

Source: Henri Chambert-Loir, *Syair Kerajaan Bima* (Jakarta/Bandung 1982) 51

MOUNT TAMBORA IN 1815: A VOLCANIC ERUPTION IN INDONESIA AND ITS AFTERMATH*

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Bunyi bahananya sangat berjabuh
Ditempuh air timpa habu
Berteriak memanggil anak dan ibu
Disangkanya dunia menjadi kelabu

Asalnya konon Allah Taala marah
Perbuatan sultan Raja Tambora
Membunuh tuan haji menumpahkan darah
Kuranglah pikir dan kira-kira¹

Its noise reverberated loudly
Torrents of water mixed with ash descended
Children and mothers screamed and cried
Believing the world had turned to ash

The cause was said to be the wrath of God Almighty
At the deed of the King of Tambora
In murdering a worthy pilgrim, spilling his blood
Rashly and thoughtlessly

Introduction

The volcano Tambora on the Indonesian island of Sumbawa made history in April 1815. Its eruption at that time was a catastrophe without equal in recorded history. Large parts of the Indonesian archipelago were plunged into darkness for three days as a consequence of the vast quantities of ash released by the eruption. The sounds of explosions accompanying the eruption were audible as far away as Sumatra, and in many places were mistaken for cannon reports. In Makasar and Jogjakarta troops even prepared to march into battle,² and it only became clear from the ash showers pouring down a few days later that what had taken place was not a military action but a volcanic eruption. The consequences of

* This is a revised version of a Dutch-language article, "Tambora 1815: De geschiedenis van een vulkaanuitbarsting in Indonesië," published in *Tijdschrift voor Geschiedenis* 107 (1994): 371–92. I would like to thank Luc Nagtegaal for his welcome suggestions for improvements on the earlier version, and Ria van Yperen for preparing the English translation.

¹ These two stanzas have been taken from the indigenous poem *Syair Kerajaan Bima*, which was written around 1830 and published by Chambert-Loir in 1982.

² See J. T. Ross, "Narrative of the Effects of the Eruption from the Tomboro Mountain in the Island of Sumbawa on the 11th and 12th of April 1815," *Verhandelingen van het Bataviaasch Genootschap VIII* (1816): 3–4, 12–13.

this natural disaster were catastrophic and far-reaching, not only for the subsequent history of the Indonesian archipelago, but also for developments in the world at large. The catastrophe is still remembered in Sumbawa today, and is referred to as “*zaman hujan au*,” as I was informed by Pak Imbik in Sumbawa Besar in July 1994. There is also a folk tale about the eruption of Mount Tambora.

In this folk tale the eruption is viewed as an act of divine retribution. The ruler of the small principedom of Tambora had allegedly called down Allah’s wrath upon himself and his principedom by giving a *hadji*, a pious Muslim who had performed the pilgrimage to Mecca, (impure) dog’s flesh to eat and killing him afterwards.³ This local interpretation of the event explains the factually unexplainable, namely the reason why natural disasters occur. The story clarifies the cause of the violent eruption of Mt. Tambora by saying that it was a punishment from God for godless behavior. The eruption is thus made comprehensible and logical, as it were. This mythical tale in fact points to an important feature of volcanic eruptions, namely that they are arbitrary and unpredictable, yet may nevertheless have drastic consequences for both man and the environment. Hence in a country that is as richly endowed with active volcanoes as Indonesia,⁴ volcanic eruptions are apt to be regarded as important events and/or turning points in history generally and in ecological history particularly.

“Ecological history” can be defined as the study of the relationship between man and the natural environment, past and present. Currently, this relationship usually receives a rather biased emphasis, as so many writers focus on the damage man has done to the environment through the course of history,⁵ damage evidenced by phenomena such as acid rain, deforestation, and the hole in the ozone layer. At a time of serious degradation of the environment, this emphasis is wholly understandable. Even so, the reverse relationship—the effects of natural phenomena on man and the environment—is also important and deserves attention. Sometimes Mother Nature strikes mercilessly, with all the attendant consequences.

The eruption of Mt. Tambora in April 1815 was a natural disaster that acted as a turning point in the (ecological) history of Indonesia. This eruption was extraordinary for a number of reasons. Firstly, it was one of the biggest volcanic eruptions in human memory, “the biggest in modern times.”⁶ Secondly, it had a major impact on socioeconomic and ecological developments in the Indonesian archipelago. And lastly, this eruption provided people with a better insight into the relationship between volcanic eruptions and climate.⁷

In spite of the uniqueness of this particular eruption, it is anything but well known. Although almost everyone has heard of the eruption of Mt. Krakatau in 1883, many people have never heard of the eruption of Mt. Tambora. Yet, in the latter explosion much larger quantities of volcanic material were released (the respective figures being 18 and 150 cubic

³ This local, mythical, explanation of the eruption was first mentioned by P. P. Roorda van Eysinga, *Handboek der land- en volkenkunde, geschied-, taal-, aardrijks- en staatkunde van Nederlandsch Indië* (Amsterdam, 1841), pp. 37–41. A similar folk-tale is still preserved by the inhabitants of the village of Pekat today. See M. J. Hitchcock, “Is This Evidence for the Lost Kingdoms of Tambora?” *Indonesia Circle* 33 (1984), p. 34. In Chambert-Loir, *Syair Kerajaan Bima*, pp. 21–22 and 101–2, the eruption is viewed as an act of divine vengeance as well.

⁴ There are 127 volcanoes in Indonesia, about seventy of them active, experiencing a major eruption on average once every three years. See Ministry of Social Affairs, *Natural Disasters in Indonesia* (Jakarta 1971), p. 4, and Kusumadinata, *Data dasar gunung api di Indonesia* (Bandung 1979), p. 1.

⁵ See, for example, Ponting, *A Green History of the World* (London: Sinclair-Stevenson, 1991).

⁶ P. Francis, *Volcanoes: A Planetary Perspective* (Oxford: Clarendon Press, 1993), p. 226.

⁷ *Ibid.*, p. 226.

km.)⁸ and many more people were killed (approximately 36,000 and 117,000 respectively).⁹ The aim of the present article is to rescue the eruption of Mt. Tambora from oblivion and show what ecological, demographic, and economic changes this natural calamity wrought.

Sumbawa and Mt. Tambora before 1815

A long time ago, Sumbawa was probably much more densely wooded than it is now. When the first people came here, parts of the forest were chopped down for dry-rice cultivation (*ladang*). Around 1400 the Javanese introduced wet-rice growing (*sawah*) and started importing horses. To graze these horses grasslands were needed. In the course of the seventeenth century the *sawah* area increased steadily, with the produce from these irrigated rice fields going mostly to the Sultan of Makasar (Sulawesi), who had subjugated Sumbawa and exacted regular tribute from the people. A relatively large stream of immigrants traveled from South Sulawesi to Sumbawa, causing a steady population growth here. The landscape as well changed as a result of these developments. Larger and larger tracts of land were needed for rice growing and cattle grazing, and this expansion took place at the expense of the forest. By about 1800 human settlements were established throughout the island, all belonging to one or another of the six petty princedoms or sultanates existing here at the time: namely Sumbawa, Bima, Dampo, Sanggar, Pekat, and Tambora (see map). These settlements were located mainly near rivers and teak (*Tectona grandis*) forests.¹⁰ People made a living primarily by growing rice, mung beans (*Phaseolus radiatus*), and maize, and by selling coffee, pepper, cotton, timber, and horses. The principal export commodities before the year 1815 were rice, honey and/or beeswax, birds' nests, horses, salt, cotton, and sapanwood, also called redwood.¹¹ In 1786 Radermacher described the district of Tambora as

a tiny, barren, rocky district, where nothing grows in the mountains but a little paddy, hardly enough to feed its inhabitants, who therefore obtain this from traders in exchange for the products which are found in abundance in the forests and are available in their purest form here, and by which, as well as by horse breeding, the king, nobles and subjects are compensated annually for the barrenness of their country.¹²

It is further apparent from earlier sources that the sultanate of Tambora used formerly to be also known as "Kengkelu."¹³ In earlier times Mt. Tambora was also known as Mt. Aram, as is evident from, among other things, old maps in Tomé Pires' *Suma Oriental* (1944, map facing p. 200) and the maps reproduced in *Begin ende voortgangh van de Oost-Indische Compagnie, 1646, Deel III*. An account of his voyage by Pieter Willemsz contains the following passage: "reaching the tip of Sombava . . . we approached Mount Aram Aram in the evening. . . ."¹⁴

⁸ R. D. M. Verbeek, *Kort verslag over de uitbarsting van Krakatau op 26, 27 en 28 augustus 1883* (Batavia 1884), p. 15.

⁹ See Ministry of Social Affairs, 1971, pp. 20–21, and below.

¹⁰ See G. Kuperus, *Het cultuurlandschap van West-Soembawa* (Groningen: J. W. Wolter, 1936), pp. 5, 134–35.

¹¹ *Ibid.*, pp. 20–21.

¹² Radermacher, *Korte beschrijving van het eiland Celebes ende eilanden Floris, Sumbauwa, Lombok en Bali* (1786), p. 186.

¹³ See J. Noorduyn, "Makasar and the Islamization of Bima," *Bijdragen tot de taal-, land- en volkenkunde* 143 (1987): 317, 321.

¹⁴ *Journael ende verhael van alle het gene dat ghesien ende voor-ghevalen is op de reyse, gedaen door den E. ende Gestrengen Pieter Willemsz*, in Isaac Commelin (ed.), *Begin ende voortgangh van de Oost-Indische Compagnie, 1646, Deel III*, fol. 48.

Schelle and Tobias described the island of Sumbawa as it was before the eruption in a missive of 1824.¹⁵ They wrote:

Nature had poured its bountiful blessings on this island, [which,] no matter how mountainous, is the proud possessor of the most extensive of plains and the loveliest of verdant valleys. Rice, beans and maize were plentiful, the forests provided wax and excellent timber, in particular sapanwood, the quality of which is second to none in the entire archipelago. Coffee, pepper and more especially cotton were grown, which latter crop constituted an important source of income for the inhabitants.

There are birds' nests, including some of the most excellent quality, and the island has been proved to contain gold resources, even though these have never been exploited. In a bay in Dampo on the south coast there are pearls, some of which are very large, although pearl fishing has never been properly supervised. There are saltpans in Bima, which supplies the entire coast and part of Bonerate, Manggarai, Saleijer and Bonie with salt from these. Finally, who has never heard of the fine horses from this island, which are surpassed in quality by none?

About the tiny principedom of Tabora they observe that it had its own language, which was slightly similar to the language of the realm of Flores. In their view, most of the inhabitants of Tabora originally came from Manggarai in Flores. About these inhabitants they write:

Those [the inhabitants] of Sanggar and Tabora are different altogether—in the same way as their language has nothing in common with those of the others, so they are altogether different in physical appearance and mentality. We have reason to compare them to the bravest inhabitants of this archipelago, in addition to which they are very industrious and possess sufficient wits to be able to attain to and preserve wealth. They are obedient to the laws, but if their ruler fails to be just as obedient as they are in this respect, he will soon run the risk of losing his life or at the very least being exiled to a foreign country.

The Eruption

About 7 pm on the 10th of April [1815], 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 [= Sangar] 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 8 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 9 and 10 pm 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 away 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). The sea rose nearly 12 feet higher than it had ever been known to be before, and completely

¹⁵ Missive concerning Saleijer, Bouton, and Sumbawa, June 15, 1824; ARA, Schneither collection, No. 127, documents pertaining to Makasar.

spoiled the only small spots of rice lands in Saugur—sweeping away houses and every thing within its reach.

The above is an eyewitness account by one of the few survivors of the calamity to witness it at close quarters, the Raja of Sanggar. It was originally taken down by the British lieutenant Owen Phillips.¹⁶ The latter had been sent to Sumbawa by Lieutenant-Governor Raffles to inspect the damage caused by the Tambora eruption, having been “furthermore instructed by the Government . . . to give the needy natives of the island help and distribute foodstuffs among them.”¹⁷

The eruption of Mt. Tambora occurred quite unexpectedly. The volcano had never erupted or been active before in living memory. Early signs of an impending eruption had been noted three years earlier. Since 1812 there had been a permanent cloud hanging over the summit, growing increasingly dark with time, and a constantly louder rumbling noise had been audible.¹⁸

One eyewitness of these early omens was John Crawfurd, who writes in his *Descriptive Dictionary of the Indian Islands*:

The year preceding the eruption, I accompanied an expedition to Macassar in Celebes, and in our course we passed close to the coast of Sumbawa, and even then the volcano of Tomboro was in a state of great activity. At a distance, the clouds of ashes which it threw out blackened one side of the horizon in such a manner as to convey the appearance of a threatening tropical squall (in fact, it was mistaken for one and the commander of the ship in which I was, took in sail, and prepared to encounter it. As we approached, the real nature of the phenomenon became apparent, and ashes even fell on the deck).¹⁹

These early signs had made many inhabitants of Sumbawa quite anxious. They had asked the Resident at Bima to institute an investigation, and Resident Pielaat had dispatched a certain Mr. Israël to Tambora. This was to be Israël’s last brief. He reached Tambora at the exact moment of the eruption and did not survive the cataclysm.²⁰

The eruption started on April 5, 1815. It was attended by violent explosions which could be heard in large parts of the Indonesian archipelago and which later, around April 10, became even more violent. They were almost everywhere mistaken for cannon reports. It became clear a few days later from the descending ash that this noise must have been produced by a volcanic eruption. The question was, what volcano.

There is a letter of April 14, 1815 from Solo, in Java, containing the following report:

We have been involved in a cloud of ashes for the last four days occasioned by the eruption of a Mountain in our neighbourhood. Major Johnson and the Emperor have sent to ascertain where it is. Some suppose it is a Mountain called Dhuka-toonga—

¹⁶ The account was published in Ross, *Narrative*, pp. 23–24. A Dutch-language version appeared in A. S. Bickmore, *Reizen in den Oost-Indischen Archipel* (Schiedam, 1873), p. 107.

¹⁷ J. Olivier, *Land- en zeevogten in Nederlands Indië (1827–1830)*, II, p. 252.

¹⁸ H. Zollinger, *Besteigung des Vulkanes Tambora auf der Insel Sumbawa und Schilderung der Erupzion desselben im Jahr 1815* (1855), p. 11, and M. Neumann van Padang, “Catalogue of the Active Volcanoes of the World including Solfatara Fields,” *The Active Volcanoes of Indonesia*, Part 1 (The Hague, 1951), p. 166.

¹⁹ John Crawfurd, *A Descriptive Dictionary of the Indian Islands and Adjacent Countries* (London: Bradbury and Evans, 1856). I would like to thank Christiaan Heersink for this reference.

²⁰ *Ibid.*, p. 11.

others suppose Clute. The former is three days journey from hence and the latter six. The explosions were extremely violent and very frequent, and resembled the discharge of mortars. It commenced on Wednesday the 5th in the evening with repeated explosions, and ceased about 8 o'clock. It again commenced on Monday night or Tuesday morning, and continued extremely violent until a late hour the next night. Yesterday the ashes fell so thick that it was quite uncomfortable walking out as it filled our eyes and covered our clothes.²¹

Crawfurd, who was stationed in Surabaya at the time of the eruption, later wrote:

The day after the sounds and shocks of earthquake which accompanied them were heard at Surabaya, the ashes began to fall, and on the third day, up to noon, it was pitch dark; and for several days after I transacted all business by candlelight. For several months, indeed, the sun's disk was not distinct, nor the atmosphere clear and bright, as it usually is during the southeast monsoon.²²

Major M. H. Court, Resident of the island of Banka, wrote: "On the morning of the 11th of April 1815, a constant succession of sounds was heard at Minto, like reports of distant cannon . . . the sounds were afterwards proved to have proceeded from the explosion of a hill on the island of Sumbawa . . . a distance not less than seven hundred miles, and still farther from Palembang, over which country also the sounds were distinctly heard."²³

The sounds were even audible on the island of Borneo. In 1874, an approximately eighty-year-old woman, named Hawa, living in Borneo told Georg Zimmer that she recalled a sound of "terrible shooting" such as she had never heard before in the year 1815. She further said that the earth had trembled and that people had been afraid that the very heavens would collapse. On the day following this, it had rained ashes (which were later sold as a kind of medicine). She still did not know in 1874 where the ashes had come from, so Zimmer informed her that they had originated from a volcano in Java.²⁴ Zimmer was probably mistaken, however; as the year mentioned was 1815, this volcano must have been Mt. Tambora on Sumbawa.

The volcano remained active for several more weeks after April 15, though much less intensely so. Later calculations showed Mt. Tambora to have lost approximately one third of its original height during this eruption, shrinking from 4200 to about 2800 meters.²⁵ In the process, a crater (or caldera) six kilometers in diameter, containing a crater lake, was formed. Verbeek estimated that the eruption dislodged some 150 cubic km. of volcanic material,²⁶ and this estimate is still accepted today.²⁷ At the moment of the eruption the

²¹ *Java Government Gazette*, April 29, 1815.

²² John Crawfurd, *A Descriptive Dictionary of the Indian Islands*, p. 437.

²³ M. H. Court, *An Exposition of the Relations of the British Government with the Sultaun and State of Palembang and the designs of the Netherlands' Government upon that Country* (London, 1821), pp. 129–30.

²⁴ See Georg Zimmer, "Brief van Georg Zimmer aan den redacteur," *De Rijnsche Zending* I, 1874, p. 140. I would like to thank Han Knapen for drawing my attention to this reference.

²⁵ Zollinger, *Besteiging des Vulkanes Tambora*, p. 11; Neumann van Padang, *Catalogue*, p. 166, and *History of the Volcanology in the Former Netherlands East Indies* (Leiden, 1983), p. 20.

²⁶ Verbeek, *Kort verslagg*, p. 15.

²⁷ See W. A. Petroeshevsky, "A Contribution to the Knowledge of the Gunung Tambora (Sumbawa)," *Tijdschrift van het Koninklijk Nederlandsch Aardrijkskundig Genootschap*, 2nd ser., vol. 66 (1949): 695; M. R. Rampino and S. Self, "Historic Eruptions of Tambora (1815), Krakatau (1883) and Agung (1963), Their Stratospheric Aerosols and Climatic Impact," *Quaternary Research* 18, 2 (1982): 129; and Francis, *Volcanoes*, p. 226. This estimate was made on the basis of reports of the height/depth of the layer of ash on the different islands, while later on measurements

easterly monsoon had started, so that the wind was blowing from the southeast. Consequently most of the ash was blown in a northwesterly direction, as far away as South Sumatra and Borneo, about 1,300 kilometers from Mt. Tambora. A certain amount of ash did fall to the south and east of Sumbawa, as well as in Flores, Sumba and Timor, but the quantity of ash descending on these islands was considerably smaller than in Bali, Lombok, and South Sulawesi.²⁸

Sumbawa Shortly after the Eruption

The consequences of the eruption for Sumbawa were disastrous. There was pumice stone, lava and ash scattered all over the island; the average depth of the layer of ash covering the ground measured 50–60 centimeters, though closer to the volcano it reached as high as 1.20 meters. The falling pumice and masses of ash destroyed many homes. The princedoms of Pekat and Tambora were wiped off the face of the earth, with none of their inhabitants, including their rajas (Abdul Gafur of Tambora and Muhamad of Pekat²⁹), surviving the cataclysm. As a consequence, the Tambora language, probably the easternmost Austro-Asiatic language at the time became extinct.³⁰ In Sanggar, too, numerous people were killed. The total death toll as a direct result was estimated at 10,000.³¹ The tidal wave arising immediately after the eruption also claimed a number of human lives on Sanggar's northern coast.³² Many of the surviving inhabitants immediately fled to Ngembé, in the princedom of Bima.³³ Koreh, the chief town and port of Sanggar's north coast, which was once famous for its trade in and export of horses, was never to recover its position.

The ash blanket had also destroyed the crops. According to Schelle and Tobias, 95 percent of the rice crop had been on the fields at the time of the eruption.³⁴ As a result there was a major famine in Sumbawa immediately after the disaster.³⁵ It was accompanied by all kinds of diseases, especially diarrhea and fevers. The former was caused partly by pollution of the drinking water with ash particles. Clean water was hardly to be had anywhere. The famine was so serious that people were reduced to eating dry leaves and poisonous tubers³⁶ and even to selling their children in order to obtain rice, sometimes only one *gantang* (3

were taken at sea as well to see where the ash had landed and how much had descended; see G. Neeb, "The Composition and Distribution of the Samples," *The Snellius-Expedition 1929–1930* 5, 3, 2 (Leiden 1943): 88–97.

²⁸ See Zollinger, *Besteigung des vulkanes Tambora*, ; and Petroeschevsky, "Contribution," p. 694.

²⁹ KITLV, Hisdoc, 506 a and b, Transcription of an Arabic manuscript owned by H. Achmad, p. 81.

³⁰ R. M. W. Dixon, "The Endangered Languages of Australia, Indonesia and Oceania," in *Endangered languages*, ed. R. H. Robins and E. M. Uhlenbeck (Oxford/New York: Berg, 1991), p. 241.

³¹ Zollinger, *Besteigung des Vulkanes Tambora*, p. 20.

³² W. H. Davenport Adams, *The Eastern Archipelago* (London, 1880), p. 198.

³³ KITLV, Hisdoc, H 226 I, "De overwalsche rijken op Sumbawa van 1669 tot 1846," aantekeningen van A. Ligtvoet.

³⁴ Missive of 1824, ARA, Schneither collection, no. 127.

³⁵ Ross, *Narrative*, p. 22; and Roorda van Eysinga, *Handboek*, p. 40.

³⁶ Chambert-Loir, *Syair Kerajaan Bima*, p. 37.

kilos).³⁷ People also resorted to eating horseflesh.³⁸ Normally horses were never eaten for they were an important economic asset for the Sumbawanese people, which meant eating horses would mean destroying capital. Inhabitants were even driven to scavenge from the dead. According to Reinwardt, the Dou Donggo, a tribe living in the mountains at the western side of Bima Bay, dug up many of personal belongings they had buried with their dead in order to use them for barter in an attempt to survive the famine of 1815.³⁹ The resultant mortality was enormous; the famine and outbreaks of diarrhea exacted a toll of another 37,000 human lives.⁴⁰ There were corpses lying about everywhere, at roadsides, in rice fields, and on the beach, so many of them that they couldn't be buried, and so became prey for dogs, pigs, and birds.⁴¹ The calamity was so immense and funds so limited that the ship which had been sent by Raffles could do little to alleviate the famine. Owen Philips, mentioned above, was unable to offer any help.⁴² According to A. Ligtvoet's notes, Resident Pielaat on June 8, 1816 wrote a letter saying that Sumbawa was stricken by "a serious plague" to which the "king of Sumbawa and three of his grown-up sons" had succumbed as well.⁴³

To escape from hunger and disease people fled to neighboring islands on a massive scale. About 37,000 people left for Java, Bali, South Sulawesi, Makasar (see Chassé), Greater and Lesser Koerie (see Liedermoy), and Ceram Laut, among other places.⁴⁴ About this latter tiny island, Bik noted that, when he visited it in 1824, he discovered many of its inhabitants originally came from Sumbawa, having allegedly sold themselves as slaves to traders from Ceram after the eruption.⁴⁵ In all, the eruption of Mt. Tambora led to a considerable reduction of the population of Sumbawa. Zollinger estimates Sumbawa to have lost about 84,000 of its 170,000 inhabitants as a result of the catastrophe: about 10,000 as a direct consequence of the eruption, 38,000 as a result of famine and disease, and 36,000 through

³⁷ Roorda van Eysinga, *Handboek*, p. 41; E. Francis, *Herinneringen uit den levensloop van een Indisch ambtenaar van 1815 tot 1851* (Batavia, 1856), p. 137; and C. G. C. Reinwardt, *Reis naar het oostelijk gedeelte van den Indischen archipel, in het jaar 1821* (Amsterdam, 1858), p. 317. See also Ligtvoet, "Aanteekeningen betreffende de economische toestand en de ethnografie van het rijk Sumbawa," *Tijdschrift voor Indische Taal-, Land- en Volkenkunde* 23 (1876): 555–92.

³⁸ C. G. C. Reinwardt, *Reis*, p. 317.

³⁹ *Ibid.*, p. 322.

⁴⁰ Zollinger, *Besteigung des Vulkanes Tambora*, p. 20; and Chambert-Loir, *Syair Kerajaan Bima*, p. 19.

⁴¹ Chambert-Loir, *Syair Kerajaan Bima*, p. 107.

⁴² T. S. Raffles, *Memoir of the Life and Public Services of Sir Thomas Stamford Raffles*, edited by his widow [Sophia Raffles] (London: John Murray, 1830), pp. 244–50.

⁴³ Sultan Muhammad Kaharud-din of Sumbawa died on February 14, 1816. See J. Noorduyn, *Bima en Sumbawa, Verhandelingen van het Koninklijk Instituut voor Taal-, Land- en Volkenkunde* 129 (Dordrecht, 1987), pp. 24, 123.

⁴⁴ Roorda van Eysinga, *Handboek*, p. 40; Zollinger, *Besteigung des Vulkanes Tambora*, p. 20; Francis, *Herinneringen uit den levensloop*, II, p. 124; P. H. van der Kemp, "P.T. Chassé's werkzaamheid als commissaris voor de onderneming van Makassar en onderhoorigheden gedurende September–October 1816, blijkens eenige van hem uitgegane en nog niet uitgegeven rapporten," *BKI* 73 (1917): 432; and C. F. Liedermoy, "De Nijverheid op Celebes," *Tijdschrift voor Nederlandsch Indie* 16, 2 (1854): 371.

⁴⁵ See A. J. Bik, *Dagverhaal eener reis, gedaan in het jaar 1824, tot nadere verkenning der eilanden Kefing, Goram, Groot- en Klein-Kei en de Aroe eilanden* (Leiden: Sijthoff, 1928), p. 14..

migration and/or flight.⁴⁶ Hence the demographic effects of the disaster were enormous, even though a number of refugees later returned to their villages of origin.⁴⁷

Peter Goethals, in *Aspects of Local Government in a Sumbawan village (Eastern Indonesia)*, points to a second very interesting demographic development. He writes:

The Tambora holocaust had done more than merely depopulate the land and bring starvation to a passive remnant population of men and livestock. In many instances it had also forced the survivors to seek fresh land and establish new settlements in the distant forested uplands of the interior. Many of these mountain slopes, in contrast to the lowlands, had either been less heavily inundated by the dolvanic debris or, through accelerated high altitude erosion by wind and rain, had recovered more rapidly from its effects. Thus many of western Sumbawa's present mountain villages were probably first settled in the two decades following the holocaust by land starved pioneers driven from their choked and barren rice terraces in the lowlands. On the upland slopes they took to shifting field (swidden) cultivation of dry rice and established themselves in semi-autonomous new communities. Almost certainly many of the present villages in those foothills enclosing the heartland of the old sultanate represent these originally pioneer, post-1815 communities. The villagers' own traditions and the little available historical evidence consistently support this inference.⁴⁸

A great many animals, incinerated by falling ash or attacked by disease, lost their lives as well. Famine and ash-polluted water caused widespread suffering among horses, buffaloes, and goats, just as among the human population.⁴⁹ According to Zollinger, 75 per cent of the livestock died.⁵⁰ Birds and bee colonies were also wiped out by falling ash.⁵¹ As mentioned above, the vegetation of the island was seriously damaged. Large tracts of forest were destroyed and all the rice fields smothered by ash. It was about five years before the first crops could be harvested again in East Sumbawa. In West Sumbawa it took the soil even longer to recover, as more ash had fallen there because of the easterly monsoon winds.⁵²

In the period immediately following the eruption, Sumbawa was wholly dependent for its rice on Java, where a price of 8 guilders a *pikul* (61.76 kg.) had to be paid.⁵³ Because many bees, birds, and horses did not survive the disaster, there was a serious dearth of key commodities like honey and/or beeswax, birds' nests, and horses. As a result the economy collapsed. Everything had to be imported.⁵⁴ The supply of sapanwood,⁵⁵ which the Dutch colonial government controlled through a monopoly in accordance with a treaty of 1765,

⁴⁶ H. Zollinger, *Verslag van eene reis naar Bima en Soembawa* (Batavia, 1850), p. 176, and *Besteigung des Vulkanes Tambora*, p. 20.

⁴⁷ G. Kuperus, *Het cultuurlandschap*, p. 137.

⁴⁸ Peter R. Goethals, *Aspects of Local Government in a Sumbawan Village (Eastern Indonesia)*, Cornell Modern Indonesia Project (Ithaca: Cornell University Southeast Asia Program, 1961).

⁴⁹ Ross, *Narrative*, p. 22.

⁵⁰ Zollinger, *Verslag*, p. 152, and *Besteigung des Vulkanes Tambora*, p. 20.

⁵¹ See Zollinger, *Verslag*, p. 151; G. Kuperus, *Het cultuurlandschap*, pp. 20–21.

⁵² See G. Kuperus, *Het cultuurlandschap*, p. 22.

⁵³ E. Francis, *Herinneringen uit den levensloop*, II, p. 137.

⁵⁴ Zollinger, *Verslag*, p. 109.

⁵⁵ Sapanwood (*Caesalpinia sappan*) is a variety of wood which, in a powdered form, may be used as a red dye, and which was much in demand among the Dutch at the time.

also came to a halt.⁵⁶ The governor of Makasar, Kruijthoff, “in view of the dire straits in which the island of Sumbawa found itself,” had granted a request by the rulers of Bima, Dampo, and Sanggar to be excused from visiting Makasar for the extension of contracts in 1817.⁵⁷

Slow Recovery

The gradual recovery of the island’s peoples and ecology following the eruption was described in various reports by people visiting Sumbawa after 1815.

The first reports originate from J. C. Vetter, who was Resident of Bima at the time. He made a trip to Tambora in 1819 to investigate the current situation of the small princedoms of Tambora and Pekat. He writes that the route to these areas, the overland as well as the sea route, was very difficult. The sea was still strewn with floating pumice and the ground was still full of cracks and fissures and covered with ash, pumice, and tree trunks. He described the appearance of these princedoms as “horrifying” in places, though in other places some green growth had already reappeared.⁵⁸

In a letter from 1820, Vetter indicates that conditions have begun to change for the better; he writes that it was possible for a crop to be harvested in the princedom of Bima again for the first time in five years. He mentions an “abundance of rice, fruits, and vegetables.” But the abundance of produce, according to him, was attributable not so much to a copious harvest as to a scarcity of consumers, for only the coasts were inhabited.⁵⁹ A considerable portion of the harvest was consequently sent to the princedom of Sumbawa, as food production there still had not got under way. Vetter further reports that trade in Bima remained at a complete standstill as there continued to be a serious shortage of former commodities, namely honey and/or beeswax, birds’ nests, and horses. Although another commodity, sapanwood, in 1820 was available again in large quantities, trade in this product could not resume because there was too little manpower available for felling the timber.⁶⁰

Rice growing in Bima had also started again by 1820, though the recovery was still far from complete. When the botanist C. G. C. Reinwardt came to Bima in 1821, he experienced great difficulty in getting supplies for his ship because of the dearth of foodstuffs; this contrasted with the situation before 1815, when Bima had been an excellent victualling port. According to him, the town was looking derelict and there were hardly any horses—formerly the principal commodity—to be got.⁶¹

In 1824 the two government officials, Schelle and Tobias, wrote in their report that the princedoms of Sumbawa and Dampo were beginning to recover, but that Tambora and Papekat were still a “desolate heap of rubble.”⁶²

⁵⁶ J. Noorduyn, *Bima en Sumbawa*, pp. 10, 125–30.

⁵⁷ *Ibid.*, pp. 24, 41.

⁵⁸ J. C. Vetter, “Tambora vier jaren na de bekende uitbarsting.” *Bataviasche Courant*, July 22, 1820, and *Indisch Magazijn* 2 (1845): 87–90.

⁵⁹ See J. C. Vetter, KITLV, Hisdoc, H 226 II, A. Ligtvoet from 1669 to 1846.

⁶⁰ See G. Kuperus, *Het cultuurlandschap*, pp. 20–21.

⁶¹ C. G. C. Reinwardt, *Reis*, p. 318.

⁶² See G. Kuperus, *Het cultuurlandschap*, pp. 22–23.

From 1831 we have the following report by the Indies colonial official, E. Francis. He was sailing along the coast of the peninsula of Sumbawa and could see Mt. Tambora from his ship. Through his binoculars he beheld "a horrendous scene of devastation." This depressing scene led him to write that "in its fury, the eruption [. . . had] spared, of the inhabitants, not a single person, of the fauna, not a worm, of the flora, not a blade of grass"(English translation of the original Dutch). He observed large tracts that were barren, infertile and covered with ash. In other parts, however, he saw "small round trees" growing—a first sign of the recovery of the princedoms of Tambora and Pekat. Francis remarked that this plainly showed "what little progress nature had made in its restorative powers in the course of sixteen years."⁶³ Yet records from a few years later show that recovery was steadily progressing; in 1844, some Sanggarese who had fled to Ngembe requested permission from the king of Bima to resettle in the district of Sanggar.

In 1847 the naturalist Heinrich Zollinger paid an extensive visit to Sumbawa. He writes: "Since the havoc of the year 1815, the flora of the country may also have degenerated, as many species of plants which require humid forests and a thick layer of humus for their development have probably died out. Many places which formerly had a thick covering of vegetation are now blanketed with ash or only have a thin layer of plant growth. That the plant population has suffered individual losses is demonstrable; with regard to species this will always remain conjectural." On his travels through Sumbawa he observed a lot of *alang-alang* grass (*Imperata cylindrica*) growing everywhere in places formerly covered with forests, which had been burnt down and uprooted.⁶⁴ He nevertheless describes the flora and fauna of Sumbawa as being "varied."⁶⁵ But he noted traces of the eruption everywhere on his trip across the island, observing numerous dusty cinder tracks, a village consisting for three quarters of cemeteries, and abandoned wet-rice fields.⁶⁶ These deserted fields later led Kuperus⁶⁷ to conclude that the eruption of Mt. Tambora had wrought a major change in the agricultural landscape. The area of cultivated land had decreased considerably in an absolute sense, while the percentage of pasture or grasslands (formerly wet-rice fields), conversely, was on the increase. Livestock grazing caused these lands to remain unforested.

Like so many other observers, Zollinger reports that the land in the princedom of Sumbawa had suffered more severely under the eruption than in Bima and had still not entirely recovered. Exports of commodities were lower than in Bima, though this was attributable not only to the consequences of the eruption but also to the laziness of the inhabitants, according to Zollinger.⁶⁸ Trade in Bima in 1847 was, by contrast, very lively. There was rice, maize, tobacco, onions, sugar cane, coffee, and indigo. Sapanwood, birds' nests, and horses were being exported at a lively pace,⁶⁹ which leads one to conclude that the horse and bird populations had recovered by this time.

According to Zollinger, the principal change occurring after the eruption was a climatic change. Survivors of the catastrophe interviewed by Zollinger claimed that the rainfall was much lower than it had been before the eruption. Zollinger ascribed this to the serious loss

⁶³ E. Francis, *Herinneringen uit den levensloop*, II, p. 124.

⁶⁴ Zollinger, *Verslag*, p. 72.

⁶⁵ *Ibid.*, pp. 70, 76–80.

⁶⁶ *Ibid.*, p. 26.

⁶⁷ G. Kuperus, *Het cultuurlandschap*, p. 137.

⁶⁸ Zollinger, *Verslag*, p. 163.

⁶⁹ *Ibid.*, pp. 102–5.

of vegetation. Because the climate had become drier and warmer, numerous springs and wells had dried up.⁷⁰

As part of his journey, Zollinger took a trip to Tambora and actually ascended the mountain. This was the first time it had been climbed since 1815 (and possibly the first time ever, as there are no earlier reports of any excursion to the top of Mt. Tambora). He describes the journey to Mt. Tambora in detail,⁷¹ but it did not yield a great quantity of important data. He observes that the mountain was largely stripped of vegetation, although he had come across a few species of plants and trees there, as well as some animals. The summit was wholly denuded, however, and from there he had been able to see the crater lake.

Later climbers of Mt. Tambora, such as Pannekoek van Rheden in 1913 and Petroeschovsky in 1947 mention seeing vegetation—trees and grass—inside the crater. Even a century after the explosion, however, this vegetation was sparse. Petroeschovsky attributed the thin plant cover inside the crater to the many solfataras—vents emitting mainly sulphurous gases—he could see from the summit. These solfataras were located especially on the western side of the crater.⁷² Regeneration advanced more quickly on the outer slopes of the mountain. In 1847, when Zollinger climbed to the peak, the slopes of Mt. Tambora were still bare from a height of 2,100 meters upward,⁷³ but Pannekoek van Rheden came across a casuarina forest at an altitude of 2,200 meters, noting trees at higher altitudes still, up to 2,550 meters. There were stands of tall timber especially on the northern slopes, but there were trees and shrubs growing again even on the southwestern slope, which had suffered the most from the eruption.⁷⁴

The Consequences of the Eruption for the Neighboring Islands

The consequences of the volcanic eruption in Sumbawa were not restricted to this particular island; other islands in the vicinity also experienced the effects. The islands of Bali and Lombok, Sumbawa's western neighbors, and South Sulawesi, to the north of Sumbawa, were particularly badly hit. This was because the heavy ash falls following the eruption were blown primarily in a northwesterly direction by the wind, which covered the nearby islands with a blanket of ash about 20–30 cm. thick.

A letter from Makasar (South Sulawesi), written by a person who happened to be on a ship in the vicinity of Makasar at the time of the eruption, reports the following:

By noon on the 12th [of April, 1815], the sun again appeared, but very faintly through the dusky atmosphere. The air still being charged with the ashes which continued to fall lightly all the day and the succeeding one.

On going on shore at Moressa, I found the face of the country completely covered to the depth of an inch and a quarter—great fears were entertained for the crop of paddy that was on the ground; the young plants being completely beaten down and covered by

⁷⁰ *Ibid.*, pp. 84–85.

⁷¹ *Ibid.*, pp. 145–58, and *Besteigung des Vulkanes Tambora.*

⁷² W. A. Petroeschovsky, "A Contribution," pp. 700–701.

⁷³ Zollinger, *Verslag*, p. 9.

⁷⁴ See note 77.

it—the fish in the ponds at Moressa were killed and floating on the surface, and many small birds lying dead on the ground.⁷⁵

Large quantities of ash fell in Bali and Lombok as well. For a number of people these ash falls were directly fatal. Many were killed immediately, buried under collapsing buildings which caved in under the weight of the huge quantities of ash.⁷⁶ The great majority, however, lost their lives as a result of the destruction of the wet-rice crop, which was still in the fields at the time of the eruption and was entirely wiped out by falling ash. A serious famine in Bali and Lombok resulted soon after the eruption. These islands became totally dependent on Java for their rice supply, but as a result of the abolition of the slave trade, there were no exchange commodities with which to pay for the rice.⁷⁷ The dire effects of the famine were intensified by epidemics and rat plagues. All this plunged the islands into an abyss of poverty and misery. The *Bataviasche Courant* of October 26, 1816 reported that in Bali “the survivors are too weak and too few in number to pay the daily dying victims the honour of a funeral.” According to a letter from Dubois, an epidemic in 1817 claimed the life of the king of Badung, Gusti Ngurah Made Kaleran, among others.⁷⁸ In 1818 government commissioner Van den Broek, during a visit to Bali, saw 34 corpses lying in the street, and in 1821 a sailor noted numerous corpses lying about on the beach. There was such serious famine that the Balinese resorted to eating horse and dog flesh and even sold themselves and their children for food.⁷⁹ Olivier, on a trip along the coast of Bali (some time between 1817 and 1826), saw the bodies of children lying on the beach. On inquiry he learned that these children had been killed by their parents because they had no food for them.⁸⁰

The estimates of the numbers of people in Bali and Lombok who did not survive the disaster and the subsequent famine and epidemics vary greatly. Van den Broek estimates that more than two-thirds of Lombok’s original population of 200,000 died and that there were only 20,000 to 25,000 survivors.⁸¹ Melvill de Carnbee agrees with this estimate.⁸² Zollinger, however, estimates the dead as a result of the eruption at the much lower figure of 10,000,⁸³ while Lekkerkerker,⁸⁴ too, inclines to the view that Van den Broek grossly exaggerated the number of dead in Lombok. Junghuhn assesses the number of dead in Lombok at 44,000, which figure is also quoted by Petroeshevsky.⁸⁵ Vickers states that the Dutch estimated the number of dead in Bali at 25,000, though he himself believes that this

⁷⁵ *Keur van nuttige en aangename mengelingen*, 1818, p. 15; see also *Java Government Gazette*, 20 and 27 May 1815.

⁷⁶ H. A. van den Broek, “Verslag nopens het eiland Bali,” *De Oosterling* 1, 1835, p. 183.

⁷⁷ See Olivier, *Land- en Zeetogten*, 1827, p. 451, and H. A. Van den Broek, “Verslag,” p. 165.

⁷⁸ A. Vickers, *Bali: A Paradise Created* (Berkeley, Singapore: Periplus Editions, 1989), p. 67; also Linda Connor, personal communication.

⁷⁹ H. A. van den Broek, “Verslag,” p. 176, and Vickers, *Bali: A Paradise Created*, p. 67.

⁸⁰ Olivier, *Land- en zeetogten*, pp. 450–51. It should be noted that Olivier himself did not attribute the famine to food shortage as much as to shortage of money to buy food with (because of the abolition of the slave trade). I myself am inclined to think it was due to a combination of these factors.

⁸¹ H. A. van den Broek, “Verslag,” p. 183.

⁸² M. P. Melvill de Carnbee, “Essai d’une description des îles de Bali et de Lombok,” *Le Moniteur des Indes Orientales et Occidentales*, 1846/47, p. 91.

⁸³ Zollinger, *Besteigung des Vulkanes Tambrora*, p. 20.

⁸⁴ C. Lekkerkerker, “De tegenwoordige economische toestand van het gewest Bali en Lombok,” *Koloniaal Tijdschrift* 12 (1923): 166.

⁸⁵ See W. A. Petroeshevsky, “A Contribution,” p. 695.

figure may be too low.⁸⁶ All the existing publications invariably omit to mention the number of dead in Bali as a result of the eruption in 1815. Hence at least another 25,000 should be added on to the total estimate of 92,000 dead in Sumbawa and Lombok,⁸⁷ which then brings the total to at least 117,000.

Whatever the exact numbers of dead may have been, it is clear that the short-term consequences of the eruption of the volcano for Bali and Lombok were devastating. Over a slightly longer term, however, the effects were much more favorable. After a few years of famine, disease, and plague, people were able literally and figuratively to start reaping again. The ash had made the rice fields more fertile than ever before.⁸⁸ From 1828 onward the crops increasingly thrived. This positive effect of the ash falls was noticeable not only in Bali and Lombok but also in South Sulawesi, where a lot of ash had fallen as well.⁸⁹

Hence Bali and Lombok recovered from this natural disaster quite quickly, and their agriculture flourished. A few years later they even became the largest rice exporters in the region, thanks partly to the eruption. From 1835 on they exported increasingly large quantities of rice to Java, Singapore, and China,⁹⁰ so that by 1846 Bali was regarded as the "chief granary for Singapore."⁹¹ In addition tobacco, coffee, coconut oil, and cotton were exported from these islands.⁹²

For the island of Flores, especially the western part called Manggarai, the consequences of the eruption of Mount Tambora were distinctive. Here also, according to Coolhaas,⁹³ the death toll was enormous, but a certain political consequence of the disaster temporarily benefited the people of Manggarai. Manggarai had been a dependency of the realm of Bima since 1661, and its people had to pay regular tribute to the Sultan of Bima in the form of slaves, cinnamon, mats, horses, chickens, and dogs.⁹⁴ As a result of the destruction wrought by the eruption in Bima, the Bimanese had so many other problems to worry about that from 1815 onward Bimanese power over Manggarai weakened considerably. The people of Manggarai grasped this opportunity to rebel against Bima and stopped paying tribute for quite a number of years. Only in 1851, when Bima had apparently recovered sufficiently

⁸⁶ Vickers, *Bali: A Paradise Created*, p. 67. It is not exactly clear why Vickers believes this. It is probably because, according to his figures, in Lombok about 17 per cent of the population died, which is considerably more than the 3 per cent quoted for Bali.

⁸⁷ Inter alia in Petroeshevsky, "A Contribution"; Ministry of Social Affairs, 1971; and P. Francis, *Volcanoes*.

⁸⁸ See, for example, Melvill de Carnbee, "Essai d'une description des îles de Bali," p. 91; H. G. C. Schulte Nordholt, *Een Balische dynastie: Hiërarchie en conflict in de Negara Mengwi 1700-1940* [PhD thesis] (Haarlem 1988), p. 89; and Vickers, *Bali: A Paradise Created*, p. 67.

⁸⁹ See Roorda van Eysinga, *Handboek*, p. 40; Chambert-Loir, *Syair Kerajaan Bima*, p. 42; and Lapian, *Volcanoes and the History of Indonesia*, 1983, p. 8.

⁹⁰ G. W. Earl, *The Eastern Seas, or Voyages and Adventures in the Indian Archipelago, in 1832-33-34* (London, 1837), p. 90; G. E. Davidson, *Trade and travel in the Far East: Or recollections of twenty-one years passed in Java, Singapore, Australia and China* (London, 1846), p. 63; and Schulte Nordholt, *Een Balische dynastie*, p. 89.

⁹¹ G. Irwin, *Nineteenth-Century Borneo: A study in Diplomatic Rivalry* (Gravenhage, 1944), p. 115.

⁹² G. W. Earl, *The Eastern Seas*, p. 90.

⁹³ W. Ph. Coolhaas, "Bijdrage tot de kennis van het Manggaraische volk (West Flores)," *Tijdschrift van het Nederlandsch Aardrijkskundig Genootschap*, 2nd ser., 59 (1942): 172.

⁹⁴ W. van Bekkum, "Geschiedenis van Manggarai (West-Flores)," *Cultureel Indië* 8 (1946): 69.

from the disaster, did the Bimanese undertake an expedition to Manggarai and regain power over it.⁹⁵

The Year without a Summer: Effects of the Eruption of Mt. Tambora for the Rest of the World

The consequences of the eruption were starkly evident in the area around Mt. Tambora, but they were not confined there, for debris and/or chemicals shot up into the atmosphere affected the weather of the whole world, particularly Europe and North America.⁹⁶ The summer of the year following 1815 was unusually rainy and cold; in fact, 1816 came to be known as the “year without a summer.” Although at the time no one suspected any connection with the volcanic eruption of the previous year, today this connection is widely recognized.

The summer of 1816 was exceptionally cold—an average of 1 to 2.5 degrees lower than normal—especially in the northeastern parts of the United States, in Canada and in Western Europe. The minimum daily temperatures in the northern hemisphere were extremely low. New Haven, Connecticut, experienced its coldest month of June in the entire period between 1780 and 1968; the Lancashire Plain in England experienced the coldest July, and Geneva (Switzerland) the coldest summer for the period 1753–1960. New England saw spring arrive much later than normal that year and experienced three cold snaps with frost, hail, and snow during summer. Almost everywhere in northeastern America the cold summer led to crop failure and high food prices. The entire corn crop was lost, a disastrous failure because corn was the staple food crop at the time.⁹⁷ As a consequence, many people went hungry and many animals died of cold and hunger, as the prices of feed skyrocketed. Livestock farmers had no alternative but to kill their animals or sell them at give-away prices. In New England in 1816–1817 twice as many farmers as normal decided to move westward. For farmers who had already been contemplating migrating, the summer of 1816 was probably the last straw. Another consequence of the cold summer was that there were far fewer flies and mosquitoes than usual, to the great disappointment of one entomologist collecting these insects for a New York museum.⁹⁸

Europe, too, was seriously affected by the cold summer. It was abnormally cold in the Netherlands, Germany, France, Switzerland, England, and Ireland. Crops failed everywhere in Europe, which in Switzerland and Ireland led to serious famine. The grapes in France had never ripened as late as in 1816, for instance. In Ireland typhoid fever broke out as a result. In Switzerland people resorted to such “famine foods”⁹⁹ as sorrel, moss, and cat flesh.¹⁰⁰ The situation was so critical in Switzerland that official assistance was given to people to

⁹⁵ Ibid., pp. 69–70, and M. Erb, “When Rocks Were Young and Earth Was Soft: Ritual and Mythology in Northeastern Manggarai” (PhD dissertation, State University of New York, 1982), p. 37.

⁹⁶ H. Stommel and E. Stommel, “The Year without a Summer,” *Scientific American*, June 1979, pp. 240–46 and *Volcano Weather: The Story of the Year without a Summer* (Newport, R.I.: Seven Seas Press, 1983); K. Burke and P. Francis, “Climatic Effects of Volcanic Eruptions,” *Nature* 314, 1985, p. 136, and *Kroniek van de mensheid* (Amsterdam/Brussels, 1986), pp. 687–88.

⁹⁷ H. Stommel and E. Stommel, *Volcano Weather*, p. 67.

⁹⁸ H. Stommel and E. Stommel, “The Year Without a Summer,” p. 139.

⁹⁹ “Famine foods” are foods which are considered “inedible” under normal circumstances but are eaten at times of serious famine. See D. Arnold, *Famine: Social Crises and Historical Change* (Oxford: B. Blackwell 1988), p. 24.

¹⁰⁰ H. Stommel and E. Stommel, *Volcano Weather*, p. 47.

help them distinguish poisonous from nonpoisonous plants.¹⁰¹ In Asia the weather in the year 1816 was also highly abnormal and in Korea and other parts of the Far East and India the monsoon pattern clearly deviated from the usual.¹⁰²

Today, scientists are more or less agreed that the eruption of Mt. Tambora in 1815 was largely to blame for the abnormal weather of the following years. It has been discovered that high concentrations of dust particles in the upper layers of the earth's atmosphere may block solar radiation, causing the earth to cool down. The principal natural sources of such dust particles in the atmosphere are volcanic eruptions.¹⁰³ The first scientist to suggest that there might be a link between volcanic eruptions and a cooling down of the earth was Benjamin Franklin in 1783. Only much later, in the years 1914–1920, was the idea elaborated by, among others, W. J. Humphreys of the United States' meteorological office.¹⁰⁴ Humphreys was one of the first to establish a connection between the bad weather of 1816 and the eruption of Mt. Tambora the previous year.

Much later, in the 1960s, the meteorologist Hubert Lamb evolved the so-called dust-veil index. With the aid of this index, it is possible to compare volcanic eruptions on the basis of the number of particles discharged by them. This makes it possible to quantify the effects of an eruption on the climate. The eruption of Mt. Krakatau in Indonesia in 1883 is taken as index and assigned the number 1000. The eruption of Mt. Tambora in 1815 has the highest score so far on the dust veil index: 4200.¹⁰⁵ It is regarded by some as the eruption that had the strongest effect on the climate.¹⁰⁶

One should note here that other scientists argue that the climactic impact of a volcanic eruption depends not so much on the quantity and height of dust penetrating the stratosphere as on the amount of sulphur dioxide ejected during the explosion.¹⁰⁷ This sulphur dioxide combines with other elements in the atmosphere to form sulphuric acid and sulphates. This gives rise to a layer permeated with sulphur droplets and particles which block out the sunlight. As the process of formation of new droplets is continuous, this layer is much more persistent than the dust veil, which spends itself relatively quickly. According to Rampino and Self it is not therefore the size of the blast and the quantity of dust discharged that are the determining factors, but rather the amount of sulphur released. So a small explosion with a large sulphur emission is likely to cause greater variations of temperature than a huge explosion in which little sulphur is ejected.¹⁰⁸ Consequently, where the eruption of Mt. Tambora was an indisputable record breaker as far as size of the blast and extent of the ash fallout is concerned,¹⁰⁹ these scientists would question how much

¹⁰¹ H. Stommel and E. Stommel, "The Year without a Summer," p. 140.

¹⁰² H. H. Lamb, *Climate, History and the Modern World* (London/New York: Methuen, 1982), p. 237.

¹⁰³ J. van Arkel, *Wat is er mis met het weer? Broeikas-effect of nieuwe IJstijd*, Amsterdam, 1984, p. 81.

¹⁰⁴ H. Stommel and E. Stommel, *Volcano Weather*, p. 129, and R. W. Decker and B. B. Decker, *Mountains of Fire: The Nature of Volcanoes* (Cambridge/New York: Cambridge University Press, 1991), p. 15.

¹⁰⁵ J. van Arkel, p. 83.

¹⁰⁶ According to Rampino and Self, Mt. Tambora has a score of 3000 on this index. See M. R. Rampino and S. Self, "Historic Eruptions of Tambora (1815), Krakatau (1883) and Agung (1963), their Stratospheric Aerosols and Climatic Impact," *Quaternary Research* 18, 2 (1982).

¹⁰⁷ M. R. Rampino and S. Self, "Historic Eruptions," and B. Zwart, "Kan stof in de atmosfeer het klimaat veranderen?" *Nieuw Rotterdamse Courant-Handelsblad*, December 30, 1982.

¹⁰⁸ M. R. Rampino and S. Self, "Historic Eruptions," p. 135.

¹⁰⁹ The eruption of Mt. Tambora is commonly regarded as the most explosive one in the past 10,000 years. A comparison of the quantities of dust released in the eruptions of Mt. Tambora in 1815, Mt. Krakatau in 1883 and

sulphur was discharged by it. Although relatively speaking the quantity of sulphur emitted in the eruption was not so large¹¹⁰ in an absolute sense, the Tambora eruption appears to be without parallel on this point also.¹¹¹

Besides cooling the earth's surface, a dust and sulphur veil may also create spectacular optical effects.¹¹² Because shortly after sunset the sun still irradiates these veils in the stratosphere, the sky appears to be intensely red at sunset and dusk. Verbeek has searched the *Javasche Courant* of the period for reports of "red glows" in the sky in Indonesia, but without success.¹¹³ Such glows are, however, mentioned in a report on Makasar from 1818.¹¹⁴ And in the summer and autumn of 1815 beautifully coloured sunsets were to be observed in England.¹¹⁵ In fact, there is speculation about whether these may have inspired the painter Turner.¹¹⁶

Did the particles or chemicals released into the atmosphere by the eruption change the weather of Indonesia? As mentioned above, Zollinger learned from survivors that rainfall was much lower following the eruption, but he attributed the reduction in rain to a decrease in plant cover. There are no other written reports describing weather in Indonesia as either colder or otherwise abnormal after the volcano exploded. We can speculate about the likely effects of exceptionally cold weather or blocked radiation in a country like Indonesia, however. In tropical areas where weather is normally hot and steamy, air rises and condenses steadily, producing rain. Consequently, conditions that reduce sunshine will result in less heat, less condensation, less rain. If this is indeed what happened, the weather in Indonesia must have been unusually dry during the years in question.

This conclusion is confirmed by dendrochronological research in Java, where an examination of the growth rings of teak trees (*Tectona grandis*) by H. P. Berlage¹¹⁷ has shown these rings for the years 1817 and 1818 to be extremely thin. As trees hardly grow in the absence of rain, this allows us to conclude that the years 1817 and 1818 were indeed unusually dry years.

Mt. Tambora and the Cholera Epidemic

Some authors establish a link between the abnormal climatic conditions of 1816 and the first worldwide cholera epidemic. The first person to hold the Tambora eruption responsible

Mt. Agung in 1963 (all of them in Indonesia) reveals a ratio of 150:20:1. M. R. Rampino and S. Self, "Historic Eruptions," p. 138.

¹¹⁰ A comparison of the sulphur emissions in the 1815 eruption of Mt. Tambora, the 1883 eruption of Mt. Krakatau and the 1963 eruption of Mt. Agung reveals a ratio of 7.5:3:1. See M. R. Rampino and S. Self, "Historic Eruptions," pp. 132, 138.

¹¹¹ Nowadays the cooling effects of the release of sulphur into the atmosphere by volcanic eruptions is widely recognized. Whereas the average mean temperature of the world has been rising for the past twenty years, there was a decline in 1992 and 1993, probably as a result of the eruption of Mount Pinatubo in the Philippines in 1991 and the subsequent ejection of millions of tonnes of sulphur (*De Volkskrant*, December 31, 1994, p. 7, "Toeval maakt 1994 tot zeer warm jaar").

¹¹² See E. Francis, *Volcanoes*, pp. 379–80, and Zwart, "Kan stof in de atmosfeer," p. 2.

¹¹³ R. D. M. Verbeek, *Krakatau* (Batavia, 1885), p. 149.

¹¹⁴ *Keur van nuttige en aangename mengelingen*, 1818, p. 14.

¹¹⁵ R. A. van Sandick, *In het rijk van vulkaan: De uitbarsting van Krakatau en hare gevolgen* (Zutphen, 1890), p. 163.

¹¹⁶ E. Francis, *Volcanoes*, p. 380.

¹¹⁷ "Over het verband tusschen de dikte der jaarringen van djatiboemen (*tectona Grandis* L.f.) en den regenval op Java," *Tectona* 24 (1931): 949, 952.

for this epidemic, according to Stommel and Stommel, was a certain J. D. Post.¹¹⁸ Stommel and Stommel themselves note that this is an intriguing and plausible assumption, while at the same time admitting that it is impossible to substantiate. Before the large-scale eruption of the disease, cholera allegedly was endemic in the vicinity of a particular Hindu place of pilgrimage on the River Ganges in India. The bad weather of 1816 caused a number of crop failures in India. This weakened people's resistance, making them more susceptible to disease. As a consequence a local cholera epidemic broke out in Bengal. The disease was spread further afield by British soldiers.¹¹⁹ First it moved to Afghanistan and Nepal, and thence gradually to Southeast Asia (reaching Indonesia in 1820) and the Caspian Sea (1823). A second epidemic, which broke out in India in 1826, spread to Moscow (1830) and western Europe (1831). From there it crossed the Atlantic Ocean, reaching New York in 1832. This worldwide epidemic claimed thousands of human lives and gave rise to flight and migration on a massive scale.¹²⁰

The question is whether the assumption of a link between the Tambora eruption in 1815 and the outbreak of the first universal cholera epidemic in 1817 is plausible, or whether the link should be dismissed as nonsense. Stommel and Stommel's publications do not make clear how exactly this link should be understood. If cholera had been endemic in the place of pilgrimage on the Ganges, it is strange, for instance, that the disease had not spread long before, carried by the many religious travelers.

The literature on cholera shows that a specific strain of the disease occurred (in India and Europe, among other regions) long before 1817. This type, commonly referred to as *cholera nostras*, is caused by *Salmonella paratyphi* bacteria. Although the disease may be a killer, it seldom assumes the proportions of a major epidemic.¹²¹ Very probably it was this type of cholera that was endemic in the pilgrimage area on the Ganges prior to 1817 and never developed into a (worldwide) epidemic. In 1817, however, a wholly new, much more contagious and virulent variant, also known as Asiatic cholera, sprang up in Jessore (Bengal, on the border between present India and Bangladesh).¹²² This type of cholera is caused by the *Vibrio cholerae* and/or *Vibrio El Tor* bacteria.¹²³ Morris says of the origins of this new type of cholera: "There may have been some mutation in the cholera vibrio which enabled it to spread with greater speed and savagery, but more likely the cause was some change in the economic and social conditions of India."¹²⁴

Semmelink, who published a historical study on cholera in India and the Indonesian archipelago in 1885, several times connects the origin of the new strain of cholera with the abnormal weather of 1815 ("exceptionally cold, wet weather") and 1816 ("extreme drought")¹²⁵ and the subsequent famine, saying,

It is quite likely that the flooding of vast tracts of land, the great irregularity of the seasons, and the subsequent famine in *Bengal*, which in 1816 gave rise to epizootics and

¹¹⁸ H. Stommel and E. Stommel, "The Year without a Summer."

¹¹⁹ See McNeill, *Plagues and Peoples* (London, 1979), pp. 241–43.

¹²⁰ *Ibid.*, and N. Longmate, *King Cholera: The Biography of a Disease* (London, 1966), pp. 2–3.

¹²¹ See J. Semmelink, *Geschiedenis der cholera in Oost-Indië voor 1817* (Utrecht, 1885), pp. 1–2; N. Longmate, *King Cholera*: pp. 1–2; P. Kager, *Hoe blijf ik gezond in de tropen?* (Amsterdam, 1994), p. 37.

¹²² See J. Semmelink, *Geschiedenis der cholera*, pp. 1–2; Longmate, *King Cholera*, p. 2; Morris, *Cholera 1832*, p. 2.

¹²³ P. Kager, *Hoe blijf ik gezond*, p. 38.

¹²⁴ R.J. Morris, *Cholera 183, The Social Response to an Epidemic* (London: Croom Helm, 1976), p. 21.

¹²⁵ J. Semmelink, *Geschiedenis der cholera*, p. 470.

epidemics of known diseases in which numerous animal and human corpses remained unburied, are also to be regarded as the prime causes, through their combined action in 1817, of the origin of two new diseases in those regions, namely *cholera Asiatica* and the virulent form of *contagious pharyngitis*,¹²⁶

and “Our historical study has brought to light certain . . . facts which have led us to suppose that *cholera nostras* under unfavourable hygienic conditions might develop into *cholera Asiatica*, in other words, might become contagious.”¹²⁷ (Semmelink did not himself establish any causal link between the Mt. Tambora eruption of 1815 and the abnormal weather in India the following year. This connection was not made until early in the twentieth century).

It would be going too far to hold the eruption of Mt. Tambora responsible for the universal spread of cholera. It is not inconceivable, however, that this eruption played a direct or indirect role in the origin of the new, aggressive form of cholera. It was possible for this type of cholera to come into being and do its deadly work in Bengal in 1817 through a combination of factors, and it is not too far-fetched to assume that there was a link between some of these factors—such as the abnormal weather, the crop failures and subsequent famine, and the reduced resistance to disease—and the 1815 eruption of Mount Tambora.

Recent History of the Tambora Volcano

Research was done on the island of Sumbawa at the beginning of the twentieth century (around 1908) by J. E. Jasper. Jasper was told a number of stories about Mount Tambora by the local inhabitants, who maintained that around 1888 there had been three “bushmen” living high up on the slopes of the mountain as “hermits in the jungle.” They were a man and a woman and their son, who had lived in isolation in the bush ever since the eruption of 1815, which they had personally witnessed. There is another story about some “subterranean chamber allegedly on the highest slopes of Mt. Tambora” in which a great treasure allegedly lies buried. As it is reportedly guarded by snakes and other dangerous animals, no one has ever gained access to this fabled treasure.

According to Jasper, no one had reached the summit of Mt. Tambora since Zollinger. An attempt was made in 1907 by Von Schmidt auf Altenstadt, but his expedition ran aground at the coffee plantation which had been located on one of the slopes of the mountain since 1897,¹²⁸ and which according to Jasper had rather run to seed.¹²⁹ We know, however, that in 1913, as indicated above, J. J. Pannekoek van Rheden succeeded in reaching the summit, though it took him nine days to do so. In the 1930s, when the Swede G. Björklund started a new coffee plantation on the northwestern slope of Mt. Tambora, the village of Pekat on the west coast of the Sanggar peninsula was resettled and in subsequent years, the plantation marked the starting point for the ascent to the summit. The *adspirant-controleur* P. Koster climbed the volcano from this point together with C. N. H. de Voogd and some other people from September 2 to 6, 1933. This attempt was later followed by a number of others, including several by Björklund himself, who made the trip to the summit two or three

¹²⁶ *Ibid.*, p. 480.

¹²⁷ *Ibid.*, p. 493.

¹²⁸ C. N. H. de Voogd, “Botanische aanteekeningen van de Kleine Soenda Eilanden (VIII): Een tocht naar de Tambora op Soembawa,” *De Tropische Natuur* 27 (October 1938): 177.

¹²⁹ J. E. Jasper, “Het eiland Soembawa en zijne bevolking,” *Tijdschrift voor het Binnenlandsch Bestuur* 34 (1908): 85.

times.¹³⁰ Other successful mountaineers included the above-mentioned W. A. Petroeschovsky in 1949, and two Indonesians, namely Adnawidjaja in 1951 and Hamidi in 1969.¹³¹ The coffee plantation no longer exists today. On its site now is located the small village of Tambora or Pancasila.¹³²

The ascent of Mt. Tambora by Koster, De Voogd, and others is described in a report by De Voogd.¹³³ He relates how they set out together (about 30 people in all) and were led on the first part of their journey through "fairly barren, dry and hot country."¹³⁴ Not long after that they came to a cool forest, a "mighty jungle of *Duabanga moluccana*." De Voogd describes the trees as "huge, majestic forest giants" and speaks of a forest of "rare beauty" on the northern slope of the volcano.¹³⁵ This leads him to conclude, like Pannekoek van Rheden in 1913, that the layer of ash and debris was not everywhere uniform. In his view, the dense forest of *Duabanga moluccana* trees, which require a fertile soil, could never have reached such proportions in a period of slightly over a hundred years.¹³⁶ Hence he inferred that this forest must have antedated the eruption.

At an altitude of 1,100 meters, De Voogd noticed a change in the shape of the trees as the party entered a "varied rain forest with a multitude of thin stems." Higher up still, the going became increasingly difficult, with stinging nettles, giant reeds and climbing ferns impeding their progress. Above the 1,800-meter line, they came upon expanses of yellowish-green shrubs (*Dodonaea viscosa*) alternating with *Tjemara* trees, where there were many deer tracks. The final part of the journey took them across "barren slopes covered with loose stones," where the vegetation was strikingly sparse.¹³⁷ De Voogd speaks of "[this] dead mountain country." He nevertheless saw some silvery edelweiss flowers here and there, as well as a few "fragile blue bell-shaped flowers" (*Walenbergia*).

On reaching the rim of the crater, De Voogd could smell a faint sulphurous odor and observed a "flat, sandy crater floor" "partially covered with grass" and a few stunted and discolored trees. He concludes his report with the words: "In spite of the virtually impenetrable armor of itchy, thorny, jabbing, scratching and stinging undergrowth in which the giant mountain has clothed itself, we have subdued it and have witnessed the beauty of its highest peaks. It is a sight well worth a little thirst and weariness!"

We are told by Lekkerkerker in 1933 (on the basis of the reports of one Nyessen) that most of Mount Tambora was covered with forest at that time, but that water was scarce there, so that anyone intending to climb the mountain should take their own water with them. The place was a hunters' "paradise."¹³⁸ Lekkerkerker further observes that the parts that had become depopulated after 1815 had for the greater part remained unsettled. Some fields had been laid out on the southern slopes of the mountain, however, which had given birth to a few villages there (Goewoe Tjirah, Goewoe Prangga, Goewoe Woro, and Goewoe Karombo).

¹³⁰ Petroeschovsky, *A Contribution*, 1949, p. 690.

¹³¹ Kusumadiata, *Data dasar gunung api di Indonesia*, 1979, pp. 440-41.

¹³² M. J. Hitchcock, "Is this evidence for the lost kingdoms of Tambora?" *Indonesia Circle* 33 (1984): 32.

¹³³ C. N. H. de Voogd, "Botanische aantekeningen."

¹³⁴ *Ibid.*, p. 176.

¹³⁵ *Ibid.*, p. 177-78.

¹³⁶ *Ibid.*, p. 175.

¹³⁷ *Ibid.*, p. 179.

¹³⁸ C. Lekkerkerker, *Tijdschrift van het Nederlands Aardrijkskundig Genootschap*, 1933, p. 74.

Since 1972, Mt. Tambora has been discovered by the commercial logging industry. P.T. Veneer Products Indonesia holds a timber-cutting concession for an area of 20,000 hectares on the slopes of the mountain, up to a height of 1,400 meters, and is cutting down the *Duabanga moluccana* trees, an important source of tropical hardwood here. The timber is exported by Veneer Products as a raw material for plywood. In the same period the village of Calabai was founded, slightly to the north of Pekat. Some of its residents came to Sumbawa from Lombok under the authority of the Indonesian government's transmigration scheme.¹³⁹ Most of its inhabitants are engaged in the timber industry. A sawmill has been operating in Calabai for several decades now.¹⁴⁰ The village also serves as a port for timber export.¹⁴¹

From an article by Puspa Dewi Liman which appeared in *Kompas* in 1983,¹⁴² it is apparent that the *Duabanga moluccana* forest today occurs at an altitude from 1,000 to 2,810 meters, where it covers an area of some 80,000 hectares. Hence this forest is partly owned by P.T. Veneer Products Indonesia. The large-scale logging activities by this company pose a serious threat to the rain forest growing on Mt. Tambora. The southern slope of the mountain has already become largely deforested as a consequence of these activities.¹⁴³ Another part of this forest, about 30,000 hectares, is used as a hunting ground. Slightly to the north of this chase another coffee estate, of about 1,100 hectares, has sprung up.

In between the area held in concession by P.T. Veneer Products Indonesia and the hunting ground an area of about 80,000 hectares has been set aside as a wildlife reserve. It is the habitat of species such as deer, buffalo, wild pigs, bats, including flying foxes, and various species of reptiles and birds.¹⁴⁴

A study by Nurcahyo in 1987¹⁴⁵ shows, furthermore, that an area of 34,500 hectares on the slopes of Mt. Tambora, particularly the southern slope, is covered with grass and *alang-alang* (*Imperata cylindrica*). The majority of the local people believe that these large tracts of grass have developed as a consequence of the eruption in 1815,¹⁴⁶ even though they admit that cultivation on *ladang* (unirrigated fields) is also partly to blame. The inhabitants use this grass as fodder¹⁴⁷ and roofing, and thus place a fairly positive value on it. The Indonesian government does not take such a positive view of *alang-alang*, however, and attributes its spread solely to slash-and-burn agriculture, which is responsible for the destruction of forests. It has placed a ban on *ladang* cultivation, in fact, and is trying to control the growth of *alang-alang* as much as possible and initiating reforestation schemes in these very spots.¹⁴⁸

¹³⁹ The Indonesian government's transmigration policy is aimed at the transfer of people from densely populated islands like Java, Bali and Lombok to sparsely populated islands. See R. Cribb, *Historical Dictionary of Indonesia* (Metuchen, NJ: Scarecrow Press, 1992), pp. 474-75.

¹⁴⁰ M. J. Hitchcock, "Is This Evidence?" p. 33.

¹⁴¹ *Ibid.*; see also Puspa Dewi Liman, "Tambora Utara sebagai suaka margasatwa," *Kompas*, September 25, 1983, p. 6.

¹⁴² Puspa Dewi Liman, "Tambora Utara sebagai suaka margasatwa."

¹⁴³ K. Muller, *Nusa Tenggara: Lombok tot Timor* (Singapore, 1991), p. 126.

¹⁴⁴ See Puspa Dewi Liman "Tambora Utara sebagai suaka margasatwa," and Nurcahyo Tri Arianto Sumantri, "Ekologi dan ekonomi padang alang-alang (sabana) di lereng gunung Tambora," in Michael R. Dove and Sugeng Martopo, *Manusia dan alang-alang di Indonesia* (Yogyakarta: Gadjah Mada University Press, 1987), p. 172.

¹⁴⁵ Nurcahyo, "Ekologi dan ekonomi padang alang-alang," pp. 169-221.

¹⁴⁶ *Ibid.*, pp. 87, 208.

¹⁴⁷ *Ibid.*, p. 204.

¹⁴⁸ *Ibid.*, pp. 202-3.

In 1980 P.T. Veneer Products discovered “what appeared to be a site of human settlement” to the northwest of the village of Tambora. According to Hitchcock the finds included pottery fragments, some of them resembling late eighteenth-century porcelain from South China, pot shards and bones. Hitchcock was told by foresters from the nearby village of Tambora that some of them had also found coins, pots, and brassware. Indeed, he was shown some twenty Dutch coins dating from the period between 1731 and 1791. Hitchcock’s conclusion is that “the presence of bones, charred timber, and pottery fragments trapped beneath a thick layer of volcanic debris suggests that the settlement was smothered during the eruption.”¹⁴⁹

The volcano may still be climbed by tourists today, its summit offering views of the dichromatic crater lake, the isle of Moyo (a nature reserve), and the Rinjani volcano in Lombok. The view can by no means be said to be spectacular, however. There are, in fact, few tourists prepared to make the three-day climb for a view from the top of this once deadly volcano.¹⁵⁰ All told, Mt. Tambora attracts little interest today, except from the logging company and a few American volcanologists. But this forgotten mountain has the power to reclaim the world’s attention. It is not inconceivable that Mt. Tambora will erupt again some time in the future.

Conclusion

In summary, we may say that the eruption of Mt. Tambora in 1815 claimed many thousands of human lives (at least 117,000), destroyed the vegetation of entire regions, and as a result caused widespread famine in Sumbawa, Lombok, and Bali. It further gave rise to serious socio-economic problems. Finally, the eruption brought about worldwide climatological changes, which in turn occasioned further socio-economic problems.

Theorists can find a silver lining in even the darkest cloud. Some contend that the effects of a future eruption would not be entirely negative. The positive effects of volcanic eruptions with their ash fallout and the resultant drop in the temperature of the face of the earth as a counter-balance against the rise in carbon dioxide in the atmosphere and the resultant rise in temperatures (the so-called greenhouse effect) is a hotly debated issue at present.¹⁵¹ It is hoped, therefore, that besides the positive long-term effects for the fertility of the soil in neighboring islands, a future eruption of Mt. Tambora with the resultant release of ash into the atmosphere will help to partially eliminate the worldwide greenhouse effect.¹⁵²

Of course one can only speculate about the consequences of a future eruption. It is probable, however, that a new explosion would be even more murderously catastrophic than the 1815 eruption. Since 1815, Indonesia has experienced a rapid population growth, the total population increasing from ten million then to about 182 million today.¹⁵³ Hence the death toll now would far outstrip that of 1815. As the world population has also grown

¹⁴⁹ M. J. Hitchcock, “Is This Evidence?” pp. 30–35.

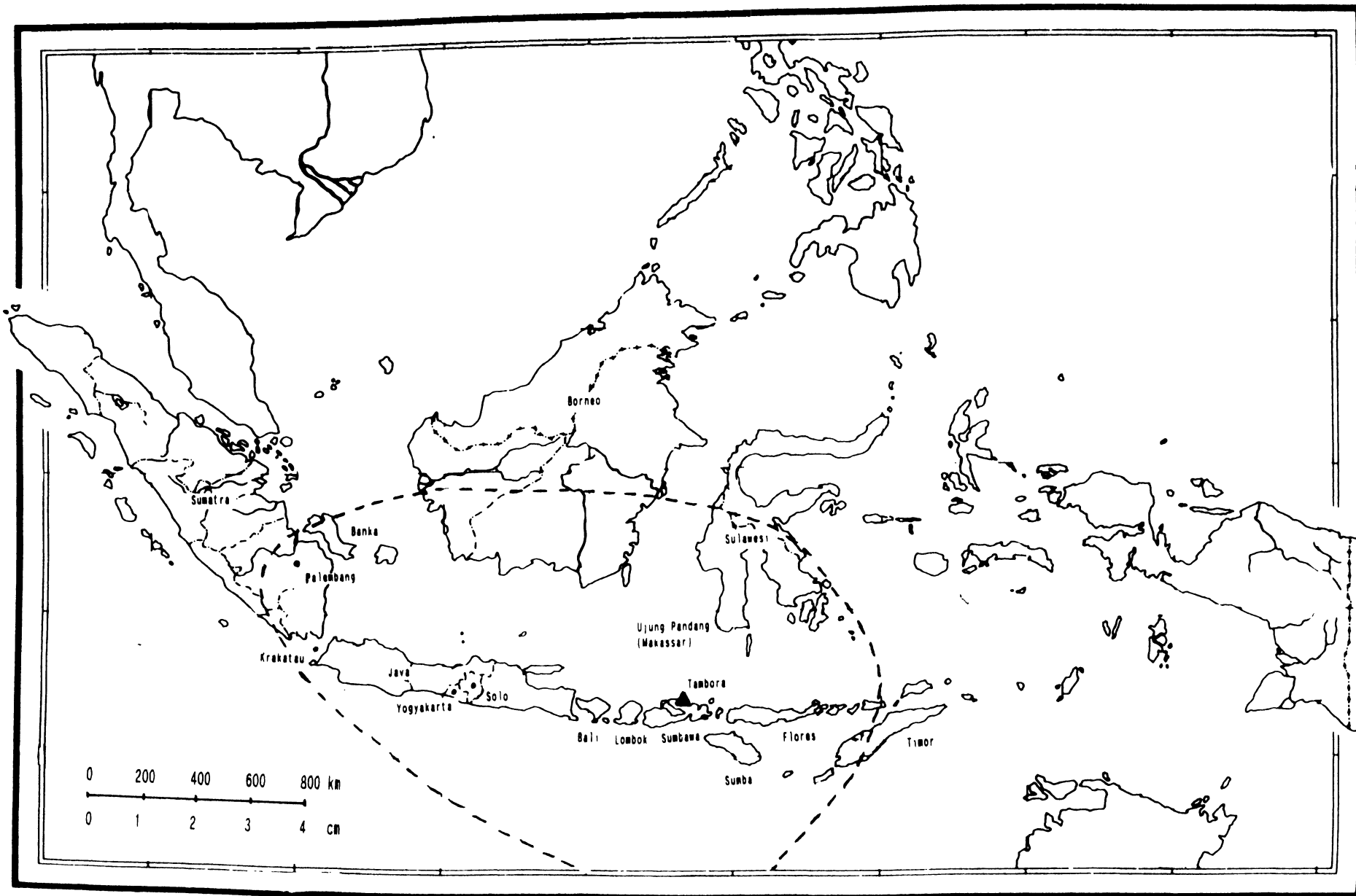
¹⁵⁰ C. Thring, “Gunung Tambora: Regenwoud en kale woestenij,” in K. Muller, *Nusa Tenggara: Lombok tot Timor* (Berkeley, 1992), p. 120, and Robert Storey et al., *Indonesia: A Travel Survival Kit* (Hawthorn, Vic.:Australia; Berkeley, CA, USA: Lonely Planet Publications, 1992), p. 637.

¹⁵¹ H. Stommel and E. Stommel, *Volcano Weather*, pp. 156–57; Zwart, “Kan stof in de atmosfeer het klimaat veranderen?” 1982, p. 2; and Decker and Decker, *Mountains of Fire*, 1991, pp. 149–60.

¹⁵² One volcanic eruption is not enough for eliminating the “greenhouse effect.” Several eruptions in a row would be necessary for this.

¹⁵³ See P. Boomgaard, “Multiplying Masses: Nineteenth Century Population Growth in India and Indonesia,” *Itinerario* 9, 1 (1987): 145, and H. Soetjijto, *Indonesia 1991; An Official Handbook* (Jakarta, 1990/1991), p. 20.

astronomically since then, the number of people affected by resultant crop failures, famines, and epidemics as a result of such an eruption would also be much larger.



1 : 20.000.000.

----- The dotted line roughly indicates the area affected by ash falls from Tambora in 1815 (according to Zollinger, 1855 and Petroschevsky, 1949).

Source: K.G. Krol, A.J.P. Moereels and C. Lekkerkerker, *Kaart en tekst: eerste atlas van Nederlandsch-Indië voor de Indische lagere school*, Groningen/Batavia 1940, p.36. I have added the dotted line and placenames.