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Human Sickness and Mortality Rates in Relation to the Distant Eruption of Volcanic Gases: Rural England and the 1783 Eruption of the Laki Fissure, Iceland

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Introduction

Chapter 3 explores an apparent relationship between human mortality in England and exposure to acid volatiles derived from the Laki fissure eruption of 1783. It has long been known that volcanic tephra and gases may be transported great distances (Thórarinsson 1981). Research into their impacts on human health and the environment has typically focused on populations and environments relatively close to the eruption (e.g. Oskarsson 1980, Rose 1977, Thórarinsson 1979). However, recent investigations of documentary sources such as diaries and newspapers have suggested that in particular meteorological situations, and where air masses are stable, profound health and environmental consequences may have occurred in the British Isles and elsewhere in Europe, at great distances from the volcanic source in Iceland (Brayshay and Grattan 1999, Dodgshon et al. 2000, Durand 2000, Durand and Grattan 1999, Grattan 1998 a and b, Grattan and Brayshay 1995, Grattan and Charman 1994, Grattan and Pyatt 1994, 1999, Grattan et al. 1998, Stothers 1996). This chapter presents and examines documentary evidence for human illness, which may have been induced by volcanogenic air pollution, and mortality in several widely dispersed villages in rural England in the late eighteenth century. Burial records for these settlements point to a singular peak in mortality in the summer of 1783, a period that is coincident with the peak concentration of volcanic gases from the Laki fissure in the European environment.

Eruption Dynamics of Laki in 1783

The Laki fissure eruption took place between June 1783 and February 1784. It produced large quantities of acid volatiles — approximately ~120 Mt SO_2, 6.8 Mt HCl, and 15.1 Mt HF plus H_2S and NH_3. Of the total compounds emitted, approximately 60% were emitted during the first few months of activity and the majority of these emissions were confined to the troposphere (Sparks et al. 1997, Thordarson et al. 1996, Thordarson and Self 1993). The eruption therefore generated the largest known air pollution event of the last two millennia (Stothers 1996) and, moreover, one that was entirely natural in origin. A series of stable high-pressure air masses were stationed over northwest Europe throughout the summer of 1783 (Kington 1988). This meteorological situation resulted in the concentration of eruptive gases, which were manifested as a persistent, foul-smelling dry fog and various forms of acid-damage and were observed across the greater part of Europe during the summer of 1783 (Grattan et al. 1998, Stothers 1996) and perhaps even further afield in such far-flung locations as the Altai Mountains in China, Baghdad, and the coast of North America (Demarée et al. 1998, Stothers 1996, Thórarinsson 1979). The phenomena, which accompanied the dry fog, included a variety of forms of respiratory illness and acid damage to crops, trees, and bodies of water (Durand and Grattan 1999), the veiling and reddening of the sun and moon, and an intense smell of sulphur (Grattan and Brayshay 1995, Grattan and Pyatt 1995, Grattan et al. 1998).

Mortality and Human Health Impacts in 1783

The descriptions of human ill health in 1783 are remarkably consistent and link the presence of a strange dry fog or a strong sulphurous stench, with headaches, eye irritation, decreased lung function, and asthma. Several authors also link sudden epidemics and deaths to the sulphurous fogs; fuller descriptions are found in Durand and Grattan (1999) and inevitably more accounts come to light as new archival sources are located and consulted. The following selections are typical of many. In France "it (the fog) tires the eyes; and in Sallon, those people who have a weak chest, have endured some disagreeable symptoms ... many people in the town have had headaches and ... have lost part of their appetite" (Anon 1784). Elsewhere in France, Dreux (1783) described severe impacts on respiratory health, to which he attributed a large number of deaths: "The parish of Champseru has been afflicted by a pestilential sickness. Patients were afflicted by a sickness of the throat. Many ignorant doctors treated it by bleeding and applying emetics and after 18 days there were 40 dead. One believes that the fogs of May, June, July and August that offended the sun and turned it red as blood forecast this curse. May God preserve my parish."

In the Netherlands, Brugmans (1787) and Swinden (1786) recorded similar problems. "After the 24th, many people in the open air experienced an uncomfortable pressure, headaches and experienced a difficulty breathing exactly like that encountered when the air is full of burning sulphur . . . asthmatics suffered to an even greater degree" (Brugmans 1787). "Between the 18th of June and the 21st of July the atmosphere was absolutely covered by the fog, and between the 22nd and 28th the air was very calm with little clouds. . . . Those people with weak chests experienced a similar sensation to that experienced when exposed to burning sulphur" (Swinden 1786). Descriptions in Britain were equally dramatic: "Such multitudes are indisposed by fevers in this country, that farmers have with difficulty gathered in their harvest, the labourers having been almost every day carried out of the field incapable of work and many die" (Cowper in King & Ryskamp 1981).

The descriptions presented above suggest that the noxious or toxic compounds within the volcanic dry fog may have been responsible for severe respiratory dysfunction in some people. The symptoms described suggest that the concentrations of SO_2 occasionally reached as high as 3000 μg/m³. Bronchitis may be worsened when concentrations of SO_2 exceed 80 μg/m³, while asthma is worsened at concentrations in excess of 572 μg/m³ (Beverland 1998, Wellburn 1994) and the volcanogenic dry fog of 1783 clearly passed these critical thresholds for human health on many occasions. The concept that severe anthropogenic air pollution may cause respiratory illness and/or the death of vulnerable sections of the population is familiar in modern western societies (Dockery et al. 1992, Ostro et al. 1991, 1993, 1995, Pope and Kanner 1993, Pope et al. 1995). There are no compelling reasons to propose that volcanogenic air pollution, of sufficient concentration, may not have a similar impact on human health to anthropogenic air pollution.

The mortality data presented at right are drawn from the parish registers of three English rural parishes chosen at random. They cover the period from AD 1770 to AD 1795. In each case the data point to an atypical, singular, and profound increase in deaths in the summer months of 1783 — a feature that bears no obvious relationship to any longer term background trends. These three parishes clearly do not provide a statistically significant sample, yet they serve as a first test of an hypothesis that the prolonged and concentrated presence of volcanic gases in the boundary layer of the atmosphere over rural England in 1783 AD may have triggered widespread bronchial distress and death.

These data are gathered from the records of burials maintained in each parish. Typically these record the name of the deceased and the date of burial. Sadly for our purposes, they do not record cause of death or the age of the individual. Data are presented as the total deaths that occurred between July and September for the period 1770–1795.

In 1783 Cavendish in Suffolk was a small rural settlement of approximately 1000 inhabitants who made their living from maintaining woodland, dairying, and pig keeping. Between July and September 1783, eighteen people died in Cavendish set against a seasonal average for the period 1770–1795 of four. Eight people died in August and ten in September. (Fig. 3.1).

Castle Donington in Leicestershire was also an agricultural settlement of approximately 2000 people, who mainly

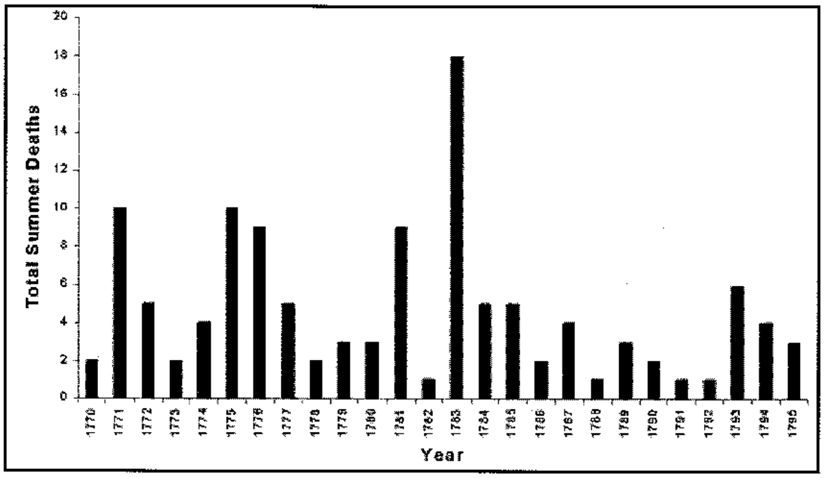


Figure 3.1: Total deaths occurring July–September — Cavendish, Suffolk

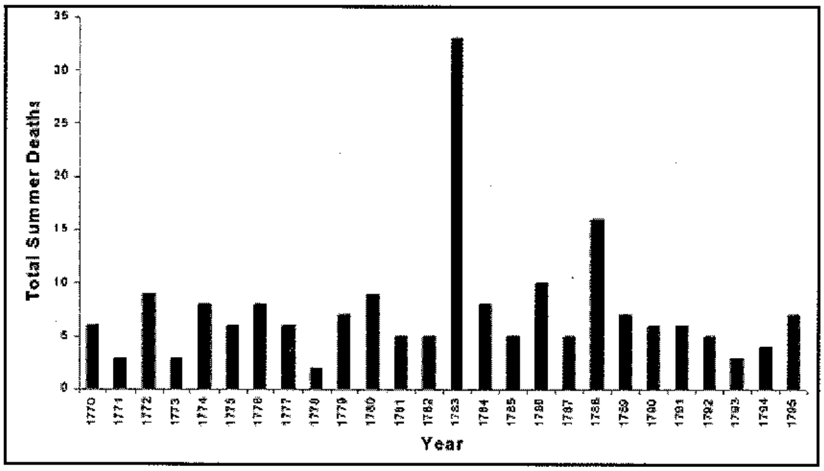


Figure 3.2: Total deaths occurring July–September — Castle Donington, Leicestershire

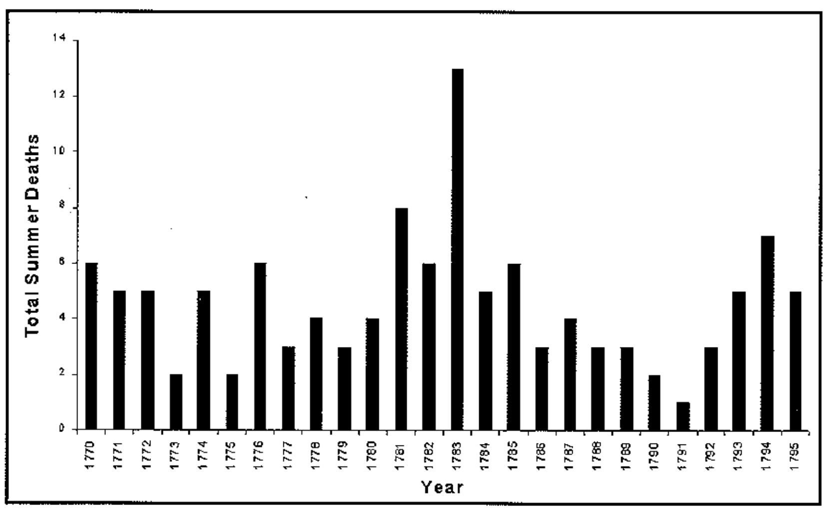


Figure 3.3: Total deaths occurring July–September — Banham, Norfolk

made their living from rearing and fattening livestock. Between July and September 1783, thirty-three people died in this parish, against an average for the period under review of seven. Eleven people died in August and sixteen in September. The deaths for the summer of 1783 are five standard deviations beyond the 1770–1795 average (Fig. 3.2).

In 1783, Banham in Norfolk was a small agricultural settlement of about 900 inhabitants making their living from pastures and pig keeping. Between July and September 1783, thirteen people died against an average of four (Fig. 3.3).

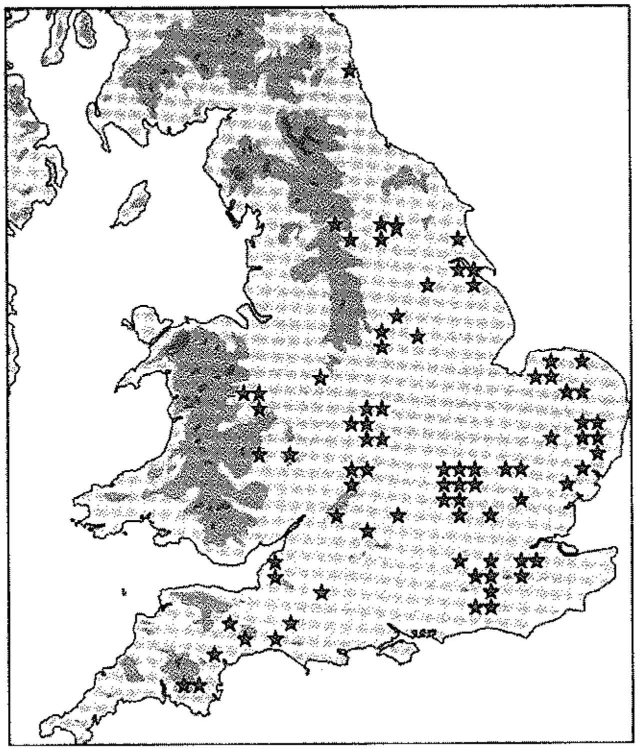
Castle Donington is approximately 150 km from Banham and Cavendish, which lie 40 km apart. While the numbers involved here may seem small to modern eyes, the summer of 1783 must have been a critical period for the parishes involved (see Fig. 3.4). These mortality patterns from three widely separated English rural parishes suggest that a crisis may have occurred during the summer of 1783 — awareness of physical process and the circumstantial evidence suggests acid volcanic gases may have been the key agent.

Discussion

Persistent and intense concentration of volcanic gases from Laki in the atmosphere of the British Isles in 1783 during the summer of 1783 has been demonstrated by considerable scholarship and is no longer in doubt. That these acid gases were present in sufficient concentrations to damage a wide range of tree and crop species and to cause respiratory health problems has also been suggested (Durand and Grattan 1999). Modern studies of anthropogenic air pollution incidents in and around major cities suggest that in addition to respiratory disorders similar to those described above, death rates may rise as vulnerable groups are affected by severe air pollution. In brief, the physiological stress caused by air pollution may reduce individual ability to cope with preexisting medical conditions, particularly cardiovascular problems. In the summer of 1783, the increased death rates and observations of respiratory disorders are co-incident in time with the eruption of the Laki fissure and the transport of volcanic gas and derived aerosols to Europe. The mortality figures presented here point to a potential link between the continental scale air pollution caused by the Laki fissure eruption and a remarkable increase in death rates in central and eastern England during the summer of 1783. If not caused by air pollution, the mortality patterns presented still suggest an external influence, perhaps an epidemic of some nature, as yet unknown. However, all the contemporary accounts of illness reported in the summer months of 1783 point to air pollution as the key factor, and it is not unreasonable to propose that the volcanic gases may have had a role to play in these crises. A study of 400 parishes is now under way to test this hypothesis using data gathered by the Local Population Studies Centre at the University of East Anglia. Complementary data sets for elsewhere in Europe are also being sought.

Irrespective of the extent to which this past air pollution event was associated with increased death rates, it remains clear that the volcanic gases erupted from Laki were transported great distances through the atmosphere and probably had a significant impact on human health. Nor are such volcanic fogs as described here for 1783 rare; Camuffo and Enzi (1995) have described numerous similar events recorded in the Italian documentary record between the fourteenth

Figure 3.4: English parishes displaying anomalously high summer mortality in 1783.



and nineteenth centuries, which are ascribed to eruptions of Italian volcanoes. The Laki fissure eruption and its impact on human health in Europe form a stark illustration of the need for scientists to explore the relationship between human health and all aspects of geological activity. In many areas of the world, air pollution is a serious problem; one need only consider the proximity of many rapidly growing cities to volcanic centers to conclude that volcanic gases will inevitably have a profound influence upon human health in the future (Durand and Grattan 2001).

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