAREE, Gaston R. et OGILVIE, Astrid E. J., 'L'éruption Du Lakagigar En Islande Ou "Annus Mirabilis 1783". Chronique d'une Année Extraordinaire En Belgique et Ailleurs'.

« *Observations on the cloud (dry fog) which appeared in June 1783* » (Observations sur le nuage (brouillard sec) qui est apparu en juin 1783), et les livres écrits par Brugmans et Gilbert White, ont un intérêt tout particulier.

Au-delà des informations relatives à la météo, que l'on peut naturellement s'attendre à trouver dans les journaux de bord de navires, il y a plusieurs cas de capitaines qui ont rapporté des événements inhabituels. Par exemple, il existe au moins deux rapports sur l'éruption de Nýey en mai 1783 ; celui du capitaine Mindelberg ; un rapport du capitaine danois Pedersen et son assistant Svendborg, depuis le navire le Forsken ; et un rapport sur la brume du Laki par un capitaine anonyme d'un bateau naviguant de la Norvège à Groningue entre le 19 juin et le 2 juillet.[40]

Des illustrations contemporaines : gravures, peintures, gravures à l'eau forte ou dessins peuvent servir à éclairer un rapport, mais avec la réserve qu'elles peuvent représenter le sujet de manière inexacte. Le plus probable est qu'elles aient été créées par la suite, avec sans nul doute une grande licence artistique ; l'artiste peut avoir représenté ce qu'il a imaginé ; ce qu'il pensait que son audience souhaitait voir ; sa propre expérience de l'événement colorée par le temps ; ou il peut s'être appuyé sur des rumeurs, avec des avis contradictoires de plusieurs témoins différents. Ceci dit, il existe un dessin très vivant du témoin oculaire le capitaine Mindelberg qui représente la nouvelle île de Nýey en formation.

Avant l'arrivée de la photographie, les événements étaient souvent représentés par des estampes ou gravures, qu'elles apparaissent sous forme d'illustrations dans des livres ou qu'elles soient vendues séparément. Plusieurs exemples de ces représentations témoignent de la dévastation causée par les inondations en Europe centrale de 1784 et des fleuves, la Meuse à Rotterdam et la Tyne à Newcastle durant le Grand gel de 1784.

[40] WOOD, Charles A., 'Climatic Effects of the 1783 Laki Eruption'; VAN SWINDEN, S.P., 'Observations on the Cloud (Dry Fog) Which Appeared in June 1783'; DEMAREE, G. R. et OGILVIE, A. E. J., 'Bon Baisers d'Islande: Climatic, Environmental and Human Dimensions, Impacts of the Lakagigar Eruption (1783-1784) in Iceland.'

Comme sources d'informations beaucoup plus contestables, on retrouve les mythes et légendes transmis à l'oral d'une génération à l'autre et qui ont finalement été portés à l'écrit. Une légende inuit relative au peuple Kauwerak semble confirmer qu'il y a eu un hiver extrêmement rigoureux en 1783-1784 dans l'extrême nord-ouest de l'Alaska.

Des sermons et autres actes de dévotion religieuse publiés peuvent nous aider à comprendre les perceptions de la population en temps de crise et ses réponses. En France les prêtres ont été accusés de capitaliser sur les peurs des gens ordinaires. Le soleil rouge et l'atmosphère enfumée avaient « *alarmé la partie superstitieuse du peuple, qui avait été manipulée par ses prêtres pour croire que la fin du monde approchait* ».[41] Les prêtres d'autres pays prêchaient également des sermons déconcertants, avec notamment un prédicateur méthodiste en Angleterre qui s'est ainsi prononcé au sujet du Grand météore de 1783 : « *Une révélation ! En flammes, une énorme bête à sept têtes et dix cornes : sept couronnes et dix comètes délivrées* », tandis qu'un autre a dit que le météore était « *un coup d'avertissement, mais ils peuvent être sûrs que le prochain qui vient ne volera pas si haut, mais qu'il leur explosera la cervelle* ».[42] En Allemagne les prêtes locaux ont utilisé les inondations de 1784 pour prêcher la propagande religieuse.

2:2 Les publications universitaires

Les premières publications universitaires ont été trouvées au 17ème et 18ème siècle durant la période connue comme le siècle des Lumières, un mouvement intellectuel et philosophique qui a dominé le monde des idées en Europe à cette époque. Les deux journaux les plus prestigieux étaient le « *Journal des Sçavans* », de 1665 à 1792, et « *The Philosophical Transactions of the Royal Society* » à partir de 1665. La principale différence entre ces deux revues et la plupart des journaux modernes est qu'elles n'étaient pas évaluées par des pairs, mais elles ont été rejointes en 1731 par le premier journal évalué par des pairs, « *Medical Essays and Observations* », publié par la Philosophical Society of Edinburgh (Société philosophique d'Édinbourg).

[41] GRATTAN, John et BRAYSHAY, Mark, 'An Amazing and Portentous Summer: Environmental and Social Responses in Britain to the 1783 Eruption of an Iceland Volcano', *The Geographical Journal* 161, no. 2 (juillet 1995): 125–34, https://doi.org/10.2307/3059970.
[42] PAYNE, Richard J., 'Meteors and Perceptions of Environmental Change in the Annus Mirabilis AD1783-4'.

En plus des journaux, les idées étaient souvent diffusées sous forme de pamphlets, qui pouvaient à leur tour générer plus de pamphlets en accord ou en désaccord avec l'auteur, et une petite guerre de pamphlets pouvait s'ensuivre entre ceux qui étaient d'accord avec le postulat d'origine et ceux qui ne l'étaient pas. Ce fait est largement démontré par les nombreux pamphlets relatifs à l'efficacité du vaccin contre la variole. Pour citer un exemple, le Dr John Lettsom a publié : « *An Answer to Baron Dimsdale's Review of Dr. Lettsom's Observations on the Baron's Remarks Respecting a Letter upon General Inoculation* » (Réponse à la critique du Baron Dimsdale des observations du Dr Lettsom sur les remarques du Baron concernant une lettre sur le vaccin général).[43].

Le plus grand avantage que les auteurs d'aujourd'hui ont sur leurs collègues du 18ème est le pouvoir d'internet. Outre son utilisation pour rassembler des informations, il permet de discuter et de diffuser des idées, mais pourrait-il voir la fin des journaux publiés ? Voici la réflexion que nous propose Richard Fortey : « …*on pourrait se demander si la prochaine génération peut perdre contact avec l'histoire elle-même, parcourant toujours quelques journaux virtuels du mois, une amnésie de groupe effaçant le passé alors que l'obsolescence intellectuelle rampe inexorablement vers les publications de l'avant-veille. »*.[44]

2:3 La documentation populaire

Cette thèse utilise le terme « documentation populaire » pour désigner des livres, journaux et articles de journaux, blogs etc. qui sont destinés au grand public plutôt qu'à une audience spécialisée. Bien que certains articles populaires relatifs au Laki soient écrits par des experts spécialisés dans ce domaine, d'autres sont rédigés par des journalistes ou autres qui ont peu de connaissances sur le sujet ce qui, en retour,

[43] LETTSOM, John Coakley, *An Answer to Baron Dimsdale's Review of Dr. Lettsom's Observations on the Baron's Remarks Respecting a Letter upon General Inoculation.* (London: C. Dilly; and H. Payne, 1779), https://books.google.fr/books?id=t_1ZAAAAcAAJ&pg=PA46&lpg=PA46&dq=thomas+dimsdale+dr.+lettsom&source=bl&ots=q7Fz8YVji8&sig=rXTItfFaGash0ElznmicpEvdSIw&hl=en&sa=X&ved=0ahUKEwj0ztjq0LPTAhWSK1AKHS7DDyMQ6AEINDAE#v=onepage&q=thomas%20dimsdale%20dr.%20lettsom&f=false.

[44] FORTEY, Richard, *Dry Store Room No. 1: The Secret Life of the Natural History Museum* (London, New York, Toronto, Sydney & New Delhi: Harper Perennial, 2008), 313.

peuvent mener à une simplification à outrance, une dramatisation ou une déformation des faits.

Au moins trois romans ont pour décor le Laki ou son éruption, tandis que l'éruption, les météores du 18 aout et les inondations de Calabre sont mentionnés dans un poème contemporain de William Cowper ; mais il semble que le dernier mot de la documentation sur le Laki revienne à un article du Télérama qui tient le Laki pour responsable du manque de production de whisky écossais en France.[45]

Le chapitre 3 de la thèse se penche sur les conditions de vie rurales et urbaines et leur rapport aux maladies endémiques et épidémiques qui étaient répandues dans la seconde moitié du dix-huitième siècle. Il examine en détails la pathologie et la transmission de ces maladies. À cet égard, les London Bills of Mortality (statistiques sur la mortalité de Londres) sont particulièrement intéressants puisqu'ils listent plus de 80 causes de décès. Cette thèse examine ensuite l'état des connaissances médicales et du corps médical durant cette période dans le contexte de l'histoire médicale et sociale. Le nombre effrayant de décès infantiles couplé à la fréquence des infanticides fait l'objet d'une discussion, avec des comparaisons des taux de survie dans les hôpitaux d'accueil en Angleterre et en Europe. De plus, les dangers que représente l'inhalation de poussière des éruptions volcaniques sont examinés, en particulier pour ce qui concerne la Grande-Bretagne et l'Europe.

3:1 Les conditions de vie

Selon les normes actuelles, la qualité du logement était mauvaise : sol en terre plutôt qu'en pierre, manque de couches d'étanchéité et absence de murs creux impliquaient que la majorité des maisons subissaient des infiltrations et augmentations d'humidité qui peuvent avoir contribué en grande partie à la faiblesse générale de la population.[46]

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[45] ROCH, Jean-Baptiste, 'France, la soif du malt', *Télérama*, 22 novembre 2017, 32–40.
[46] RAZZELL, Peter, 'The Growth of Population in Eighteenth-Century England: A Critical Reappraisal', *The Journal of Economic History* 53, no. 4 (décembre 1993): 766–69.

Un voyageur s'approchant d'une grande ville était averti de son arrivée imminente par l'odeur omniprésente. Des piles d'ordures et d'eaux usées étaient jetées hors des limites de la ville par des hommes de la nuit sans prétention d'évacuation hygiénique. Une fois à l'intérieur de la ville, les rues et fossés étaient inondés d'urine et d'excréments humains qui étaient jetés par les fenêtres des étages, au grand dam des passants, ou bien déposés dans les rues la nuit.

Le manque de place pour les inhumations des défunts était un problème récurrent dans les grandes villes. Alors que Londres avait ses « trous pour pauvres », qui étaient larges, profonds, souvent des fosses, utilisés pour l'inhumation des pauvres, souvent situés près des maisons ou commerces et qui étaient seulement recouverts de terre une fois pleins,[47] Paris disposait du cimetière des Innocents, vieux de 600 ans, qui était utilisé en permanence depuis le 14ème siècle.[48] L'odeur qui s'en dégageait était si mauvaise que, entre autres, les tonneaux de vin tournaient au vinaigre et la viande pourrissait sous les yeux des gens. Il n'a été fermé qu'après qu'un mur de la cave d'une maison s'est effondré sous le poids du sol rue de la Lingerie, répandant une masse toxique de terre et putrifiant les corps dans le sous-sol. [49]

La propreté était difficile, en particulier pour les personnes sans accès à des réserves d'eau propre. « *Alors que la plupart se lavaient le visage quotidiennement, beaucoup ne se lavaient pas le corps d'une année sur l'autre…* »[50] Cette situation existait dans toute l'Europe et a été rapportée par de nombreux voyageurs. Il n'est pas surprenant que ce manque d'hygiène personnelle, de réserves d'eau propre et ces conditions de logement insalubres aient pu causer des problèmes de santé. Les flambées d'infections bactériennes de l'estomac étaient la norme, et elles pouvaient être assez graves pour tuer leurs victimes en l'espace de quelques jours.[51]

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[47] WALLER, Maureen, *1700: Scenes from London Life*, 1st ed. (London: Hodder & Stoughton, 2001), 95; STONE, Lawrence, *The Family, Sex and Marriage in England, 1500-1800*, Réédition (London: Weidenfield and Nicolson, 1977), 77–79.
[48] THOURET, Michel-Augustin, *Rapport Sur Les Exhumations : Du Cimetière et de l'église Des Saints. Innocents; Lu Dans La Séance de La Societe Royale de Médecine, Tenue Au Louvre Le 3 Mars 1789* (Paris: Ph-Denys Pierres, 1789), http://gallica.bnf.fr/ark:/12148/bpt6k6466946s/f16.image.
[49] SCHOMBURG, Josef M., 'Les Innocents', Paris Promenades, non daté, https://www.paris-promenades.com/en/site_text/III.htm.
[50] BIRCH, C. Allan, 'The Medical History of Hastings' (Typescript, Undated), 8–9, East Sussex Record Office.
[51] STONE, Lawrence, *The Family, Sex and Marriage in England, 1500-1800*, 77–79.

L'effet nocif sur les poumons en respirant l'air étouffant et enfumé des feux de charbon domestiques et industriels était également problématique.

3:2 La nourriture

Les recherches en cours suggèrent que le niveau moyen de nutrition était bas et qu'une partie importante de la population subsistait avec des régimes qui tombaient bien en dessous des normes recommandées par les experts en nutrition d'aujourd'hui. Les riches avaient une alimentation volumineuse mais déséquilibrée. Il y avait un gros apport en protéines mais peu de légumes, car ils avaient la réputation de causer mélancolie et flatulences. Cependant, pour ceux qui pouvaient se le permettre et qui y étaient enclins, il y avait une grande variété de denrées alimentaires disponibles.[52] En revanche, la nourriture mangée par les pauvres était maigre et monotone et, en Angleterre, au moins environ deux tiers des revenus étaient dépensés en aliments et boissons, et le reste était utilisé pour les loyers, les vêtements et chaussures.[53]

3:3 Les porteurs de maladies et leurs maladies

Les principaux porteurs de maladies peuvent être classés comme suit :

> Les vecteurs mécaniques sont tous les objets ou toutes les substances capables de porter des organismes infectieux, mais où la maladie ne se reproduit et ne se développe pas, que ce soit dans ou sur le vecteur ; par exemple : l'air, qui peut porter la grippe, l'eau, qui transmet la typhoïde ; et les aliments contaminés, porteurs de maladies intestinales.

> Vecteurs humains. Les êtres humains peuvent se transmettre des maladies les uns aux autres, comme notamment la variole, la tuberculose ou la Covid-19. De

[52] SHARPE, J. A., *Early Modern England: A Social History 1550-1760*, 2nde ed. (London: Hodder Arnold, 1997), 49; HARRIS, Bernard, 'Public Health, Nutrition and the Decline of Mortality: The McKeown Thesis Revisited', *Social History of Medicine* 27, no. 4 (décembre 2004): 14, https://doi.org/10.1093/shm/17.3.379.
[53] PORTER, Roy, *English Society in the 18th Century*, Edition révisée, The Penguin Social History of Britain (London: Penguin Books, 1991), 215–16.

plus, certaines personnes qui ont guéri d'une maladie en sont devenues porteuses.

Animaux et insectes vecteurs. Le rat noir est probablement le vecteur animal le plus largement connu, puisque dans certains cas il peut transmettre la peste, tandis que divers animaux de la ferme peuvent transmettre la tuberculose bovine ou la brucellose.

Dans cette étude, les insectes sont de loin les plus grands transmetteurs de maladies. Par exemple, le typhus est propagé par les poux du corps humain ; la malaria par les moustiques anophèles ; et les mouches sont supposées transmettre au moins 65 maladies aux animaux et aux humains.[54]

L'éventail de maladies courantes que toute personne vivant au 18ème siècle était susceptible de contracter est large selon les normes actuelles et, malheureusement, comme le corps médical était mal équipé pour les traiter, le décès n'était jamais très loin. La peur de la contagion doit toujours avoir été présente. Une simple coupure ou un os cassé pouvait être le signe annonciateur d'une infection comme le sepsis, le tétanos ou la gangrène qui, sans le bénéfice des antibiotiques modernes, menaient en fin de compte au décès.[55]

Même si la variole était, sans doute, la maladie la plus redoutée, causant souvent de graves épidémies avec de nombreux décès, d'autres comme le typhus pouvaient être tout aussi fatales. La tuberculose, autre infection dévastatrice, était plus souvent endémique plutôt qu'épidémique, et était particulièrement courante dans les conditions de logement sordides des villes industrielles en développement rapide. Elle pouvait également être classée comme maladie professionnelle causée par les horribles conditions de travail, par exemple dans les filatures de coton de Manchester.

[54] RILEY, J. C., 'Insects and the European Mortality Decline', *American Historical Review* 91, no. 4 (octobre 1986): 850. https://www.researchgate.net/post/Cockroach_versus_fly-which_is_germier, (accès le 19/04/2016)
[55] WILLS, Simon, *How Our Ancestors Died: A Guide for Family Historians;* (Pen & Sword, 2013), 200–202.

Les maladies professionnelles n'affectaient que certains membres de la société. Ils étaient nombreux et variés et tués sur une période de temps, principalement par l'ingestion de minuscules particules dans les poumons – on peut penser à la silicose, une maladie des mineurs et des ouvriers de la pierre – ou par l'absorption de substances toxiques par la peau ou les muqueuses du nez et des poumons ; par exemple en inhalant la vapeur du mercure utilisé dans la fabrication de chapeaux en feutre à l'origine de la maladie du chapelier fou.

Les maladies causées par les éruptions volcaniques peuvent être classées en trois catégories : irritantes, toxiques ou inertes. Le brouillard sec du Laki était un brouillard irritant, composé principalement de SO_2 et de plus petites quantités de HCl, HF et NH_3 qui peuvent avoir eu des effets nocifs sur la santé des asthmatiques et des personnes souffrant de bronchite ou d'autres affections respiratoires.

Les London Bills of Mortality sont probablement les rapports les plus connus et les plus complets relatifs aux décès et maladies que nous avons depuis le 18ème siècle et, même s'ils présentent de nombreuses lacunes, ils nous donnent le meilleur aperçu disponible des maladies du 18ème siècle, nonobstant le fait que beaucoup des termes utilisés ne seraient pas reconnaissables aujourd'hui.

3:4 Le corps médical

En général, le corps médical européen était divisé en quatre catégories principales : les médecins, les chirurgiens, les apothicaires et les sages-femmes. Comme l'on peut s'y attendre, ces divisions n'étaient pas bien définies, et les cabinets généraux étaient de plus en plus répandus. Même à Londres, où l'on pourrait s'attendre à des spécialisations, les apothicaires et les chirurgiens ont commencé à se ressembler et la démarcation entre les chirurgiens et les médecins est devenue de plus en plus floue.[56] Les chirurgiens empiétaient également sur le terrain des sages-femmes et

[56] DIGBY, Anne, *Making a Medical Living : Doctors and Patients in the Market for Medicine, 1720-1911.*, Cambridge Studies in Population, Economy and Society in Past Time 24 (Cambridge: Cambridge University Press, 1994), 29; RAMSEY, Matthew, *Professional and Popular Medicine in France, 1770-1830: The Social World of Medical Practice*, Reprint, Cambridge History of Medicine (Cambridge, New York, New Rochelle, Melbourne, Sydney: Cambridge University Press, 2002), 29–31, https://books.google.fr/books?id=f_Qap3_F8x8C&pg=PA247&lpg=PA247&dq=charles+x+scrofula&source=bl&ots=Ju54OOhLnr

prenaient en charge des cas difficiles ainsi que des naissances normales sur demande. Au grand dam des sages-femmes, dans certains pays protestants comme l'Angleterre, l'Allemagne du sud et le Pays-Bas, des sages-femmes hommes avaient commencé à empiéter sur leur terrain depuis début 1700, mais dans les pays catholiques comme la France, l'Italie et l'Espagne, l'Église insistait sur le recours aux sages-femmes féminines pour protéger la pudeur des femmes.[57]

En outre, la hiérarchie médicale officielle était soutenue par toute une myriade de personnalités non officielles, allant de simples charlatans à des devins-guérisseurs et leveurs de sorts, en passant par des personnes d'autres professions qui pratiquaient la médecine en marge.[58] Malheureusement, le corps médical étant mal équipé pour traiter efficacement la plupart des maladies et la mort guettant à tous les coins de rues, il n'est pas surprenant que beaucoup de gens, en particulier ceux qui n'avaient pas les moyens de se procurer un traitement médical, aient fait confiance à des remèdes testés. Comme le dit Porter : « *la médecine sans Médecins était une nécessité pour beaucoup mais une préférence pour certains.* »[59] La citation ci-dessous attribuée à Voltaire devait être très pertinente. *« L'art de la médecine consiste à distraire le malade pendant que la nature le guérit* ».

C'est dans ce contexte d'incertitude que l'industrie des médicaments brevetés a commencé à se développer et s'est trouvée en plein essor à la fin du siècle.

&sig=vYVBP_btJm86ccr2a50u3SmDknI&hl=en&sa=X&ved=0ahUKEwjD3tzy6cLJAhVErRoKHWXlCBU4ChDoAQgqMAQ#v=onepage&q=charles%20x%20scrofula&f=false.

[57] KONTOYANNIS, Maria et KATSETOS, Christos, 'Midwives in Early Modern Europe (1400-1800)', *Health Service Journal* 5, no. 1 (2011): 31–36, http://www.hsj.gr/medicine/midwives-in-early-modern-europe-14001800.pdf; SCIENCE MUSEUM, 'Man-Midwives', Science Museum brought to Life Exploring the History of Medicine, accès le 1er mai 2016, http://www.sciencemuseum.org.uk/broughttolife/people/manmidwives; Pour les arguments pour et contre les sages-femmes hommes, voir : Samuel Gregory, Man-midwifery exposed and corrected (Boston & New York, 1828), et Do History,The Controversy: http://dohistory.org/man-midwife/controversy/index.html (accès le 1/05/2016). Adrian Wilson dans Making of man-midwifery: childbirth in England, 1660-1770 (Harvard University Press, Cambridge, 1995), p.192, soutien de manière convaincante que seules les femmes pouvaient se permettre les 10 guinées facturés par William Hunter, le célèbre chirurgien. "The artisan's wife might not be able to afford a carriage, but every couple of years she could afford a man-midwife. .Man-midwifery thus became an area of conspicuous consumption;" 'King's Evil and the Royal Touch', Exploring the History of Medicine, accès le 22 octobre 2015, http://www.sciencemuseum.org.uk/broughttolife/techniques/kingsevil.aspx.

[58] PORTER, Roy, *Quacks: Fakers and Charlatans in English Medicine*, Illustré (Stroud & Charleston, SC: Tempus, 2000); WESTON, Robert, *Medical Consulting by Letter in France, 1665-1789*, The History of Medicine in Context (Farnham & Burlington: Ashgate, 2013), 49; RAMSEY, Matthew, *Professional and Popular Medicine in France, 1770-1830: The Social World of Medical Practice*, 27–28.

[59] PORTER, Roy, *The Greatest Benefit to Mankind : A Medical History of Humanity from Antiquity to the Present*, 1ère ed. (London: HarperCollins, 1997), 281.

Les patients aisés pouvaient « prendre les eaux » dans les nombreuses villes thermales qui étaient établies en Angleterre et en Europe. C'est à peu près l'époque où la baignade en eau de mer était présentée comme très bénéfique pour la santé et certains médecins recommandaient même que cette eau de mer soit bue seule ou accompagnée de toutes sortes d'ingrédients farfelus comme du corail, des os de seiche, de la chair de vipère, des éponges brûlées et tant d'autres. [60] À l'ère du « *bas peuple* » et de la complaisance des riches, ses qualités désinfectantes et purifiantes en usage externe et de purge en boisson ont dû s'avérer extrêmement bénéfiques.

Dans le chapitre 4, la thèse se penche sur les conséquences de l'éruption du Laki pour tester l'hypothèse qu'elle aurait causé une augmentation incalculable du nombre annuel moyen d'inhumations en Europe de 1783 à 1785. Rien qu'en Grande-Bretagne, les statistiques de plus de deux mille registres funéraires, représentant 1448 paroisses en Angleterre et au Pays de Galles, ont été comptées pour la période de 1770 à 1799, et une analyse mois pas mois a été effectuée pour les années 1783 à 1784. Ce nombre dépasse largement celui utilisé par les chercheurs précédents, qui ont basé leur estimation du nombre de décès supplémentaires causés par l'éruption sur les 404 paroisses obtenues par Wrigley et Schofield pour leur magnum opus, *The Population History of England* (L'histoire de la population d'Angleterre). De plus, les registres de 30 paroisses de l'Île de Man et de Jersey ont été examinés avec 43 autres des Pays-Bas, de Norvège et de Suède. Les chiffres funéraires français sont ceux estimés par le INED (l'Institut national d'études démographiques).

4:1 Les registres paroissiaux

Les registres paroissiaux sont les actes de baptême, mariage et inhumation de l'Église et ils constituent la pierre angulaire de toute recherche sur les statistiques démographiques. Même s'ils peuvent comporter un certain nombre d'insuffisances et d'erreurs d'interprétation de type négligence administrative ; dégâts accidentels ou pertes ; erreurs de transcription ; ils constituent souvent le seul moyen que nous avons

[60] RUSSELL, Richard, *A Dissertation on the Use of Sea-Water in the Diseases of the Glands Etc: To Which Is Added an Epistolary Dedication to R. Frewin.*, 2nde ed. (Oxford: James Fletcher, 1753), 1 et seq.

à notre disposition pour les recherches. Ces défauts sont pleinement abordés dans la thèse.

4:2 Angleterre et Pays de Galles

Après avoir compté et inscrit les chiffres dans des feuilles de calcul Excel, les totaux annuels pour chaque pays ont été obtenus ; des graphiques ont été créés via l'outil dédié d'Excel, et des moyennes sur 20 ans ont été calculées à compter de l'année 1770. Cette méthode a permis d'obtenir deux ensembles de chiffres : 1770-1789 et 1780-1799. Une troisième moyenne a également été calculée sur la période complète de 30 ans, à savoir 1770-1799. Outre leur simplicité et leur facilité d'utilisation, il y avait l'avantage de disposer de ces trois paramètres pour confronter les chiffres de 1780 à des crises majeures et mineures.

Les chiffres de 1783 et 1784 ont été inscrits dans le tableau de manière mensuelle, ce qui a potentiellement permis d'obtenir une analyse très détaillée du caractère saisonnier ainsi que de la gravité générale et de la cause de toute crise de mortalité. De plus, une analyse sur dix ans a été entreprise pour découvrir s'il y avait eu une crise entre 1770 et 1799. Une année de crise est une année où un nombre annuel d'inhumations est plus de deux fois supérieur au nombre moyen d'inhumations pour cette année.[61] Pour identifier les crises qui ne ressortent pas de ces chiffres, nous avons suivi l'exemple de Turner et dénommé un chiffre situé entre une fois et demi et deux fois la moyenne une crise mineure ; et les chiffres d'au moins deux fois plus, une crise majeure.[62]

Une analyse des chiffres montre que le nombre annuel d'inhumations en 1783 n'est que le quatrième plus important de la décennie, tandis que le nombre de 1784 est le deuxième plus bas, et qu'aucune de ces années n'était une année de crise. Une analyse mensuelle montre également qu'il n'y a pas eu de crise majeure durant cette

[61] SCHOFIELD, R. S., 'Crisis Mortality', *Local Population Studies*, no. 9 (1971): 13, http://www.localpopulationstudies.org.uk/PDF/LPS9/LPS9_1972_10-22.pdf.
[62] TURNER, Derek, 'Crisis Mortality in Nine Sussex Parishes', *Local Population Studies*, no. 11 (1973): 40.

période ; il y en a eu huit mineures en aout et septembre 1783 et neuf en 1784, dont six sont survenues durant les mois d'hiver.

Sans plus d'informations, il est impossible de dire avec certitude ce qui a causé ces épidémies mineures. Cependant, l'été chaud était la période idéale pour le développement de la diarrhée infantile et de toutes sortes de troubles gastriques comme la dysenterie et la typhoïde, et il est fort probable qu'ils aient été la cause de nombreux décès infantiles.[63] Selon Gilbert White : « *… la chaleur était si intense que la viande de boucherie pouvait à peine être consommée le lendemain de sa mort ; et les mouches grouillaient dans les ruelles et dans les haies…* »[64] En raison de la vitesse à laquelle les mouches pondaient dans l'eau chaude – la mouche domestique commune peut prendre seulement six jours pour se développer d'œuf à mouche – il n'est pas surprenant qu'il y ait une probabilité accrue de propagation de l'infection par la nourriture contaminée.[65]

Il parait raisonnable de penser que le froid glacial de l'hiver ait réduit la résistance des gens aux maladies et qu'ils aient succombé à toutes sortes de troubles respiratoires comme le rhume, la grippe, la bronchite et la pneumonie.[66] Le regroupement des gens pour se tenir chaud constituait un terreau idéal pour le typhus.

Il n'y a pas eu de crise annuelle majeure au Pays de Galles de toute la période 1770-1799, et seulement une mineure en 1784. Au niveau mensuel, il y a eu trois crises mineures en février 1784, probablement dues à des infections respiratoires.

[63] CREIGHTON, Charles, *A History of Epidemics in Britain. Vol. 2 From the Extinction of Plague to the Present Time.*, 1ère ed., vol. 2 (Cambridge: Cambridge University Press, 1894), 763.
[64] WHITE, Gilbert, *The Natural History and Antiquities of Selborne in the County of Southampton: With Engravings and an Appendix*, 301–2.
[65] WITHAM, C. S. et OPPENHEIMER, C., 'Mortality in England during the 1783–4 Laki Craters Eruption', *Bulletin of Volcanology* 67 (novembre 2004): 22, https://doi.org/10.1007/s00445-004-0357-7; WHO, 'Houseflies', WHO, 302–3, accès le 12 novembre 2016, http://www.who.int/water_sanitation_health/resources/vector302to323.pdf.
[66] WITHAM, C. S. et OPPENHEIMER, C., 'Mortality in England during the 1783–4 Laki Craters Eruption', 22; ALBERT, Michael, DY, Norman, et FEESER, Scott, 'Winter Illness Guide', John Hopkins Medicine, accès le 27 février 2020, https://www.hopkinsmedicine.org/health/conditions-and-diseases/winter-illness-guide.

4:3 L'île de Man et Jersey

L'île de Man a été sujette aux épidémies de variole durant la période de 30 ans et 1783 a été l'une des années les plus saines, avec le nombre d'inhumations le plus bas de la décennie. Nous pouvons dire en toute confiance que l'éruption du Laki n'a pas eu le moindre effet sur l'île cette année-là. L'hiver très rigoureux qui a suivi a fait des ravages sur la population, avec 24 crises mineures enregistrées en janvier et mai 1784. Il n'en est fait aucune mention dans les registres, la cause en était donc probablement les maladies respiratoires de type pneumonie, asthme, grippe, et éventuellement typhus ou même variole.

Jersey n'a pas souffert du brouillard sec qui a recouvert la majorité de l'Europe pendant plusieurs mois depuis mi-juin 1783. Même si le nombre annuel d'inhumations est plus élevé que celui de 1782 ou de 1784, la plupart ont eu lieu durant la première moitié de l'année avant l'éruption du Laki. Sans surprise, l'hiver rigoureux a causé quelques crises majeures les premiers mois de 1784, mais elles n'étaient pas assez importantes pour empêcher l'année d'avoir le deuxième nombre d'inhumations le plus faible de la décennie.

Les années 1780 et 1794 ont eu les deux taux de décès les plus élevés des trois dernières décennies du siècle. Il n'y a aucune information concernant les décès en 1780, mais 1794 a connu quatre épidémies majeures et six mineures, dont beaucoup parmi la garnison militaire stationnée au fort St Aubin, où les soldats avaient été mis en quarantaine pour ne pas infecter la population.[67] La peste a été suggérée, mais puisque le régiment ne s'était formé que récemment au Lancashire et était venu directement à Jersey – sans qu'il n'y ait de peste sur le continent – c'était impossible. D'après ce que nous savons de son étiologie, le typhus semble être le candidat le plus probable pour cette maladie, ayant souvent une manifestation soudaine et un taux de décès entre 40 et 60% sans traitement.[68]

[67] THE ISLAND WIKI, 'Plague Outbreaks', theislandwiki, 1er aout 2014, https://www.theislandwiki.org/index.php/Plague_outbreaks.
[68] VYAS, Jatin M., 'Typhus', MedlinePlus, 12 juillet 2014, https://www.nlm.nih.gov/medlineplus/ency/article/001363.htm.

4:4 L'Europe continentale – la France

Nous avons utilisé les données de mortalité françaises présentées dans une série d'articles de Grattan et al., et Garnier, et Balkanski et al. puisqu'elles ont été interprétées de la manière la plus convaincante, pour montrer que le brouillard sec généré par l'éruption du Laki, en association avec la chaleur extrême de l'été, a eu un effet direct sur la santé de la population.[69] Si l'on extrapole cette information – à partir d'un échantillon de seulement 53 paroisses, il est vrai – sur l'ensemble de la France, le nombre total de décès aurait été catastrophique. Cette information a été utilisée en conjonction avec les chiffres des inhumations calculés par l'INED pour calculer qu'il y a eu 48 500 inhumations supplémentaires en 1783 causées par la pollution de l'air suite à l'éruption du Laki, couplée au stress psychologique généré par la grande chaleur de l'été. Cependant, il y a eu une épidémie de grippe en Europe en 1781-82, qui a entrainé le taux mortalité le plus élevé de la décennie, même si d'autres fièvres peuvent y avoir contribué.[70] Si les membres les plus vulnérables de la population, les vieux, les malades ou les très jeunes, ont été suffisamment affaiblis par l'une de ces maladies, un nouveau stress environnemental l'année suivante – comme celui causé par le brouillard sec du Laki, un été extrêmement chaud et l'hiver très rigoureux qui s'est ensuivi – peuvent avoir mené à un taux de mortalité plus élevé que la normale, en particulier parmi ceux souffrant de problèmes respiratoires.

Selon les données disponibles, le brouillard de basse altitude avait disparu de l'Europe au début de l'automne 1783.[71] Ceci étant, aurait-il toujours été préjudiciable à la santé de la population ? Sinon, l'été chaud ou l'hiver rigoureux qui ont suivi peuvent-ils être tenus responsable de nombre de ces décès ? Il est maintenant reconnu que « *…au-delà des impacts incontestables du Laki, il est probable que les circonstances relativement rares et synchrones d'une ONA négative dans l'Atlantique et d'un El Niño dans le Pacifique durant l'hiver 1783-1784 soient plus fondamentalement à blâmer*

[69] GRATTAN, John et al., 'Volcanic Air Pollution and Mortality in France 1783-1784', *C. R. Geoscience*, no. 337 (2005), http://www.google.fr/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&ved=0CC8QFjAB&url=http%3A%2F%2Fwww.researchgate.net%2Fprofile%2FThorvaldur_Thordarson%2Fpublication%2F37145366_Volcanic_air_pollution_and_mortality_in_France_17831784%2Flinks%2F0c96052ab09ddb2314000000.pdf&ei=XAMxVb71IofSaN6tgbgC&usg=AFQjCNEu4GPSOz-wZdzpmC2hcI5PiG9umQ&bvm=bv.91071109,d.d2s; GARNIER Emmanuel, *Les dérangements du temps : 500 ans de chaud et de froid en Europe* (Paris: Plon, 2010); BALKANSKI, Y., et al., 'Mortality Induced by PM2.5 Exposure Following the 1783 Laki Eruption Using Reconstructed Meteorological Fields', *Scientific Reports*, 26 octobre 2018, 11, https://doi.org/10.1038/s41598-018-34228-7.

[70] POST, John D., 'The Mortality Crises of the Early 1770s and European Demographic Trends', *The Journal of Interdisciplinary History* 21, no. 1 (été 1990): 42–45, https://doi.org/10.2307/204917.

[71] THORDARSON, Thorvaldur, 'Volatile Release and Atmospheric Effects of Basaltic Fissure Eruptions', 103–4.

pour les conditions sévères en Amérique du nord et en Europe que les effets d'affaiblissement du Laki. »[72]

Malgré l'hiver très froid de 1783-84, il y a eu 61 000 inhumations de moins en 1794 qu'en 1783, et 49 000 de moins qu'en 1785, et on ne peut que présumer que les faibles et les vulnérables sont morts durant les événements des deux années précédentes.

4:5 L'Europe continentale – Les Pays-Bas, la Norvège et la Suède

« *Dans l'Europe du dix-huitième siècle, le nombre annuel de décès fluctuait de manière significative quasiment tous les ans, et les fluctuations variaient considérablement d'une région à l'autre et d'un pays à l'autre.* »[73]

Malgré l'obtention de données nationales sur la mortalité pour la Norvège et la Suède, il n'a pas été possible d'accéder aux données relatives au Pays-Bas. En raison de contraintes de temps et d'accessibilité, les données paroissiales ont été limitées à 12 paroisses au Pays-Bas, 14 en Norvège et 17 en Suède. Néanmoins, durant l'année 1773, la Norvège et la Suède ont connu une crise mineure mais grave. Elle était probablement due à une vague de maladies épidémiques sévères – les plus mortelles étant la dysenterie, le typhus et les fièvres typhoïdes, et la variole – qui ont touché l'Europe centrale et la Scandinavie, à l'exception de la Finlande.[74]

Une épidémie de grippe qui a balayé l'Europe en 1781-1782 semble avoir affecté les Pays-Bas et la Suède. Même si la mortalité était basse, la morbidité était élevée ; affectant peut-être les trois quarts de la population européenne les huit premiers mois de 1782, et qui pouvait s'avérer fatale pour les personnes âgées et celles souffrant déjà de maladies respiratoires. On estime le nombre de décès en Europe a des

[72] D'ARRIGO, Rosanne et al., 'The Anomalous Winter of 1783-1784: Was the Laki Eruption or an Analog of the 2009-2010 Winter to Blame?'; BARRIOPEDRO, David et al., 'Witnessing North Atlantic Westerlies Variabilityfrom Ships' Logbooks (1685–2008)', *Climate Dynamics*, 8 octobre 2013, 7, https://doi.org/10.1007/s00382-013-1957-8.
[73] POST, John D., 'The Mortality Crises of the Early 1770s and European Demographic Trends', 37.
[74] POST, John D., 38.

centaines de milliers au total,[75] mais le brouillard du Laki semble avoir eu peu d'effet l'année suivante.

4:6 Les répercussions de l'éruption du Laki hors Europe

La thèse s'est penchée sur trois autres catastrophes, à savoir celles en Égypte, en Inde et au Japon, puisqu'il a été suggéré que le Laki peut les avoir causées.

L'Égypte

Il n'y a aucun doute sur le fait que l'éruption du Laki ait eu un effet désastreux sur l'Égypte rurale. La quantité d'aérosols de SO_2 dégagée par l'éruption a entrainé le réchauffement de l'atmosphère arctique, donnant lieu par conséquent à un courant d'air chaud plus faible à l'ouest, qui a contribué à son tour à l'affaiblissement des moussons d'Afrique et de l'océan indien. La moisson de l'océan indien alimente le Nil, qui est l'essence même de la vie égyptienne. L'éruption du Laki qui a commencé en juin est arrivée juste à temps pour interrompre les moissons d'été, ce qui a causé un manque dramatique dans les inondations annuelles, le courant étant réduit de 18%, selon les estimations ; les étés de 1783 et 1784 ayant connu les inondations la plus basse et la troisième plus basse entre 1737 et 1800.[76] Le voyageur et orientaliste français C. F. Volney offre une excellente description de la situation dans son livre, « *Voyage en Syrie et en Égypte, pendant les années 1783, 1784 & 1785* ».[77]

Une mauvaise gestion, une imposition exorbitante, des années de guerre intestine et de troubles politiques, ont chassé des milliers de personnes de la terre. Il n'y avait pas de réserves, et le manque de moissons occasionné par le Laki a enfoncé le dernier clou du cercueil. [78]

[75] HAYS, J. N., *Epidemics and Pandemics: Their Impacts on Human History* (Santa Barbara, Denver, Oxford: ABC-CLIO, 2006), 171–75.
[76] DAMODARAN, Vinita et al., 'The 1780s: Global Climate Anomalies, Floods, Droughts, and Famines', 537.
[77] VOLNEY, Constantin François de Chasseboeuf, *Travels in Syria and Egypt, during the Years 1783, 1784 & 1785*, vol. 1 (London and Edinburgh: R. Morison, Will. Morrison, William Creech (Edin.) West & Hughes (Ldn), 1801), 133–34, https://ia802706.us.archive.org/2/items/travelsinsyriaa00volngoog/travelsinsyriaa00volngoog.pdf.
[78] GRATTAN, John Patrick, MICHNOWICZ, Sabina A. K., et RABARTIN, Roland, 'The Long Shadow: Understanding the Influence of the Laki Fissure Eruption on Human Mortality in Europe', dans *Living under the Shadow : The Cultural Impacts of Volcanic Eruptions*, One World Archaeology 53 (Walnut Creek, California: Left Coast Press, 2007), 156.

L’Inde

Il a été suggéré que la famine de Chalisa de 1783-84 qui, selon les estimations, a tué près de 11 millions de personnes, a été causée par l’éruption du Laki.[79] Cependant, elle a fait partie d’une série de famines qui a commencé en 1780 suite à un événement El Niño inhabituel, qui a entrainé un manque de moissons annuelles, causant ainsi de graves sécheresses dans la région. Elle a affecté de nombreuses parties de l’Inde du nord, du Cachemire au Pendjab au nord, au Rajasthan à l’ouest et à l’Uttar Pradesh à l’est.[80] De plus, cette situation désastreuse a été exacerbée par la guerre, une imposition exorbitante et un conflit politique.[81]

Le Japon

La Grande famine de Tenmei est considérée comme ayant commencé en 1782 et fini en 1786. Elle est survenue dans la région nord-est de Honshu, l’île principale du Japon, en raison de périodes de froid prolongées et de chutes de précipitations excessives durant les mois d’été, qui ont empêché le riz de murir. La cause probable en a été la grande quantité de cendres volcaniques éjectées par les monts Iwaki et Asama de novembre 1782 à aout 1783, diminuant la quantité de radiation solaire. Dans l’état actuel de nos connaissances, il semblerait peu judicieux de rejeter la faute de la famine de Tenmei sur le Laki, même s’il peut y avoir contribué.

Personne ne sait combien de personnes sont mortes de la famine et les estimations varient largement, de 20 000 à 100 000 ou plus. [82]

Dans le chapitre 5, une comparaison a été faite entre l’éruption du Laki et cinq autres d’un VEI égal ou supérieur, en vue d’évaluer leur effet sur le climat mondial, la mortalité

[79] GROVE, Richard H., ‘The Great El Niño of 1789–93 and Its Global Consequences: Reconstructing an Extreme Climate Event in World Environmental History’, *The Medieval History Journal* 10, no. 1–2 (1 octobre 2006): 80, https://doi.org/10.1177/097194580701000203; GRATTAN, John Patrick, MICHNOWICZ, Sabina A. K., et RABARTIN, Roland, ‘The Long Shadow: Understanding the Influence of the Laki Fissure Eruption on Human Mortality in Europe’, 156–57.
[80] DAMODARAN, Vinita et al., ‘The 1780s: Global Climate Anomalies, Floods, Droughts, and Famines’, 523.
[81] GRATTAN, John Patrick, MICHNOWICZ, Sabina A. K., et RABARTIN, Roland, ‘The Long Shadow: Understanding the Influence of the Laki Fissure Eruption on Human Mortality in Europe’, 156; DAMODARAN, Vinita et al., ‘The 1780s: Global Climate Anomalies, Floods, Droughts, and Famines’, 523.
[82] MACFARLANE, Alan, ‘The Three Major Famines of Japanese History.’, 2002, 2–3, http://www.alanmacfarlane.com/savage/A-JAPFAM.PDF; WIKIPEDIA, ‘Great Tenmei Famine’, Wikipedia, 16 février 2018, https://en.wikipedia.org/wiki/Great_Tenmei_famine.

humaine et les réponses sociales et artistiques. La propagation du brouillard sec du Laki a été comparée au grand smog Londres de 1952 et au nuage radioactif émis par la catastrophe de Tchernobyl de 1986. Le VEI (indice d'explosivité volcanique) qui est utilisé pour mesurer la magnitude de l'activité volcanique durant une éruption ou une phase d'une éruption a été expliqué, et un tableau a été préparé pour comparer le VEI de plusieurs éruptions célèbres.

5:1 Les cinq fameuses

Une étude détaillée a été entreprise en utilisant les résultats de recherches scientifiques récentes et de nombreux témoignages contemporains relatifs à trois éruptions volcaniques tropicales historiques : le Samalas, le Tambora et le Krakatoa, et deux récentes : le mont Saint Helens à Washington et L'Eyjafjallajökull en Islande.

5:2 Le mont Samalas, Lombok, Indonésie – de mai à octobre 1257

L'éruption du Samalas, l'une des plus grandes éruptions volcaniques riches en soufre de l'histoire documentée a été graphiquement racontée dans le Babad Lombok, un ancien poème indonésien.

Les chroniques médiévales décrivent l'effet profond que l'éruption a eu sur le temps en Europe occidentale. Une pluie incessante et un été anormalement froid ont entrainé de mauvaises récoltes qui ont causé une famine de masse.[83] Le moine Matthew Paris a rapporté que : *« Rien qu'à Londres 15 000 pauvres ont péri ; en Angleterre et ailleurs, des milliers sont morts ».*[84]

[83] STOTHERS, Richard B., 'Climatic and Demographic Consequences of the Massive Volcanic Eruption of 1258', *Climatic Change* 45 (2000): 361–74, https://doi.org/10.1023/A:1005523330643; LAVIGNE, Franck et al., 'Source of the Great A.D. 1257 Mystery Eruption Unveiled, Samalas Volcano, Rinjani Volcanic Complex, Indonesia', ed. Kushiro, Ikuo, *PNAS* 110, no. 42 (15 octobre 2013): 16742–47, http://www.pnas.org/content/110/42/16742.full.pdf+html; GUILLET, Sébastien, CORONA, Christophe, et ORTEGA, Pablo, 'Climate Response to the Samalas Volcanic Eruption in 1257 Revealed by Proxy Records Together with Supplementary Information', *Nature Geoscience*, 23 janvier 2017, 123–28, 1–45, https://doi.org/10.1038/NGEO2875.

[84] PARIS, Matthew, *Matthæi Parisiensis, monachi Sancti Albani, Chronica majora*, ed. LUARD, Henry Richards, vol. 5, Rerum britannicarum medii aevi scriptores, or Chronicles and Memorials of Great Britain and Ireland during the Middle Ages (London: Trübner, 1880), 690–702, https://ia902604.us.archive.org/13/items/matthiparisiens01luargoog/matthiparisiens01luargoog.pdf; FARR, William, 'The Influence of Scarcities and of the High Prices of Wheat on the Mortality of the People of England', *Journal of the Statistical Society of London* 9, no. 2 (juin 1846): 161, https://www-jstor-org.distant.bu.univ-rennes2.fr/stable/pdf/2337834.pdf?refreqid=excelsior%3A74cb3c02bbecb01a811bda3a50fa5bc5; STOTHERS, Richard B., 'Climatic and Demographic Consequences of the Massive Volcanic Eruption of 1258', 365.

L'année suivante, 1258, fut « une année sans été ». Les cultures ont été détruites par le mauvais temps, les récoltes ont été tardives, et la famine a suivi. [85] Cependant, il y a eu un revirement l'année suivante, avec de bonnes conditions météorologiques en Europe occidentale[86] et une abondance de nourriture à certains endroits.[87]

5:3 Le Tambora, 10 -11 April 1815, Sumbawa, Indonésie

L'éruption du mont Tambora fut l'une des plus grandes et des plus mortelles de l'histoire documentée. Selon les estimations, elle aurait tué entre 90 000 et 117 000 localement, et probablement beaucoup plus dans le monde entier.[88]

Le volcan a commencé avec une éruption de taille modérée au soir du 5 avril avec de fortes explosions qui se faisaient entendre à des centaines de kilomètres à la ronde. Le matin suivant, des centres fines sont tombées à l'est de Java et les explosions se sont progressivement éteintes, jusqu'au soir du 10 avril où le sommet du volcan a littéralement explosé, avec des explosions spectaculaires qui s'entendaient jusqu'à 2 600km de distance dans Java.

D'immenses coulées pyroclastiques se sont formées et ont détruit le village de Tambora, ont créé un puissant tourbillon qui a déchiré de grands arbres et emporté des maisons, des personnes et du bétail. Cette éruption a également généré un léger tsunami – d'1 à 2 mètres de hauteur environ – qui a touché les îles locales de l'archipel indonésien. La mer a été recouverte sur de nombreux kilomètres de larges pierres ponce qui ont rendu la navigation des navires difficile.

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[85] ANON, 'Notae Constantienses', dans *Recueil des historiens des Gaules et de la France*, ed. DE WAILLY, DELISLE, et JOURDAIN, vol. 23 (Paris: H. Welter, 1894), 543, https://ia600209.us.archive.org/0/items/recueildeshistor23bouq/recueildeshistor23bouq.pdf; GUILLET, Sébastien, CORONA, Christophe, and ORTEGA, Pablo, 'Climate Response to the Samalas Volcanic Eruption in 1257 Revealed by Proxy Records Together with Supplementary Information', 34.

[86] GUILLET, Sébastien, CORONA, Christophe, et ORTEGA, Pablo, 'Climate Response to the Samalas Volcanic Eruption in 1257 Revealed by Proxy Records Together with Supplementary Information', 33.

[87] MATTHEW of WESTMINSTER, *Flowers of History : Especially Such as Relate to the Affairs of Britain : From the Beginning of the World to the Year 1307*, trad. YONGE, C. D., vol. 2 (London: Henry G. Bohn, 1853), 373, https://ia800202.us.archive.org/23/items/flowershistorye03parigoog/flowershistorye03parigoog.pdf.

[88] BRÖNNIMANN, Stefan et KRÄMER, Daniel, 'Tambora and the "Year Without a Summer" of 1816. A Perspective on Earth and Human Systems Science', *Geographica Bernensia G90*, 2016, 9, https://doi.org/10.4480/GB2016.G90.01.; SUTAWIDJAJA, I. S, SIGURDSSON, Haraldur, et ABRAMS, L, 'Characterization of Volcanic Depostis and Geoarchaeological Studies from the 1815 Eruption of Tambora Volcano', *Jurnal Geologi Indonesia* 1 (2006): 50, https://media.neliti.com/media/publications/64048-EN-characterization-of-volcanic-deposits-an.pdf.

Les champs ont été ruinés par le tsunami ou par de grandes quantités de cendres volcaniques qui les ont rendus inexploitables et qui ont empoisonné l'eau potable. La famine et la maladie ont suivi, causant des milliers de morts.

L'énorme quantité de dioxyde de soufre injectée dans la stratosphère a eu un effet profond sur le temps à l'échelle mondiale. L'apparition de l'éruption au milieu de la décennie la plus froide du 19ème siècle a coïncidé avec une période de faible activité solaire qui a produit un temps froid et humide sur une grande partie de l'Europe, le nord du Canada et la Nouvelle Angleterre. De mauvaises récoltes au Canada et en Nouvelle Angleterre ont causé beaucoup de difficultés et beaucoup de bétail est mort par manque de nourriture durant l'hiver 1816-17.[89] C'est ainsi que 1816 est connue comme « l'année sans été ».

Les réponses sociales pour cette période ont été variées. La démobilisation de plusieurs millions d'hommes du service militaire après les guerres napoléoniennes a saturé le marché du travail et causé un chômage de masse. Les cultures ont été ruinées en Europe du nord, entrainant la famine dans de nombreux endroits et les pays alpins, en particulier la Suisse, ont énormément souffert.[90] Les maladies, notamment le typhus, étaient courantes.[91] La réaction populaire a mené à des manifestations dans les marchés céréaliers et devant les boulangeries, et parfois des émeutes et des destructions de biens.[92]

[89] WILSON, Harold Fisher, *The Hill Country of Northern New England: Its Social and Economic History, 1790-1930*, Columbia University Studies in the History of American Agriculture 3 (New York: Columbia University Press, 1936), 22, https://books.google.fr/books?redir_esc=y&hl=fr&id=DIAuAAAAMAAJ&focus=searchwithinvolume&q=famine+year; BARON, William R., '1816 in Perspective: The View from the Northeastern United States', dans *The Year Without a Summer? World Climate in 1816* (Ottawa, Canada: Canadian Museum of Nature, 1992), 576, https://ia800700.us.archive.org/19/items/yearwithoutsumme1992hari/yearwithoutsumme1992hari.pdf.

[90] PFISTER, Christian et WHITE, Sam, 'A Year Without a Summer, 1816', in *The Palgrave Handbook of Climate History* (London: Palgrave Macmillan, 2018), 552–53.

[91] OPPENHEIMER, Clive, 'Climatic, Environmental and Human Consequences of the Largest Known Historic Eruption: Tambora Volcano (Indonesia) 1815', *Progress in Physical Geography* 27, no. 2 (2003): 253, https://doi.org/10.1191/0309133303pp379ra; BRÖNNIMANN, Stefan et KRÄMER, Daniel, 'Tambora and the "Year Without a Summer" of 1816. A Perspective on Earth and Human Systems Science', 28.

[92] ANON, 'Riots in Suffolk', *Caledonian Mercury*, 23 mai 1816, 2, https://search.findmypast.co.uk/bna/viewarticle?id=bl%2f0000045%2f18160523%2f003; OPPENHEIMER, Clive, 'Climatic, Environmental and Human Consequences of the Largest Known Historic Eruption: Tambora Volcano (Indonesia) 1815', 251; LINTHICUM, Kent, '"Bread or Blood": Climate Insecurity in East Anglia in 1816', Historical Climatology, 5 aout 2017, https://www.historicalclimatology.com/blog/bread-or-blood-climate-insecurity-in-east-anglia-in-1816.

Les effets visuels produits par le Tambora ont été particulièrement sensationnels et ont influencé de grandes œuvres de Turner et Friedrich, entre autres. En Suisse, le mauvais temps a été le catalyseur qui a entrainé la création d'œuvres littéraires mondialement connues, et a permis à Mary Shelley d'écrire son roman « *Frankenstein* », qui n'a jamais été épuisé depuis sa publication le 1er janvier 1818.

5:4 Le Krakatau (Krakatoa), Indonésie, 26 - 27 aout 1883

Avant l'éruption de 1883, le Krakatau était une île inhabitée dans le détroit de Sunda entre Java et Sumatra. Elle était composée de trois volcans – le Perbuatan, le plus au nord ; le Danan, au centre ; et le Rakata, le plus grand, qui formait l'extrémité sud de l'île – et était restée en sommeil depuis ses dernières éruptions en mai 1680.[93]

Grâce à l'existence d'un système télégraphique en fonctionnement, les nouvelles de l'éruption se sont répandues rapidement à travers le monde, alertant ainsi les navires qui traversaient le détroit de Sunda des retards qu'ils pouvaient rencontrer. La diffusion des nouvelles de l'événement dans le monde entier a permis aux observateurs intéressés de relier les événements atmosphériques à l'éruption.

L'éruption a commencé le 20 mai avec une forte explosion et une pluie épaisse de cendres. De légères éruptions ont continué de manière intermittente jusqu'au 26 aout où cette activité a augmenté de façon spectaculaire avec une série d'explosions gigantesques. La quatrième et dernière de ces explosions a produit le son le plus fort jamais enregistré et s'est fait entendre à quelque 3 600 km de distance à Alice Springs au sud de l'Australie, et à 4 800 km sur l'île de Rodrigues, près de l'île Maurice. Les détonations ont été entendues sur $^{1}/_{12}$ de la surface de la terre et les ondes aériennes créées par les explosions ont fait sept fois le tour de la terre.[94]

[93] SIMKIN, Tom et FISKE, Richard S., *Krakatau 1883: The Volcanic Eruption and Its Effects* (Washington, D.C.: Smithsonian Institution Press, 1983), 286; HURLBUT, G. and VERBEEK, R. D. M., 'Krakatau', *Journal of the American Geographical Society of New York* 19 (1887): 233, https://doi.org/10.2307/196734.

[94] SYMONS, G. J., *The Eruption of Krakatoa and Subsequent Phenomena. Report of the Krakatoa Committee of the Royal Society* (Trübner, 1888), 79, 84, 87, https://ia601406.us.archive.org/6/items/eruptionkrakato00whipgoog/eruptionkrakato00whipgoog.pdf; SCHALLER, Nathalie et al., 'Climate Effects of the 1883 Krakatoa Eruption: Historical and Present Perspectives', *Vierteljahrsschrift Der Naturforschenden Gesellschaft in Zürich* 154, no. 1/2 (2009): 33, https://www.researchgate.net/profile/Nathalie_Schaller/publication/255700466_Climate_effects_of_the_1883_Krakatoa_eruption_Historical_and_present_perspectives/links/0f31752f4ab5f1da2c000000/Climate-effects-of-the-1883-Krakatoa-eruption-Historical-and-present-perspectives.pdf; SIMKIN, Tom et FISKE, Richard S., *Krakatau 1883: The Volcanic Eruption and Its Effects*, 32 et seq.; AUSTRALIAN GOVERNMENT, BUREAU of METEOROLOGY, 'The Eruption of Krakatoa, August 27, 1883', Australian Government, Bureau of Meteorology, 2010, http://www.bom.gov.au/tsunami/history/1883.shtml.

L'éruption a généré une série d'énormes tsunamis qui ont dévasté de nombreux villages et de nombreuses villes, tuant ainsi plus de 36 000 personnes. Sur les lieux, des centaines de corps ont été vus flottant dans la mer parmi les plaques de pierre ponce flottantes, dont de grandes quantités avaient été éjectées par l'éruption et avaient recouvert la mer sur des kilomètre à la ronde. Certaines étaient si épaisses que les navires ne pouvaient pas les traverser.[95]

Une grande quantité de cendres fines et d'aérosols de sulfate ont été injectées haut dans la stratosphère, où elles ont été prises dans de forts vents globaux et transportées dans le monde entier, produisant des crépuscules et autres phénomènes optiques spectaculaires.[96]

L'éruption et ses répercutions ont permis l'accomplissement d'une prophétie religieuse – la prophétie de Banten – qui a finalement entrainé une révolte infructueuse contre les néerlandais en 1888.

L'éruption a été une source d'inspiration pour les artistes, les écrivains et, plus récemment, les cinéastes ; elle s'est même fait sa place dans le folklore local.

5:5 Le mont St. Helens, Washington, Etats-Unis, 18 mai 1980

L'éruption du mont St Helens, avec son VEI élevé, a été décrite de façon très détaillée dans cette thèse.

Au 17 mai, plus de 10 000 séismes avaient secoué le volcan et un renflement de roche en fusion de près de 450 feet (137m) s'était formé sur le flanc nord du volcan. Le

[95] SIMKIN, Tom et FISKE, Richard S., *Krakatau 1883: The Volcanic Eruption and Its Effects*, 28–51, 91, 149–53.
[96] RUSSELL, F. A. Rollo et ARCHIBALD, E. Douglas, 'On the Unusual Optical Phenomena of the Atmosphere, 1883-6, Including Twilight Effects, Coronal Appearances, Sky Haze, Coloured Suns, Moons, &c.', in *The Eruption of Krakatoa and Subsequent Phenomena. Report of the Krakatoa Committee of the Royal Society* (London: Trübner, 1888), 494, https://ia601406.us.archive.org/6/items/eruptionkrakato00whipgoog/eruptionkrakato00whipgoog.pdf; AUSTRALIAN GOVERNMENT, BUREAU of METEOROLOGY, 'The Eruption of Krakatoa, August 27, 1883'; SELF, Stephen et RAMPINO, Michael R., 'The 1883 Eruption of Krakatau', *Nature* 294 (24 décembre 1981): 703, https://pubs.giss.nasa.gov/docs/1981/1981_Self_se02000x.pdf; SIMKIN, Tom et FISKE, Richard S., *Krakatau 1883: The Volcanic Eruption and Its Effects*, 154; SCHALLER, Nathalie et al., 'NGZH', 34.

lendemain, le 18 mai, un tremblement de terre d'une magnitude de 5,1 a frappé à 8h32, et le renflement du volcan et son sommet ont glissé dans le glissement de terrain le plus important de l'histoire documentée. Ce glissement a recouvert une zone de 23 mi² (59,6 m²) pour un volume total de 0,67mi^3 (2,8 km^3) à une vitesse de 110 à 155 mi (177 à 250 km) heure. L'explosion de l'éruption, se déplaçant à une vitesse entre 220 mi (355 km) et 670 mi (1 080 km) heure, a été entendue à des centaines de kilomètres à la ronde et a dévasté une zone d'environ 230 miles carrés (596 km²) en forme d'éventail au nord du volcan. Plusieurs lahars se sont formés, le plus grand finissant par couler dans le fleuve Colombia, détruisant ponts et maisons sur son passage.[97]

Étonnamment, 61 personnes seulement ont perdu la vie, 57 directement et quatre indirectement. Cependant, il y a eu un bilan dévastateur pour la faune sauvage, avec une estimation de 7 000 gros gibiers, tous les oiseaux et la plupart des petits mammifères tués. Des dizaines de milliers d'acres de forêt vierge ont été détruites ou sévèrement touchées.[98]

5:6 L'Eyjafjallajökull, Islande 14 avril – 22 mai 2010

Le volcan Eyjafjallajökull, qui se trouve sous le glacier Eyjafjallajökull, est entré en éruption de bonne heure le matin du 14 avril. À sept heures, l'éruption, qui avait eu lieu le long d'une fissure de 2 km de long dans le principal cratère du volcan, était entré dans sa phase explosive et avait fondu à travers l'épaisse calotte glaciaire de 250m, permettant à l'éruption de cracher des cendres dans l'air.[99] Peu de lave a été produite mais de grandes quantités de gaz et de cendres riches en verre ont été éjectées dans l'atmosphère. La fonte de la calotte glaciaire a libéré une grande quantité d'eau qui a entrainé l'inondation du sud de l'Islande. Les chercheurs de l'université d'Islande ont

[97] JANDA, R. J. et al., 'Lahar Movement, Effects, and Deposits', dans *The 1980 Eruptions of Mount St. Helens, Washington*, Geological Survey Professional Paper 1250 (Washington, D.C.: US Geological Survey, 1982), 462, https://pubs.usgs.gov/pp/1250/report.pdf; BRANTLEY, Steven R. et MYERS, Bobbie, 'Mount St. Helens -- From the 1980 Eruption to 2000, Fact Sheet 036-00', U.S. Geological Survey, 2005, http://pubs.usgs.gov/fs/2000/fs036-00/; MAYNARD, J. B., 'Cascade Range Lahars (Volcanic Debris Flows)', www.sedimentaryores.net/, 2010, http://www.sedimentaryores.net/Cascades/MtStHelens/Cascade%20Range%20Lahars.pdf; TILLING, Robert I., TOPINKA, Lyn, et SWANSON, Donald A., 'Eruptions of Mount St. Helens: Past, Present, and Future', U.S. Geological Survey Special Interest Publication, USGS Unnumbered Series (Washington, D.C.: U.S. Geological Survey, 19 mars 2002), 8,13, https://pubs.usgs.gov/gip/msh/title.html.

[98] WIKIPEDIA, '1980 Eruption of Mount St. Helens', accès le 6 mars 2015, http://en.wikipedia.org/wiki/1980_eruption_of_Mount_St._Helens; UNITED STATES DEPARTMENT OF AGRICULTURE, 'Mount St. Helens - Frequently Asked Questions', U.S. Forest Service: Pacific Northwest Research Station, accès le 27 février 2019, https://www.fs.usda.gov/pnw/page/mount-st-helens-frequently-asked-questions; TILLING, Robert I., TOPINKA, Lyn, et SWANSON, Donald A., 'Eruptions of Mount St. Helens: Past, Present, and Future', 13.

[99] JENKINS, Susanna, 'Observations of the Eyjafjallajökull Eruption', Cambridge Architectural Research, mai 2010, 2–3, http://www.carltd.com/sites/carwebsite/files/Observations%20of%20the%20Eyjafjallajokull%20Eruption.pdf.

estimé qu'il y avait environ 1 km^3 de glace dans cratère au sommet et qu'environ 25 pour cent de cette glace a fondu dans les deux premiers jours de l'éruption.[100]

Le nuage de cendres de l'éruption a recouvert les terres cultivées au sud du glacier, la partie la plus affectée étant une bande de terre d'environ 10km de large et 50km de long. Beaucoup de perturbations et de difficultés en ont résulté pour les agriculteurs de la zone, avec 200 fermes affectées.

Le panache de gaz et de cendres s'est élevé à une hauteur de 9 km (5,6 miles) et a été transporté par les vents sud-est à travers l'Europe, retardant le trafic aérien dans de nombreux pays, en particuliers ceux d'Europe du nord et de l'ouest.[101] En raison des inquiétudes que les moteurs d'avion soient endommagés par les cendres de l'éruption, 34 pays ont fermé leur espace aérien les uns après les autres jusqu'au 17 mai, ce qui a entrainé une perte de revenus considérable pour les compagnies aériennes.

Ça n'a pas été reconnu à l'époque, mais l'éruption était une aubaine pour les publicitaires et, loin de ruiner l'industrie touristique, elle a entrainé une forte augmentation du nombre de visiteurs, de 459 mille en 2010 à 2 316 mille en 2018, soit une augmentation générale de 404,6%.

L'éruption de l'Eyjafjallajökull a inspiré les artistes à produire quelques œuvres intéressantes, la plus extraordinaire étant probablement l'installation audiovisuelle de Joanie Lemercier–AntiVJ intitulée « *Eyjafjallajokull* », qui a lui a valu le prix Cube 2013 de la jeune création internationale en art numérique.[102]

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[100] ICELAND MAGAZINE STAFF, 'Seven Years Ago Today: Eruption in Eyjafjallajökull, the Volcano with the Un-Pronouncable Name', Iceland Magazine, 20 mars 2017, https://icelandmag.is/article/seven-years-ago-today-eruption-eyjafjallajokull-volcano-un-pronouncable-name; WIKIPEDIA, '2010 Eruptions of Eyjafjallajökull', Wikipedia, 30 juin 2017, https://en.wikipedia.org/wiki/2010_eruptions_of_Eyjafjallaj%C3%B6kull#Health_effects; BRITISH GEOLOGICAL SURVEY, 'Eyjafjallajökull Eruption, Iceland | April/May 2010', British Geological Survey, 2010, https://www.bgs.ac.uk/research/volcanoes/icelandic_ash.html.

[101] ICELAND MAGAZINE STAFF, 'Seven Years Ago Today: Eruption in Eyjafjallajökull, the Volcano with the Un-Pronouncable Name'.

[102] PRICE CUBE, 'Joanie Lemercier - Antivj (France): EYJAFJALLAJOKULL (Audiovisual Installation, 2010)', Prix Cube, 2016, http://prixcube.com/en/folio/joanie-lemercier/.

5:7 Les brouillards à Londres et le grand smog, 5 – 9 décembre 1952

Depuis le 13ème siècle, Londres a toujours souffert de la pollution de l'air d'une manière ou d'une autre. Les proclamations royales prononcées les siècles suivants, interdisant la combustion de charbon de mer, n'ont eu que peu ou pas d'effet et, au 19ème siècle, Londres était renommée pour son épais brouillard jaunâtre, verdâtre ou brun, qui lui a valu le sobriquet de soupe de pois ou de spécialité londonienne. La couleur était due à la pollution de l'air qui contenait du dioxyde de souffre et des particules de suie émises par les nombreux milliers de feux domestiques et industriels de charbon doux.

Les brouillards sont devenus si mauvais qu'à la fin de l'exposition de bétail du Royal Smithfield Club de 1873, de nombreux animaux ont dû être abattus car ils « *présentaient des symptômes comme s'ils avaient inhalé des gaz toxiques* ».[103] Le brouillard était si épais que plusieurs personnes ont perdu la vie en tombant dans des canaux, la visibilité étant pratiquement nulle.[104]

La nombre de brouillards a diminué depuis 1890 grâce à la Loi sur la santé publique de 1891 interdisant l'émission de fumée noire des cheminées d'usine,[105] à la propagation de gaz qui remplaçait le charbon pour la cuisine et le chauffage domestiques, ainsi qu'aux moteurs électriques remplaçant les machines à vapeur au charbon dans les petites exploitations industrielles.[106]

Londres avait toujours sa part de brouillards épais, mais a dû attendre 1952 pour vivre l'événement le plus tristement célèbre de mémoire d'homme – le grand smog – qui a duré du 5 au 9 décembre et a immobilisé la ville pendant quatre jours. Un mélange de haute pression, de températures amèrement froides et de légers vents a produit une inversion de température où l'air chaud recouvrait l'air froid, empêchant ainsi la dispersion du brouillard et des autres polluants atmosphériques. Ce brouillard a été

[103] RUSSELL, Rollo, *London Fogs* (London: Edward Stanford, 1880), 22; HARTWIG, Georg, *The Aerial World : A Popular Account of the Phenomena and Life of the Atmosphere* (London: Longmans, Green and Co, 1874), 139.
[104] ANON, 'Serious Effects of the Fog', *The Daily News*, 11 décembre 1873, 2, https://search.findmypast.co.uk/bna/ViewArticle?id=BL%2F0000051%2F18731211%2F003%2F0001&browse=true.
[105] HOLDSWORTH, W. A., *The Public Health (London) Act 1891 (54 & 55 Vict. c. 76): With an Introduction, Notes, and an Index.* (London: George Routledge and Sons, 1891), https://archive.org/details/publichealthlond00greaiala/page/n3.
[106] CORTON, Christine L., *London Fog : The Biography* (Cambridge, Massachusetts: The Belknap Press of Harvard University Press, 2015), 204–5.

appelé le « *brouillard tueur* » ou le *« smog meurtrier* » pour une bonne raison ; durant la semaine se terminant le 13 décembre 1952, le nombre de décès excédentaires dans le Grand Londres – c'est-à-dire le nombre de décès excédant ceux de l'année précédente – était entre 4 000 et 4 500.[107] Les taux de mortalité ne sont revenus à la normale qu'à la fin mars 1953 et, pendant cette période, il est estimé qu'il y a eu 12 000 à plus de 13 500 décès de plus que d'habitude en raison du brouillard.

La ceinture de brouillard s'est étendue sur près de 20 miles du centre de Londres dans toutes les directions.[108] La circulation routière était quasiment immobilisée. Au centre de Londres, la visibilité a été réduite à 5 yards (4,5m) et il était conseillé aux gens de laisser leur voiture à la maison. Tous les services de bus étaient suspendus dans la zone centrale, de nombreux vols ont été annulés à l'aéroport de Londres et la navigation sur la Tamise était immobilisée. La police du port de Londres, vêtue de gilets de sauvetage, patrouillait sur les quais après qu'au moins huit personnes sont tombées des quais dans l'eau. [109]

La temps a gravement affecté le sport, tous les matchs de football de première classe de la capitale ayant été reportés le samedi (6 décembre).[110] Les voleurs, cependant, ont pu utiliser le brouillard à leur avantage et plusieurs raids de cambriolages et de vols avec effraction ont eu lieu sous la couverture de brouillard.[111] Le brouillard était si

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[107] GLC, *50 Years on. The Struggle for Air Quality in London since the Great Smog of December 1952* (London: Greater London Authority, 2002), 3–9, https://web.archive.org/web/20110719204051/http://legacy.london.gov.uk/mayor/environment/air_quality/docs/50_years_on.pdf; BELL, Michelle L., DAVIS, Devra L., et FLETCHER, Tony, 'A Retrospective Assessment of Mortality from the London Smog Episode of 1952: The Role of Influenza and Pollution', *Environmental Health Perspectives* 112, no. 1 (January 2004): 6, http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1241789/; MET OFFICE, 'The Great Smog of 1952', Met Office, accès le 11 mars 2019, https://www.metoffice.gov.uk/weather/learn-about/weather/case-studies/great-smog.
[108] ANON, 'Transport Dislocated by Three Days of Fog', *The Times*, 8 décembre 1952, dernière édition de Londres, 8, http://gdc.galegroup.com/gdc/artemis/NewspapersDetailsPage/NewspapersDetailsWindow?disableHighlighting=false&displayGroupName=DVI-Newspapers&docIndex=&source=&prodId=&mode=view&limiter=&display-query=TX+power+cuts+AND+PU+%22The+Times%22+AND+IU+52490+AND+DA+119521209&contentModules=&action=e&sortBy=&windowstate=normal&currPage=1&dviSelectedPage=&scanId=&query=&navigationOption=issue&search_within_results=&p=TTDA&catId=&u=bright&displayGroups=&documentId=GALE%7CCS16994184&activityType=BrowseByDate&failOverType=&commentary=.
[109] DAILY MIRROR REPORTERS, 'Patrols in Life-Jackets', *Daily Mirror*, 8 décembre 1952, 1, https://search.findmypast.co.uk/bna/viewarticle?id=bl%2f0000560%2f19521208%2f001.
[110] ANON, 'A "Pea-Souper" to Remember', *Dundee Courier and Advertiser*, 8 décembre 1952, 2nde édition, 3, https://search.findmypast.co.uk/bna/viewarticle?id=bl%2f0000564%2f19521208%2f017.
[111] ANON, 'Bandits and Burglars Strike Under Cover of Fog', *Western Mail*, 8 décembre 1952, quatrième édition, 1, https://search.findmypast.co.uk/search/british-newspapers?date=1952-12-08&date_offsetdate=1952-12-08&keywords=fog&page=4&_=1552297347774.

épais que la plupart des voitures de patrouille de police ont été immobilisées et la police a répondu aux appels du 999 en se rendant à pieds sur les lieux.[112]

Le brouillard de Londres, bien que malsain et désagréable, a inspiré de nombreux artistes, les plus connus étant Monet, Turner, James McNeill Whistler, et le caricaturiste politique George Cruikshank. Les écrivains Conan Doyle et Dickens ont tous les deux écrits des romans dans lesquels le brouillard joue un rôle essentiel dans l'histoire.

Le brouillard de 1952 ne semble pas avoir eu le même attrait artistique que les brouillards victoriens mais il convient de mentionner les peintures « *1952: The Big Smog* » d'Annabel Bloxham et « *Killer Fog* » de Jacqueline Morreau, qui est une commande de l'école de médecine tropicale de Londres pour marquer le 50ème anniversaire du brouillard de Londres.

Les écrivains Lynne Reid Banks et Samuel Selvon ont utilisé le brouillard comme arrière-plan de leur roman « *The L-Shaped Room* » et « *The Lonely Londoners* ». Le brouillard a également joué un rôle central dans deux films : « *The Runaway Bus* », une comédie de 1954 réalisée par Val Guest avec Frankie Howard, Margaret Rutherford et Petula Clark, et « *Piège à minuit* », réalisé en 1960 par David Miller, avec Doris Day et Rex Harrison.

5:8 La catastrophe nucléaire de Tchernobyl, 25-26 avril 1986

L'accident du réacteur de Tchernobyl est considéré comme le pire accident de centrale nucléaire de l'histoire, et c'est le seul accident d'énergie nucléaire commerciale de l'histoire ayant causé des décès liés à la radiation.[113] Il est survenu durant un test

[112] ANON, 'Smash-and-Grab Men Busy in Fog', *Evening Express*, 8 décembre 1952, dernière édition, 12, https://search.findmypast.co.uk/bna/viewarticle?id=bl%2f0000445%2f19521208%2f120.
[113] SECRETARIAT UNSCEAR, 'The Chernobyl Accident UNSCEAR's Assessments of the Radiation Effects', United Nations Scientific Committee on the Effects of Atomic Radiation, 16 juillet 2012, www.unscear.org/unscear/en/chernobyl.html; WORLD NUCLEAR ASSOCIATION, 'Chernobyl Accident 1986', World Nuclear Association, April 2018, http://www.world-nuclear.org/information-library/safety-and-security/safety-of-plants/chernobyl-accident.aspx.

expérimental du système de contrôle électrique alors que le réacteur était mis à l'arrêt pour un entretien de routine. Les opérateurs, en violation des règles de sécurité, ont éteint d'importants systèmes de contrôle et qui ont causé l'instabilité du réacteur mal conçu. Une soudaine surcharge électrique a entrainé une immense explosion de vapeur qui a rompu la cuve du réacteur et a détaché la plaque de 1 000 tonnes recouvrant le noyau du réacteur, coupant le circuit de refroidissement du réacteur et dégageant une grande quantité de matières radioactives dans l'atmosphère.[114]

La plupart de ces matières ont été déposées sous forme de poussière et de débris autour du réacteur. Les matières plus légères ont été prises et transportées dans les vents dominants et, au 5 mai, s'étaient répandues sur la plupart de l'Europe occidentale. La radioactivité a finalement été transportée sur l'ensemble de l'hémisphère nord où elle a été détectée au Japon et en Amérique du nord en concentrations extrêmement faibles.[115]

Environ 53 000 personnes ont été évacuées de la ville de Pripyat – la ville la plus proche de l'explosion – le 27 avril.[116] Peu après la catastrophe, les forces armées soviétiques ont créé une zone d'exclusion d'un rayon de 30 km (19 mi) autour de la centrale nucléaire. Au 14 mai, près de 116 000 personnes qui vivaient dans cette zone ont été évacuées puis relogées plus tard.[117] Durant les années qui ont suivi, 220 000 autres personnes de Biélorussie, de la Fédération de Russie et d'Ukraine ont été

[114] SECRETARIAT UNSCEAR, 'The Chernobyl Accident UNSCEAR's Assessments of the Radiation Effects'.
[115] SECRETARIAT UNSCEAR; WORLD NUCLEAR ASSOCIATION, 'Chernobyl Accident 1986'; IRSN, 'Chernobyl 25 Years On', Institut de radioprotection et de sûreté nucléaire, 8–9 avril 2011, https://www.irsn.fr/EN/publications/thematic-safety/chernobyl/Documents/irsn_booklet_chernobyl_2011.pdf; IRSN, 'The Chernobyl Plume : Modelling Atmospheric Dispersion of Caesium-137 across Europe Following the Chernobyl Accident', Institut de radioprotection et de sûreté nucléaire, 2011, https://www.irsn.fr/EN/publications/thematic-safety/chernobyl/Pages/The-Chernobyl-Plume.aspx; UNSCEAR, *SOURCES, EFFECTS AND RISKS OF IONIZING RADIATION United Nations Scientific Committee on the Effects of Atomic Radiation 1988 Report to the General Assembly, ANNEX D* (New York: United Nations, 1988), 10, https://www.unscear.org/docs/reports/1988annexd.pdf.
[116] WIKIPEDIA, 'Chernobyl Disaster', Wikipedia, 13 mars 2016, https://en.wikipedia.org/wiki/Chernobyl_disaster de 'Валентина Шевченко: "Провести демонстрацію 1 травня 1986-го наказали з Москви"'. Istorychna Pravda (dans Ukrainian). 25 avril 2011.
[117] WIKIPEDIA; WORLD NUCLEAR ASSOCIATION, 'Chernobyl Accident 1986'; SECRETARIAT UNSCEAR, 'The Chernobyl Accident UNSCEAR's Assessments of the Radiation Effects'; WHO, 'Chernobyl: The True Scale of the Accident', World Health Organisation Media Centre, 5 septembre 2005, https://www.who.int/mediacentre/news/releases/2005/pr38/en/.

réinstallées dans des zones moins contaminées, et la zone d'exclusion initiale de 30 km de rayon (2 800 km²) a été étendue pour couvrir 4 300 mètres carrés.[118]

En raison de la confidentialité et du manque de transparence que l'État soviétique a entretenus en ce qui concerne son industrie nucléaire, rien n'a été divulgué par les autorités au sujet de l'accident et la première fois que le monde a entendu parler de l'accident a été lorsque le ministre de la Défense suédois a déclaré que des stations de surveillance au Danemark, en Suède, en Norvège et en Finlande avaient toutes détecté des niveaux de radioactivité anormalement élevés.[119] Dans une minimisation magistrale du 28 avril, soit deux jours après l'accident, la chaîne de télévision soviétique BPEMR a rapporté le désastre dans une annonce de 14 secondes : « *Un accident est survenu à la centrale nucléaire de Tchernobyl et l'un des réacteurs a été endommagé. Des mesures sont prises pour gérer la situation et les personnes affectées reçoivent de l'aide. Le gouvernement a formé une commission d'enquête.* ».[120]

La presse n'a pas tardé à s'emparer de l'affaire et, par manque d'informations concrètes, les gros titres à sensation abondaient, par exemple : le Mirror, « *Le nuage de la mort de Russie* » ; le Sun – peut-être le plus dramatique – a titré « *Catastrophe nucléaire rouge* », « *Des centaines de morts redoutées. Des milliers fuient la fuite* ».[121]

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[118] SECRETARIAT UNSCEAR, 'The Chernobyl Accident UNSCEAR's Assessments of the Radiation Effects'; WORLD NUCLEAR ASSOCIATION, 'Chernobyl Accident 1986'; WIKIPEDIA, 'Chernobyl Disaster'.
[119] PRENTICE, Thomson, et MOSEY, Christopher, 'Alert 1,000 Miles Away in Sweden after Moscow Admits Casualties: Huge Nuclear Leak at Soviet Plant', *The Times*, 29 avril 1986, 1, http://gdc.galegroup.com/gdc/artemis/NewspapersDetailsPage/NewspapersDetailsWindow?disableHighlighting=false&displayGroupName=DVI-Newspapers&docIndex=&source=&prodId=&mode=view&limiter=&display-query=&contentModules=&action=e&sortBy=&windowstate=normal&currPage=1&scanId=&query=&navigationOption=issue&search_within_results=&p=TTDA&catId=&u=bright&displayGroups=&documentId=GALE%7CIF0500035216&activityType=BrowseByDate&failOverType=&commentary=.
[120] McLAIN, Tim, 'Chernobyl Russian Soviet TV News Announcement', YouTube, 1er septembre 2012, https://www.youtube.com/watch?v=RuWIIiTLbFM.
[121] HERBERT, Roy, 'Chernobyl Disaster: How the Soviet Union's Cover Story Was Blown', *New Scientist* 114, no. 1557 (23 avril 1987): 34, https://books.google.fr/books?id=S-SsDtZG5WgC&pg=PA17&lpg=PA17&dq=new+scientist+23+april+1987&source=bl&ots=uC03v3mZEa&sig=ACfU3U1bsuby8o8uvoXGRbupPfBrfQgzJw&hl=en&sa=X&ved=2ahUKEwic7cjV8ZXiAhUpBWMBHTbbDmwQ6AEwAnoECAgQAQ#v=onepage&q=new%20scientist%2023%20april%201987&f=false.

Les explosions ont tué deux ouvriers de la centrale et 28 autres personnes sont décédées en trois moins de SIA (syndrome d'irradiation aigüe). À l'heure actuelle, le nombre de décès et autres problèmes de santé liés à la catastrophe de Tchernobyl est bien inférieur à ce qui était craint au départ mais le nombre total, en comptant les futurs décès, est très controversé, avec des estimations allant de 4 000 pour l'OMS, à 93 000 à 200 000 pour Greenpeace.[122]

En raison de la contamination des pâturages, des embargos ont été décrétés sur le déplacement et la consommation de bétail dans de nombreuses parties de l'Europe. Dans la zone montagneuse du Royaume Uni par exemple, des restrictions affectant près de 10 000 fermes n'ont été pas été retirées avant le 1er juin 2012.[123]

La zone d'exclusion de Tchernobyl est désormais une réserve naturelle prospère avec des populations florissantes de loups, de cerfs et de nombreux autres animaux, les plus insolites étant les troupeaux de chevaux de Przewalski en voie d'extinction.[124]

La catastrophe de Tchernobyl a inspiré énormément d'artistes sous beaucoup de formes d'art différentes allant de la peinture la plus traditionnelle, la sculpture, la musique et la littérature aux films documentaires et de fiction, séries télévisées, jeux vidéo et à l'événement multisupport « *ARTEFACT* ».

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[122] BBC, 'Greenpeace Rejects Chernobyl Toll', BBC News, 18 avril 2006, http://news.bbc.co.uk/2/hi/europe/4917526.stm; FAIRLIE, Ian et SUMNER, David, 'THE OTHER REPORT ON CHERNOBYL (TORCH)' (Berlin, Brussels, Kiev: commandé par Rebecca Harms, MEP, Greens/EFA in the European Parliament, avril 2006), http://www.chernobylreport.org/torch.pdf; GREENPEACE, *The Chernobyl Catastrophe: Consequences on Human Health* (Amsterdam: Greenpeace, 2006), http://news.bbc.co.uk/2/shared/bsp/hi/pdfs/18_04_06_chernobyl.pdf; GRONLUND, Lisbeth, 'How Many Cancers Did Chernobyl Really Cause?—Updated Version', *Union of Concerned Scientists: All Things Nuclear* (blog), 17 avril 2011, https://allthingsnuclear.org/lgronlund/how-many-cancers-did-chernobyl-really-cause-updated?; HAWLEY, Charles et SCHMITT, Stefan, 'Greenpeace vs. the United Nations The Chernobyl Body Count Controversy', Spiegel Online International, 18 avril 2006, https://www.spiegel.de/international/greenpeace-vs-the-united-nations-the-chernobyl-body-count-controversy-a-411864.html; WIKIPEDIA, 'Chernobyl Disaster'; WIKIPEDIA, 'Deaths Due to the Chernobyl Disaster', Wikipedia, 2 octobre 2018, https://en.wikipedia.org/wiki/Deaths_due_to_the_Chernobyl_disaster; WHO, 'Chernobyl: The True Scale of the Accident'.

[123] UN CHERNOBYL FORUM, 'Environmental Consequences of the Chernobyl Accident and Their Remediation: Twenty Years of Experience Report of the UN Chernobyl Forum Expert Group "Environment" (EGE)' (Vienna: UN Chernobyl Forum Expert Group "Environment" (EGE), aout 2005), 3–12, https://www-ns.iaea.org/downloads/rw/meetings/environ-consequences-report-wm-08.05.pdf; OMS, 'Chernobyl: The True Scale of the Accident', 2.

[124] MULVEY, Stephen, 'Wildlife Defies Chernobyl Radiation', BBC News, 20 avril 2006, http://news.bbc.co.uk/2/hi/europe/4923342.stm; LALLANILLA, Marc, 'Chernobyl: Facts About the Nuclear Disaster', livescience.com, 25 septembre 2013, http://www.livescience.com/39961-chernobyl.html; GILL, Victoria, 'Chernobyl: The End of a Three-Decade Experiment', BBC News, 15 février 2019, https://www.bbc.com/news/science-environment-47227767.

5:9 Conclusion

La mortalité due au Laki à l'échelle mondiale est inconnue, mais en la prenant en compte et en la comparant celle causée par les éruptions mentionnées dans le Tableau 5:3, il résulte que cette éruption représente probablement un nombre bien plus important de décès, à l'exception peut-être du Samalas. Non seulement le Samalas a causé une dévastation massive des îles de Lombok, Bali et de la partie ouest de Sumbawa, tuant des milliers de personnes – et laissant très probablement la terre stérile et inhabitable pour plusieurs générations – mais sa portée s'est également étendue jusqu'en Europe et, à cause d'un changement des conditions climatiques, il a entrainé une famine généralisée.[125]

Les gaz et poussières de l'Eyjafjallajökull sont restés dans la troposphère et, bien qu'ils n'aient pas causé de décès humains, ont entrainé de nombreuses perturbations en forçant les compagnies aériennes à annuler les vols en provenance et à destination de l'Europe. La poussière volcanique peut endommager les moteurs d'avions, menant potentiellement à une panne de moteur en plein air.[126] Il a été demandé aux agriculteurs de ne pas laisser boire leurs animaux dans les ruisseaux et autres sources d'eau contaminés à cause du danger de la fluorose et il a été demandé aux propriétaires de chevaux de garder leurs troupeaux à l'abri là où il tombait beaucoup de cendres.[127]

La hauteur du panache de matières radioactives dégagées par Tchernobyl a été mesurée à >1,2km, mais d'autres mesures indiquent que du césium et de l'iode sont montés à 6-9km et des traces ont été détectées dans la stratosphère.[128] Finalement, la radioactivité a recouvert la plupart de l'hémisphère nord, bien qu'en concentrations très basses.

[125] LAVIGNE, Franck et al., 'Source of the Great A.D. 1257 Mystery Eruption Unveiled, Samalas Volcano, Rinjani Volcanic Complex, Indonesia', 16746.
[126] BRITISH GEOLOGICAL SURVEY, 'Eyjafjallajökull Eruption, Iceland | April/May 2010'; GILL, Victoria, 'Iceland Volcano: Why a Cloud of Ash Has Grounded Flights', BBC News, 15 avril 2010, http://news.bbc.co.uk/2/hi/science/nature/8621992.stm.
[127] WIKIPEDIA, '2010 Eruptions of Eyjafjallajökull'.
[128] UNSCEAR, *SOURCES, EFFECTS AND RISKS OF IONIZING RADIATION United Nations Scientific Committee on the Effects of Atomic Radiation 1988 Report to the General Assembly, ANNEX D*, 314.

Tableau 5:3 Comparaison de cinq éruptions, du smog de Londres et de la catastrophe nucléaire de Tchernobyl au Laki

Volcan	VEI	Date	Type d'éruption	Quantité de téphra	Quantité de SO_2	Hauteur du panache	Nombre de décès	Raison
Laki, Islande	**4**	**8 juin 1783 – 8 fév. 1784**	**Fissure**	**14,7 ± 1km^3 [1]**	**122t [1]**	**9-13km [2]**	**~10 000 en Islande [3] Nombre inconnu à l'échelle mondiale**	**Famine [3] Troubles respiratoires**
Samalas, Indonésie	7	Entre mai & oct. 1815	Explosive	40km^3 [4]	158 ± 12t [5]	43km [4]	Inconnu	Famine [6] Écoulements pyroclastiques
Mt Tambora, Indonésie	7	5 – 10 avril 1815	Explosive	41 ± 4km^3 [7]	60-80t [8]	43km [9]	90-117 000 localement [10] Idem non globalement ?	Tsunami, famine [11] épidémies, écoulements pyroclastiques
Krakatau, Indonésie	6	26 – 27 aout 1883	Explosive	21km^3 [12]	20t [13]	40 km[14]	>36 000 [12]	Tsunamis, [12] écoulements pyroclastiques
Mt St Helens, Washington, Etats-Unis	5	18 mai 1980	Explosive	~1km^3 [15]	1±0,3t [16]	23-27km [17]	57 [18]	Asphysxie, [18] écoulements pyroclastiques
Eyjafjallajökull, Islande	4	14 avril – 23 juin 2010	Explosive	0,25km^3 [19]	0,39t [20]	9km [19]	Aucun [21]	N/A
Grand smog, Londres	N/A	5 – 9 déc. 1952	N/A	N/A	N/A	N/A	~12 000 [22]	Bronchite, grippe, [23] Pneumonie, autres troubles respiratoires
Catastrophe nucléraire de Tchernobyl	N/A	25 – 26 avril 1986	N/A	N/A	N/A	>1,2km [24]	31 directs [25] 19 indirects Plusieurs milliers à l'avenir ?	Explosion initiale, [25] radiation, maladie, cancer

1. Thordarson et al. 1996, Thordarson et Self 2003 ; **2.** Maclean 1984, Rampino, Self et Stothers 1988 ; **3.** Jackson 1982, Throdarson et Self 1993 ; **4.** Guillet et al. 2017 ; **5.** Vidal et al. 2016 ; **6.** Jones 2012, Lavigne et al. 2013 ; **7.** Kandlbauer et Sparks 2014 ; **8.** Oppenheimer 2003 ; **9.** Sigurdsson et al. 1992 ; **10.** Bronnimann et Krämer 2016 ; **11.** Stophers 1984, Sigurdsson et al. 1992, Sutawidjaja et al. 2006, Bronnimann 2016 ; **12.** Université d'État de San Diego non daté ; Self et Rampino 1981 ; **13.** Ramino et Self 1982 ; **14.** Gruber non daté ; **15.** Brantley et Myers 2005 ; **16.** Gerlach et McGee 1994 ; **17.** Sarah-Wojcicki et al. 1981 ; **18.** Bantley et Myers 2005, Grisham 2015 ; **19.** Iceland Magazine 2017 ; **20.** Schmidt 2014 ; **21.** Wikipédia 2017 ; **22.** Bell et Davis 2001, Hunt et al. 2003, Bell et al. 2004 ; **23.** Hunt et al. 2003 ; Bell et at. 2004 ; **24.** IRSN 2011 ; **25.** Tate 2011, UNSCEAR 2012, Llanilla 2013, Wikipédia 2018, Greenpeace 2006, Gronland 2011.

La grande quantité de radiation dégagée par la catastrophe de Tchernobyl place cet accident dans une catégorie à part car elle a le potentiel d'être complice de plusieurs milliers de décès à venir, contrairement aux éruptions volcaniques qui n'ont pas libéré de grandes quantités de radionucléides dans l'atmosphère. Cependant, l'accident datant d'il y a plus de 30 ans, il est extrêmement difficile de l'impliquer de manière concluante dans toute mortalité future.

Le chapitre 6, qui est le point culminant de la thèse, rassemble les informations des chapitres précédents pour réévaluer et réinterpréter de manière objective les conséquences de l'éruption du Laki en Europe. Nous avons placé l'éruption dans le contexte des autres événements étranges et inhabituels qui ont eu lieu cette année, lui valant ainsi le nom d'Annus Mirabilis, ou année de l'émerveillement. Nous avons également présenté un aperçu détaillé des différentes catégories de documentation – contemporaine, universitaire et populaire – que ces événements extraordinaires ont généré.

Les témoignages oculaires de l'éruption ont fait l'objet d'une analyse très détaillée de Thordarson, [129] et ses conclusions ont été résumées dans le Tableau 2:2 de la thèse. Les témoignages oculaires relatifs aux autres événements survenus durant l'année de l'émerveillement ont beaucoup été utilisés, notamment ceux concernant les tremblements de terre de Calabre ; le brouillard sulfureux sec ; l'été anormalement chaud suivi d'un hiver insupportablement froid ; les inondations massives au printemps suivant ; le Grand Météore, et beaucoup d'autres événements remarquables.

Un examen détaillé des conditions de vie durant la dernière partie du 18$^{\text{ème}}$ siècle a été effectué pour tenter de déterminer si le brouillard sec du Laki était responsable d'une partie, sinon de l'ensemble, des décès qui lui sont attribués, ou s'il ne s'agissait que d'un facteur parmi tant d'autres influençant la santé de la population déjà stressée par les apparitions fréquentes de maladies.

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[129] THORDARSON, Thorvaldur, 'The 1783–1785 A.D. Laki-Grímsvötn Eruptions I: A Critical Look at the Contemporary Chronicles'; STEINGRIMSSON, Jón, *Fires of the Earth: The Laki Eruption 1783-1784*.

L’odeur corporelle était un problème pour toutes les classes car l’eau fraiche manquait pour se laver, sauf si l’on avait accès à une pompe fluviale ou paroissiale. Par conséquent, la plupart des gens étaient, selon les normes actuelles, excessivement sales, ne se lavant régulièrement que les mains et le visage, pour ceux qui le faisaient, et rarement le corps. Le nettoyage des vêtements était un problème et ils étaient souvent portés sales jusqu’à ce qu’ils tombent en lambeaux.

Un grand choix de nourriture était disponible pour ceux qui en avaient les moyens mais, de manière générale, le régime alimentaire des riches comme des pauvres était, selon les normes actuelles, extrêmement malsain. Les riches ont probablement souffert de carences en vitamines en se nourrissant de viande riche en protéines et de peu de fruits et de légumes, mais pour la plupart des pauvres, il fallait subsister en mangeant du pain, très peu de viande et les fruits et légumes de saison.

Au cours de leur vie, les gens ont été confrontés à toutes sortes de maladies différentes et une analyse approfondie a été effectuée sur ces maladies et leurs modes de transmission. Cependant, sans le bénéfice des antibiotiques modernes, même un doigt coupé ou un os brisé pouvait causer la mort par sepsis ou tétanos. La maladie la plus redoutée été indubitablement la variole, mais il y en avait de nombreuses tout aussi mortelles comme la diarrhée estivale, le typhus, la grippe et, dans les régions marécageuses, la malaria. Il n’est donc pas surprenant, si l’on considère la distance à laquelle un nuage de pathogènes peut être éjecté par la toux et l’éternuement, que les maladies infectieuses se soient propagées comme un feu de forêt au vu des conditions de vie que beaucoup devaient supporter. La distanciation sociale était inconnue.

Nous nous sommes également intéressés aux maladies professionnelles comme le poumon du broyeur ou silicose, causé par l’inhalation de métal ou de poussière de roche, ou encore la maladie du chapelier fou due à l’inhalation de vapeur de mercure.

Les éruptions volcaniques peuvent être la cause de trois sortes de maladies : irritantes, toxiques ou inertes. Le brouillard sec du Laki était irritant et, parce qu’il était principalement composé de SO_2 et de plus beaucoup petites quantités de HCl, de HF et de NH_3, son inhalation peut avoir affecté la santé des personnes souffrants de troubles respiratoires existants.

Nous avons également examiné la forte incidence de mortalité infantile dans les hôpitaux d'accueil, et la suggestion que de nombreux décès étaient le résultat d'infanticides.

Au 18ème siècle, le corps médical n'était pas capable de faire face à la plupart des infections, ce qui n'est guère surprenant puisque la théorie des germes de la maladie n'avait pas encore été développée. Les maladies épidémiques comme la variole, la dysenterie, les fièvres de toutes sortes et la grippe étaient très courantes, et une grande partie de la population préférait faire confiance aux remèdes populaires testés, soit parce qu'ils ne pouvaient pas se permettre de consulter de médecins, soit parce qu'ils préféraient ne pas leur faire confiance. Les charlatans courraient les rues et à l'époque, comme aujourd'hui, l'industrie de la médecine brevetée était un commerce florissant.

Trente ans de données sur les inhumations récoltées dans plus de 1 400 registres paroissiaux en Grande-Bretagne, à Jersey et sur l'île de Man ont permis d'étudier leurs taux de mortalité de manière très détaillée. Il ressort de ces dossiers que l'éruption du Laki n'a pas eu l'effet désastreux qui lui est attribué, à savoir celui d'avoir causé des milliers de décès supplémentaires à la moyenne annuelle attendue.

Les données françaises n'étant basées que sur un petit échantillon de 53 registres paroissiaux, les statistiques de la population produites par l'INED ont également été utilisées et le nombre de décès supplémentaires – 48 500 – qui peuvent avoir été causées par le Laki a été calculé. Il peut cependant s'agir d'une fausse présomption puisque le taux de mortalité en 1782 était supérieur à celui de 1783 de 18 500.

Nous n'avons pu obtenir que les chiffres nationaux pour 30 ans d'inhumations relatifs à la Norvège et la Suède, et ils indiquent qu'il a eu un pic important du taux de mortalité en 1773 dû à une vague de maladie épidémiques aigües qui a frappé l'Europe centrale et la Scandinavie. Il y a également eu des niveaux de mortalité élevés en 1789, qui sont probablement dus à l'une des fièvres épidémiques circulant en Europe à l'époque. Les données obtenues à partir du nombre limité de paroisses au Pays-Bas, en Norvège et en Suède indiquent que le taux d'inhumations de 1783 et 1784 s'inscrit dans les paramètres normaux qui pouvaient être attendus.

Nous avons examiné le rôle du Laki dans trois autres catastrophes majeures, à savoir les famines en Égypte, en Inde et au Japon qui sont survenues à peu près en même temps que l'éruption du volcan. Nous avons trouvé que l'éruption a causé un manque dans les moissons annuelles qui alimentaient le Nil, générant ainsi des sécheresses sévères qui, à leur tour, ont mené à une famine désastreuse et au décès d'un nombre incalculable de personnes en Égypte. Il est tentant de blâmer le Laki pour la famine de Chalisa en Inde, mais celle-ci a été causée par un événement El Niño inhabituel qui a commencé en 1780 ; et la grande famine de Tenmei au Japon est plus probablement due aux mauvaises conditions météorologiques qui ont suivi l'éruption des monts Iwaki et Asama.

Enfin, dans le chapitre 5, l'éruption du Laki a été comparée à cinq autres éruptions de VEI 4 ou plus, et deux autres catastrophes non-volcaniques dont l'une avait le potentiel de causer une catastrophe d'envergure mondiale. Contrairement aux autres éruptions – à part celle de l'Eyjafjallajökull qui n'a causé aucun décès – l'éruption du Laki a tué indirectement par famine, alors que les autres ont tué directement par écoulements pyroclastiques, lahars ou tsunamis. Même si l'éruption du Laki est loin d'être la plus importante étudiée dans cette thèse, elle a probablement tué plus de personnes indirectement, à l'échelle mondiale, que toutes les autres éruptions combinées, à l'exception peut-être de celle du Samalas.

Il faut également mentionner « l'année sans été » de 1816, en partie causée par l'éruption du Tambora. Ce phénomène a changé les régimes climatiques dans le monde entier, faisant ainsi baisser les températures estivales et renforçant les précipitations sur de grandes parties de l'Europe centrale et occidentale. Le mauvais temps a entrainé un échec des récoltes céréalières, causant ainsi de graves pénuries alimentaires puis la famine et la maladie. Le temps froid s'est répandu jusqu'au Canada et en Nouvelle-Angleterre, donnant lieu à l'expression « *mil neuf cents morts de froid* » en Nouvelle-Angleterre.

Les désastres ont engendré une série de réponses sociales différentes, par exemple : la peur de l'inconnu générée par le phénomène étrange et inhabituel de l'Annus Mirabilis ; la pénurie de nourriture sur la plupart de l'Europe après l'éruption du Tambora qui a provoqué les émeutes de la faim et encouragé l'émigration aux Amériques et en Russie ; le fanatisme religieux répandu par un astronome italien anonyme qui est apparu en 1816 – la Prophétie de Bologne ; les prophéties du charismatique professeur Abdul Karim, qui a attisé les flammes de l'indépendance indonésiennes après l'éruption du Krakatau, qui a finalement mené à la rébellion de Banten de 1888 ; les troubles psychologiques et émotionnels après l'éruption du mont St Helens et la catastrophe nucléaire de Tchernobyl ; le port de masques faciaux durant le smog de Londres.

Au-delà de comparer le nombre de personnes tuées et les ravages causées par ces catastrophes, cette thèse examine certains des aspects positifs qui se sont accumulés. Les réponses artistiques n'ont pas manqué et les désastres mentionnés dans la thèse ont inspiré certaines œuvres d'art impressionnantes qui couvrent une grande variété de supports y compris, en autres, la peinture, la sculpture, la littérature, le cinéma, les installations audiovisuelles et les jeux vidéo.

Un résultat intéressant de ces catastrophes a été l'avènement du tourisme de catastrophe. Ça ne semble pas être un truisme que de dire que les gens apprécient une bonne catastrophe tant que ce n'est pas à eux qu'elle arrive. À l'exception du Samalas et du brouillard de Londres, tous les catastrophes mentionnées dans cette thèse ont généré des industries touristiques lucratives.

La diffusion des nouvelles a pris une vitesse inimaginable depuis la fin du 18ème siècle. Il a fallu plusieurs semaines pour que les nouvelles de l'éruption du Laki atteignent le reste de l'Europe, mais grâce au développement de la liaison câblée intercontinentale durant la première moitié du 19ème siècle, les nouvelles de l'éruption du Krakatau ont atteint le monde extérieur en quelques heures, et les autres catastrophes mentionnées ici, presque, voire immédiatement. Il y a une exception cependant. En raison de l'obstination des autorités soviétiques, il s'est passé 48 heures avant que les nouvelles de la catastrophe de Tchernobyl soient confessées.

La Laki était-il le méchant ou le bouc émissaire ? Selon les éléments présentés dans cette thèse, on peut dire que sur la scène mondiale, le Laki était assurément le méchant. Cependant, selon les éléments actuels, en Grande-Bretagne certainement et en Europe continentale probablement, le Laki était, sans aucun doute, le bouc émissaire.

Titre **L'éruption du volcan Laki en 1783-1784 : réappréciation et réinterprétation des conséquences de l'événement en Europe**

Mots clés : Laki, eruption volcanique, brouillard, maladies, refistres paroissiaux, famine

Résumé
Le 8 juin 1783, le volcan islandais Laki a commencé une éruption de huit mois qui a provoqué indirectement la mort de quelque 10 000 personnes, principalement par la famine. Cette thèse revient sur les répercussions que l'éruption du Laki a pu avoir dans toute l'Europe au moyen d'une analyse détaillée de registres paroissiaux et funéraires. L'année 1783 a valu le titre d'"Annus Mirabilis" ou "Année des Merveilles", en raison des nombreux événements inhabituels qui se sont produits. Une brume sèche malodorante, générée par Laki, s'est répandue sur une grande partie de l'Europe, atteignant même la Chine. Une série désastreuse de tremblements de terre a frappé la Calabre et la Sicile causant un grand nombre de morts. Dans de nombreux endroits, l'été a été exceptionnellement chaud, suivi d'un hiver extrêmement froid, causant le gel des rivières et de graves inondations lors du dégel au printemps suivant. Ces événements et beaucoup d'autres ont été étudiés par le biais de la littérature contemporaine, scientifique et populaire. Enfin, l'éruption du Laki a été comparée à cinq autres éruptions volcaniques célèbres, ainsi qu'au "smog tueur" de Londres de 1952 et la catastrophe nucléaire de Tchernobyl. Laki était-il le méchant ou le bouc émissaire ?

Title **The Laki volcanic eruption of 1783-1784 : a reappraisal and reinterpretation of the consequences of the event in Europe**

Keywords : Laki, eruption, fog, disease, parish register, famine

Abstract
On 8 June 1783 the Icelandic volcano, Laki, began an eight-month long eruption which resulted indirectly in the deaths of some 10,000 people, mainly through starvation. This thesis reappraises the effects that the Laki eruption may have had throughout Europe by means of a detailed analysis of the appropriate parish registers and burial records. The year 1783 has earned the title of "Annus Mirabilis" or year of wonders, owing to the many unusual events that occurred. An evil smelling dry mist, generated by Laki, spread over much of Europe, even reaching as far as China. A disastrous series of earthquakes hit Calabria and Sicily causing a great number of deaths. In many places the summer was unseasonably hot followed by an exceedingly cold winter, causing rivers to freeze over, and severe flooding on thawing the following spring. These and many other events were researched through the medium of contemporary, scientific, and popular literature. Finally, the Laki eruption was compared to five other famous volcanic eruptions, the London "killer smog" of 1952, and the Chernobyl nuclear disaster, and the following question answered, was Laki the villain or fall guy?