

THE IMPACT OF TWO VOLCANO ERUPTIONS ON THE CROATIAN LANDS AT THE BEGINNING OF THE 19TH CENTURY

Utjecaj dviju vulkanskih erupcija na hrvatske zemlje početkom 19. stoljeća

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Abstract: This paper aims to show that volcanic activity was the prime factor that initiated a sequence of natural disasters in Croatia during the early 19th century. The Napoleonic wars were still roaring when two volcano eruptions affected Europe. The first one occurred in 1808/09 and was followed by the eruption of the Tambora volcano in 1815. These eruptions produced a negative effect on weather conditions from 1809 to 1818. The daily minimal temperatures in the northern hemisphere, from late spring to early autumn, were abnormally low in this period. As a consequence, the Croatian lands were struck by crop failures, and famine became widespread because of inadequate measures against food shortage. However, the most detrimental outcome was a catastrophic epidemic plague which lasted from 1814 to 1818.

Key words: chronicle, volcano eruption, weather anomalies, the Little Ice Age, famine, plague, Croatia.

Sažetak: U radu je pokazano da je vulkanska aktivnost bila prvotni čimbenik koji je pokrenuo niz prirodnih katastrofa u Hrvatskoj početkom 19. stoljeća. Napoleonski su ratovi još tutnjali kad su dvije vulkanske erupcije pogodile Europu. Prva se dogodila 1808/9., a druga je bila erupcija vulkana Tambora u Indoneziji, 1815. One su uzrokovale negativan učinak na vremenske prilike od 1809. do 1818. Dnevne temperature na sjevernoj hemisferi od kasnog proljeća do rane jeseni u tom razdoblju bile su neuobičajeno niske. Kao posljedica toga, hrvatske zemlje bile su pogođene lošim ljetinama pa se, zbog neprikladnih mjera protiv nestašice hrane, proširila glad. Najpogubnije posljedice imala je katastrofalna epidemija kuge koja je trajala od 1814. do 1818.

Cljučne riječi: kronika, vulkanska erupcija, vremenska odstupanja, Malo ledeno doba, glad, kuga, Hrvatska

1. INTRODUCTION

The first and second decades of the 19th century were a turbulent, unsettling period in the history of Europe. The vast Napoleonic wars from Trafalgar to Moscow as well as the uprisings and rebellions in the Balkans were the human contribution to wretchedness and Nature did not fail to give its own contribution to evil. During this period, the so called Little Ice Age had not manifested any sign of abating – on the contrary – its bite was still tough (Grove, 1988).¹ Unexpectedly, the circumstances were

aggravated by two very, very distant volcanoes. While the first one is even now unidentified, the second one was so remote, that hardly anybody had ever heard of it at that time.

The eruption of the unknown volcano has been dated, using natural proxy records, from A.D. 1808/09. The main evidence was found in Greenland, as well as in the Antarctic ice cores (Mosley-Thompson et al., 2003; Budner, Cole-Dai, 2003).² The total dust veil index for that year was estimated at 1,500. As regards the location, according to analogies, the vol-

¹ Grove, 1988, 4–5., 83., 194–197.

² Mosley-Thompson, Mashiotta, Thompson, 2003; Budner, Cole-Dai, 2003

cano must have been situated somewhere at equatorial latitude – within $\pm 10^\circ$ (Lamb, 1970; Miles et al., 2004).³

The second perpetrator is well-known. The Tambora is a stratovolcano situated on the Sanggar Peninsula of Sumbawa Island in Indonesia. Its geographical coordinates are: latitude: $8.25^\circ\text{S} / 8^\circ 15' 0''\text{S}$; longitude: $118.00^\circ\text{E} / 118^\circ 0' 0''\text{E}$. Prior to the 1815 eruption, the volcano may have been more than 4,000 m tall, but now, two centuries later it reaches an elevation of 2,850 m. The diameter of the volcano at sea-level is about 60 km (Robock, 2002).⁴ The giant eruption began on 5th April 1815, and continued fiercely till the middle of July, going out in 1819. The sound of the explosion is said to have been heard at a distance of 2,700 km, clouds of gas and volcanic dust reached a height of about 44 km, ash fall-out was recorded about 1,300 km from the Tambora, a tsunami developed, about 3.5 m tall, and the total quantity of tephra was estimated at 150 cubic kilometres (*tephra* is a term for solid matter that is ejected into the air by an erupting volcano), the dust veil index was estimated at 3,000. According to Newhall and Self (1982),⁵ the volcanic explosivity index was “7” (besides the mentioned volume of tephra and the cloud column height, the other criteria for this assignment were: *qualitative description* – cataclysmic; *eruption type* – ultra-plinian; *stratospheric injection* – significant, etc.). The number of direct deaths was 10,000 and another 82,000 persons were killed in Indonesia indirectly by starvation and disease (Lamb, 1970; Stothers, 1984; Decker and Decker, 1989; Robock, 2002).⁶

Since all this horror had occurred at a distance of about 11,500 km (meaning the Tambora eruption) a question arises: how could it have affected Croatia? The answer is: only by climate disturbances. It is volcanic aerosols, developed from sulphurous gases injected into the higher layers of the atmosphere that disturb climate. Having reached the stratosphere, these aerosols blanketed the globe within a few weeks and remained there for 2–3 years. This

only happens when an eruption takes place at low latitudes (Robock, 2000).⁷ This was the case in both 1808/09 and 1815. Firstly, in Europe, contemporary reports exist of some direct effects which were linked with the Tambora eruption (coloured sunsets and luminous twilight). Secondly, the sequence of climate disasters which befell many European countries in the years 1815–1818 can be nothing but recognized as an indirect impact of the eruption. Although the year 1816 has become notorious as the “Year without summer”, this designation should not be limited only to weather circumstances but should also refer to the famine and a large array of diseases, especially infectious ones, which accompanied it (Stothers, 1984; Rampino et al., 1988; Robock, 2002).⁸

2. HISTORICAL DATA

As far as the Croatian lands are concerned, many records can be found describing the phenomena that occurred during this period. Following the standard division, we can rely on two kinds of proxy indicators: man-made and natural ones. In this case, only written descriptive sources have been used and they consist of chronicles, official reports, parish books, memories and diaries. Date verification should not be a problem, because the Croatian lands under Habsburgian and Venetian rule accepted the Gregorian calendar reform immediately after its proclamation, while the Catholic Christian lands under the Ottomans accepted it only at the beginning of the 17th century (Stipišić, 1985; Xoplaki, et al., 2001).⁹ Unfortunately, there were no instrument observations until the mid-nineteenth century (or somewhere until the 1880s) so that we are directed to these primary but subjective sources.

Here follow, for consideration, all available texts, beginning with data from the most western province of Croatia, called Istria, through Slavonia in the east, and ending with the southern parts of Dalmatia. All the locations mentioned are shown in Figure 1.

³ Lamb, 1970, 442, 447; Miles, Grainger, Highwood, 2004

⁴ Robock, 2002

⁵ Newhall, Self, 1982, 1231–1238.

⁶ Lamb, 1970, 512; Stothers, 1984; Decker, Decker, 1989, 211, 258; Robock, 2002.

⁷ Robock, 2000; Miles, Grainger, Highwood, 2004

⁸ Stothers, 1984; Rampino, Self, Stothers, 1988; Robock, 2002

⁹ Stipišić, 1985, 191.; Xoplaki, Maheras, Luterbacher, 2001



Figure 1. Map of the Croatian lands about 1800. Numerals indicate the locations of historical descriptive data. Letters indicate the locations of demographical data.

Slika 1. Karta hrvatskih zemalja oko 1800. Brojevi označavaju lokacije podataka iz povijesnih izvora. Slova označavaju lokacije demografskih podataka.

2.1. Location 1

A Sub-Deputy of Kopar informed the competent authorities (Kopar, *Koper* in Slovenia, is a small town situated 60 km northwest of Rijeka; 45°32'54"N, 13°44'04"E; climatic type *Cfa* – see chapter 3):

(12th April 1813)

... during last winter, cold and ice scourged the whole area of my district. More than one third of the vine dried, and a large amount of crops of all sorts was scorched ...

2.2. Location 2

In the district of Vodnjan (a place 61 km southwest of Rijeka; 44°57'39"N, 13°51'10"E; climatic type *Cfa*) an Imperial and Royal Commissary wrote down in his report of 1816:

... The climate in the district of Vodnjan is very healthy, since it is temperate. But, for four years it has been noticed that winters are more severe than usually, as the cold and freezing begin in the season of autumn and extend as far as spring. Because of that, unusual illnesses break

out, like pneumonia, pleurisy, various inflammations as well as recurrent fevers.

Since the rigors of the winter and spring seasons particularly affect grapevine and olive trees as well as cereals, it may be said, not without reason, that grape, olive and cereals blossoms have suffered not a little by this change of climate, the instability of seasons and the frequent fogs coming from the sea with south winds in spring.

Firm evidence of this comes from people's experience and the tithe registers. From the registers it is clear that earlier years were far more fruitful and that the income has diminished to one quarter, one eighth, even to one tenth of what it used to be. There can be no doubt that climate causes such poor crops, because from year to year ... especially in May and at the beginning of June, dense sea fogs move in, making the good years disappear visibly ... (Bertoša, 1989) ¹⁰

2.3. Location 3

In Žminj (a place 46 km southwest of Rijeka; 45°08'35"N, 13°54'43"E; climatic type *Cfb*) a parish priest, Frane Ksaver Glogovac, added a comment to the Death Register, entitled *Awful notes about the year 1816 as well as the year 1817*, providing the following evidence :

(1816)

... you have to know that it is nothing else but a sad annotation of the most sterile year: 1816 – the year bissextile.

Behold that this for us fatal year, because of frequent rain and other bad weather was so sterile that many citizens could not prepare enough cereals to last them for half a year, and some not even for two months ...

The year 1817 started with the most fair ¹¹ and mild days, except for some rain in January, and it seemed very fair for the most part of February – unusually pleasant. It continued similarly in the month of March and at the beginning of April so that the peasants, using those fair days, sowed the little cereals they had, without preserving them for their living. Still, due to lack of seed, over 2000 days of ploughing remained uncultivated (the size of this square measure was varied, generally more than 2500 m²).

¹⁰ Bertoša, 1989, 7., 46.

¹¹ To stick to the original, all weather descriptions have been translated literally, without using official meteorological terms.

In the month of April, the weather continued to be fair till the 15th and then it began to snow every day, so that on St. George's Day, the 23rd, it snowed for nearly two hours, and the snow-fall was one quarter high ...

... As early as the month of March, these people began to be affected by Black Famine; yet they supported each other as long as they had anything to eat. ...

But it was of short duration ... Reduced to the uttermost misery they were walking around and falling dead, some at home, some along roads, some in the forests etc. ...

It did not rain this year from the Feast of the Holy Name of Jesus, which was on 19th January, to 26th March, all pools ran dry, and we were all plagued by the absence of water, people and animals and beasts. ... till 18th June in the morning when an abundant rain fell. ...

Among the large number of starved persons listed in Glogovac's Death Register it is enough to adduce the following:

... 1817 ... Ivan Brenko Benić was found dead on 25th May in the forest of Žminj. ... The cause of death: weakened by famine. ...

2.4. Location 4

An epitaph on the tombstone erected by the thankful parishioners of Gračišće (a village 36 km southwest of Rijeka; 45°13'1300N, 14°00'55"E; climatic type *Cfb*) to their parish priest Frane Godenić speaks of drought:

After a bad harvest caused by drought during the year MDCCCXVII (1817) he procured cereals from the state stores and distributed them to all parishioners free of charge (Bertoša, 1989).¹²

2.5. Location 5

Count Adam Oršić of Slavetić, who was the owner of large estates in northwestern Croatia (around 46°N, 16°E; climatic type *Cfb*), mentioned weather as well as harvests in his "Memoirs":

(1812)

When it comes to crops, the year 1812 was quite mediocre, but the grapes have probably not

yielded so well in a hundred years. However, wine is very sour and fighting for survival in the barrels: it is sour and lacking in body. ...

(1813)

... This rainy weather has caused great failure of fruit crops, so that people expect bad and weak wine because at the end of September no grape in Croatia was fully ripe. ...

In every respect, the year 1813 has been among the worst ones. ... Soil fertility has been exceedingly bad, cultivated fields have hardly yielded what had been sown. Hay was quite plentiful, but wine was so scarce that those, who gathered 50 pails (a liquid measure = 56.6 l) in 1812, got barely five pails this year. Moreover, wine is sour, since most of the grapes were not consumable even as late as at the end of October. ...

Thus, only merchants, who sell the goods we badly need at a high price, imposing their usual margins and paying little taxes or excises, live well. This year, the weather has been so bad that I can not remember anything similar. Since August, we have had no more than 8 fair days in a row. Here it rained daily in torrents; ... The husbandmen managed to sow only few winter crops and, consequently, we are expecting a new unfruitful year; everybody is disheartened ...

(1814)

On 25th (January) there was a thunderstorm and in many places it hailed heavily, too. ... (Oršić, 1943)¹³

2.6. Location 6

The most systematic and most informative records are found in eastern Croatia. In the Franciscan monastery of Šarengrad (a place situated on the right bank of the Danube, 59 km to the southeast of Osijek; 45°14'06"N, 19°17'08"E; climatic type *Cfb*), the chronicle begins in 1683 but recording was discontinued. Then, in 1775, the provincial superior Ladislav Spaić organised the keeping of records. Weather and other notes were entered by Lovro Kozarević till 1812 and Kuzma Filić till 1814. They were followed by Matija Šnedić, Leonard Petrović and Adalbert Marjanović till 1818 and further. For this topic, it is interesting that the leading article emphasized that ...

¹² Bertoša, 1989, 21., 29., 48-50.

¹³ Oršić, 1943, 80., 105., 109., 110.

... This district is distinguished by miraculous field fertility and it bears all human necessities.

...

Year 1809

Cold. The cold, which was easing off after Christmas time, at the beginning of January became again more severe. It snowed and ... The cold kept increasing, so that at the end of January it grew bitter beyond all measure.

The Danube River. In this weather, the Danube started to rise. It overflowed so much that from this hill, one could not see anything but water. The weather was changeable, now it was more moderate, now it was snowing, now it was raining. The cold, however, hardly ever diminished because a cold wind kept blowing till 20th April. After St. George's Day (23rd April) the weather relented a little.

Spring weather. On 1st May, spring weather made a short appearance. Anyway, this day, warm rain fell and afterwards rain was very infrequent or very scanty, except on the three Mendicant Friars' days. ...

Weather. Fruit-trees had flowered luxuriantly and the trees were full of fruits. But there had been too little or no rain so that the fruits were destroyed by parching heat, ...

Rain. At the beginning of August and further, there was enough rain, even too much. The same was in the September and it rained 24 hours continually, day after day. People could neither thresh nor plough their fields for sowing. All activities were behind time. Grape in the vineyards became rotten. Grape-harvesting began late because people had been expecting more favourable weather. Anyway, it was a poor harvest because must was not wine but pure mud. Even so, a pail of must sold at 4 florins and pure wine at 11, 12 and 13 florins. A pail of plum brandy at 24 florins and over. Wheat, corn, barley and oats cost as much as the previous years. One pound (a weight measure = 0.56 kg) of beef at 4 groschen (1 florin=20 groschen=60 kreuzer). Fish too. A calf reached 28 florins. In a word, everything at inconceivable prices. ...

Year 1810

Weather. In January, for many days, I saw neither sun nor moon. By night it was continually clouded, till 13th January. Then it began to snow and it snowed for several days and nights.

The road turned into a sledge path. This continued for 15 days and so did severe cold. Then the cold broke. There was a disgusting amount of mud but the weather was calm. ...

Dearth. The Danube was now rising now ebbing. So was the weather: the days were now warm now cold. Privation and prices kept rising but not decreasing. A pail of old wine at 30 florins and over. Because of the changing weather, fruit-trees bore no fruits. Early in the morning, fog and clouds were often so dense that ... At half past nine in the night of 26th May, storm, hail, wind with rain. ... Later on, too cold days, especially in the morning. And this is how it continued till June. ...

Cold weather. Such cold weather lasted till half-June and further, and the sky filled with clouds by day and night without delivering rain. ... Drought settled in so that people could not plough their fields for sowing in due time and in this year of eight hundred and ten sowing started late.

Price of things. ... The production of wine was, however, average and a pail of must sold at 8, 10 and even 12 florins. There was an average amount of wheat, barley, oats and corn. A bushel (a weight measure = 46 kg) of wheat sold at 8, barley, oats and corn at 4, 5 and 6 florins. Everything was being sold at inconceivable prices. Plum brandy at 30, 40 and 80 florins. Poultry and a pair of chickens at one florin, a pair of geese at 5 florins, a pair of turkeys at 10, 12 florins. ... In December, on the 11th day, it snowed a little but the snow melted immediately. So, all month long there was no snow, but bright days without the usual coldness. There was frequent frost at night, till the end of the year 1810.

Year 1811

Weather. On the Eve, i.e. on the last day of December, it began to snow and a cold wind started blowing. It snowed up to our knees ... Rather severe cold continued ... till 19th February. ... the cold broke, but it remained constantly clouded. The cold now decreased, now increased, so that now it snowed, now it rained ...

Weather. On 24th April, towards the evening and into the night, abundant rain, which prevented the procession on St. Mark's Day (25th April). Afterwards, on 27th April, heavy rain again. It rained frequently also in May. May

was wet and cool. But from 21st May, brightness and oppressive heat, as usual on dog-days. Such hot weather continued almost throughout June.

Price of victuals. Last year, everything was selling at high prices and this year at very high prices. One pound of beef sold at 8 groschen, somewhere at 11, 12 and more groschen. A calf at 24 and 25 florins. A lamb at 10 and more florins. Everything else also at unheard-of prices. ...

Weather. As for the weather in May, it rained frequently so that May was wet and cool till Ascension Day or 26th June. On 6th July, towards the evening, it rained for a full hour. And further, on 8th July, also, at the same evening time. ...

Weather in July. It was hot all July long, twice it rained a little. Therefore, the vegetables parched. However, there was an average amount of wheat. ... Excellent wine, not even scarce, but its price was high because of the paper money. Everything sold at inconceivable prices.

Year 1812

Cold. In January, early, it snowed a little, now with rain, now without, ... But from 12th January cold began to increase. So, severe cold set in, which continued till the 26th and beyond, and then it began to subside slowly. But only a little. Almost all February, cold kept increasing and decreasing because of a cold, low wind. When the wind stopped, it began to snow, all day long it snowed and then another change, as usual in March. But yet it was chilly so that we heated our cells and spent a lot of firewood till 26th March. Cold in April, too, and now and then frost appeared, three or four times in the morning. ... We shall see what will happen later because it was continually cold, also in June. ...

Rain. On 12th July 1812, at three o'clock in the afternoon, strong wind. And at five o'clock it began raining hard with constant thunder. And this excessive rain was getting heavier till seven o'clock in the evening. It must have been a cloudburst. ...

Years 1813, 1814

... In the meantime, on 20th September, cold wind by day, frost by night. The next three days, frost appeared in the morning and even

ice was found. The most severe frost was on 27th September.

Grape-harvesting. Harvesting was late this year. However, it was completed by about 24th October, although not entirely. But there was a great quantity of wine so that people did not remember that there was ever such copiousness. A pail of must at 48 kreuzer. ...

(1813)

Rough weather. Further, on the eve of St. Bartholomew's Day, i.e. on 24th August, about 8 o'clock in the evening, such a storm rose that it brought hail and lightning, too. Rough weather continued for three or four days so that trees were uprooted. This rain brought coldness. ...

Year 1815

Snow. This year and month (December) there was very dense snow. But, two winds fought, the south and north wind. As soon as the south wind melted the snow, new snow was immediately drifted in by the north wind. ...

Bad year. At the end of the year, I can say nothing laudable, on the contrary, as this year was under-average in wine production, so it was just as bad for everything else.

Year 1816

Weather. At the beginning of the year 1816 and the month of January, the weather was unchangeable and snowy. The air was more foggy and murky than bright and bracing. ...

Poor crop yield. In 1813, 1814 and 1815, there was no crop to speak of, neither wine nor wheat, so people lived in poverty and dearth, ...

All this month (January) was muddy and foggy. ... One pound of beef sold at 15 kreuzer, fish at 15 kreuzer, one egg at 10.

(Weather) On 26th January, at seven o'clock in the afternoon, very strong wind ...

On 29th January 1816, severe cold and winter started again and continued for a long time ...

On 4th March the cold broke, rain and wind continued all night and next day ...

On 9th May heating of the cells was discontinued. On the 15th day of the same month heating was resumed. ...

Rain and floods. On 12th March it began to rain and it rained till the 26th of the same month continuously. This year and month, rain with

snow. Extensive flood, mostly because of the Danube. Nobody, not even old men remember such a flood happening before. It flooded many villages on this and on that side of the Danube, arable land and hayfields in the county of Bač. ... On 2nd and 3rd February, because of the cold (not taking into account people) more than 24 thousand sheep perished. The water rose as high as man's height and, having poured over the dike near Arad (now in west Romania), as one of that monastic community writes to me, filled up the wine-cellar so that both wine and barrels were destroyed.

On the same day and year, there was a similar flood of the Sava River on the Border, ...

Cold. On 30th March 1816, snow, and such a severe cold as does not usually occur on Epiphany (6th January). Really distressful and sad weather. Because of lack of hay and straw, many horses, oxen and sheep perished in this period. ...

At the end of April as well as at the beginning of May, very cold days with rain, ...

Frost. On 20th April there was frost. ... On 27th April it rained all day long. One pound of beef sold at 24 kreuzer.

Cold days. At the end of April and at the beginning of May, very cold days with rain ... The cold lasted till 18th May. ...

June

From the beginning to the end of this month, it rained almost every day, which prevented people from working in the fields. On the eve of the Day of the Holy Apostles Peter and Paul (on 28th June) it began to pour at four o'clock in the afternoon, when it hailed, too, and it lasted half an hour, so that it devastated this district as well as some of the neighbouring ones. ...

July

Hail. In the afternoon of the 16th day of this month, like on 28th June, at about four o'clock, it hailed ...

The next day ... soon after six o'clock in the evening a tempest broke ...

August

Poor wheat crop. On the 22nd, while threshing the small and scanty crop of wheat, barley and oats ...

September / October

... **Grape-harvesting.** It should be noted that

our grape-harvesting began on the same day too, on 7th October, and ... the weather helped not only us but also everybody else. ...

December

... This month, including its end, was plagued by snow and cold. ...

Year 1817

January

This month was cold at the beginning, but by its end it tended towards warmth mixed with rain. ...

February

... This month was warm at the beginning as well as at the end ...

March

... The beginning of this month was windy and rainy. ...

On 12th March, that is, on St. Gregory's Day, it snowed and on this very day it was biting cold because of strong wind. ... All this month was rainy and windy and because of excessive rain people could not carry out outside works. ...

April

... At the beginning of this month, pleasant days, like in the middle of summer. ...

On the 10th, 11th and 12th, continuous cold winds, and after them, on 13th, it snowed, and it went on snowing all day and night long. ...

Snow. On the 14th, snow and strong wind again. ...

Till the end of this month, it was so windy, rainy and snowy, that people were overdue with the planting of vineyards and corn. ...

May

Weather. This month, from its beginning, for an uninterrupted period of 9 days, was favourable and warm, so that these days were used for sowing and the performing of other work. ...

June

Weather. On the 18th ... (discontinuance) This month, toward its end, ended with terrific rain and horrible winds, which caused great damage. ...

July

... **Weather.** This month was rainy, changeable from the beginning; towards its end it was bright and pleasant.

In August

Weather. *This month was bright at the beginning, in the middle there was a little rain, at the end it was as bright as it was windy. ...*

In September

Weather. *This month presented us with weather like last month. ...*

October

Weather. *During this month, nothing new occurred, except some weather changes, now rain, now wind, now cool and bright days. ...*

November

... Cold weather arrived, with rain and a little snow. ...

December

... Weather changeful. ...

Year 1818**January**

... This month it snowed and rained a little, and it was terribly cold. ...

February

... With cold rain and a little snow, cold for the most part. Droughty month ...

September

Tempest. *On the 27th, about eight o'clock in the evening, a tempest set in with hail ... (Cvitković, 2002)¹⁴*

2.7. Location 7

The next chronicle is from the monastery in Slavonski Brod (a small frontier town, 69 km to the southwest of Osijek on the left bank of the Sava River; 45°09'12"N, 18°01'30"E; climatic type *Cfb*). It was the Franciscan Marijan Lanosović who was keeping the records from 1806 to 1812. He was followed by Grga Čevapović (1812 – ?), Petar Becker (? – 1814), Josip Ljubić (July 1814 – March 1817) and Rafael Lopatkay (June 1817 – May 1818). Among these, Lanosović enjoys deserved fame not only as a clergyman but also as an excellent scientist and organizer.

Year 1809**January**

... Cold. 5th. Almost unbearable cold, which lasted from 12th till 22nd December of the year that just ended. ...

Cold. 7th. The cold broke quickly. But later on, ice melted, the Sava River was swollen, it overflowed its banks and spread far and wide. The flood lasted almost three months. Not earlier than about Whitsuntide (about 21st May) and later on, the people from the Sava valley could plough and sow for the first time. ...

March

... 12th. It keeps snowing. ...

April

... the 2nd, 3rd and 4th. Thunder, rain, lightning, on the 2nd, hail again, and the following day it snows again. ...

August

... Because of drought, hayfields gave less than a half of last year's hay. ...

September

Flood of the Sava River. *28th. As it began to rain today, so it continued till the end of this month and on. ... Moreover, such a violent flood of the Sava that people from the Sava valley were forced to pick unripe corn, in some places from boats. Therefore, a great shortage of bread cereals developed ...*

Grape crop. *Where there was no frost in the vineyards of this place, wine abundance exceeded last year's crop. ...*

November

... Rain and the flood of the Sava River. Because of copious and almost continuous rain, but also because of the Sava flood, there was serious insufficiency of firewood ... but also shortage of victuals, especially flour, since nobody could either transport or convey anything to the flour-mill.

The overflowed water was rising from day to day.

The 17th and 20th. Snow mixed with rain, therefore it did not last. ...

December

... Since the overflowed water was rising, it was necessary to buy firewood. ...

Rain. *Although some days were bright, from the 22nd of this month nights were mostly rainy. ... The mud was so terrible that four horses could hardly pull out an empty wagon. ... Therefore, shortage of flour, because people could not approach the flour-mill.*

¹⁴ Cvitković, 2002, 196–219.

Here in Brod, during these three rainy and muddy months, 80 head of cattle perished. ... This month, the overflowed water rose up to the garden and yard walls and has not stopped rising.

Year 1810

January

... 12th. ... Since this date, the sky was continuously clouded, without wind and rain. This month, before the earthquake, there was little snow.

February

3rd. Further cloudy weather, however, cold increases and continues up to the 25th. ...

Inconstant snow. *Because of soft snow and rain ...*

Flood. *Although the overflowed water was long-lasting and troublesome, ...*

April

... Cold air. Further cold air, except for a few warm days so that the rooms had to be heated. ...

June

... Hail. 11th. Hail beat vineyards, gardens and fields in the neighbourhood of Gromačnik, Varoš and Brod and some other places. ...

December

... This year, average-quality wine sold at 25, even 30 florins.

Year 1811

October

... This year's wine was very good, however, not abundant ...

Abundance of wheat everywhere. ...

November

... 19th. First snow, but it was melted by the rain that followed. ...

Year 1812

April

... Throughout this half-moon period it rained and snowed, and cold strengthened and lasted longer ...

Year 1813

November

... Flood of the Sava River. 17th. Everything along the Sava was destroyed by the flood; ...

Year 1814

September

... Pestiferous disease. 24th. Owing to the spreading of pestiferous disease in Turkey

(i.e. Bosnia), the border crossing was closed and any trade between us and the Turks was forbidden. In Turkish Brod (now Bosanski Brod), 39 men died infected with plague. ...

The Sava flood. *These days there was a great flood of the Sava River and it lasted for a long time. ...*

Year 1815

July

Flood of the Sava River. *This month was very humid and rainy and prevented a lot of people from mowing hay and gathering crops, because the Sava River overflowed two times, fouling up meadows and crops and destroying sowed fields. ... Such rainy weather succeeded*

August

Merciless weather. *... That is to say, dry weather lasted hardly from the new to the full moon so that a lot of people began to mow, reap and gather plums, without threshing, which they could not perform till November because of heavy rain, which damaged the vineyards, just like it did in July. ...*

November

... Rainy weather. All this month as well as the following one, was rainy, so that people could not do anything, ...

Year 1816

... Copious snow. This month (January) was rainy and snowy; ...

February

Pestilence in Jasenovac and Dubica. *In the estates of the glorious regiment of Gradiška, as well as in Jasenovac and Dubica, the estates of the Ban regiment, a pestiferous disease broke out, which was stopped by the conscientious diligence of the High Council.*

March

Merciless weather. *Rainy, windy and snowy, so that vernal sowing could not be carried out. ...*

April

Abundant rain. *Because of rain, nothing could be done this month. ...*

May

Everyday rain. *Same as during the past months, nothing could be done because of everyday rain. ... and the sown seeds rotted in the soil. It often thundered and hailed. Although the hail was not big, ...*

June

... **Rainy month.** This month was rainy till the end, ... As a result, the Sava River rose too much and overflowed the sown fields and meadows of all the estates of the Gradiška regiment, so that peasants are going to do without corn and hay.

July

The Sava River ebbing away. On the 7th day of this month, the Sava River began to ebb away, but too late, for corn was destroyed, and grass putrefied. ...

Fair weather. This month was serene, fair and warm from the 11th, so that people could cultivate their vineyards, hoe up corn and mow grass up to the 26th, when, at 6 in the afternoon, a storm rose, and hail fell as big as walnuts ...

August

Dry weather. Pleasant and dry. Since there was no rain at all, corn, which was in urgent need of rain, looked miserable ...

Poor harvest. The harvest began but it was meagre, there was plenty of straw and little grain and it was inadequate ...

Fair weather. This month was warm and fair, without rain, till the end. In fact, because of the lack of rain there was not much millet, either.

September

Fair weather continuing. Fair weather continued till the 7th, when rain began. ... fair weather set in again, and lasted till the end of the month, so that peasants could not sow anything, what because of the drought what because of lack of seed ... since the price of one Pozsonyian bushel (a Dry Measure = 62 l) of pure wheat was 30 florins, of mixed grain 25 florins and barley was at 15 florins a Pozsonyian bushel.

October

... (**Grape-harvesting**) On the 12th, grape-harvesting began and was scanty. Namely, some people, brought in all the crop in two-three baskets from where they had been gathering 30 to 40 pails the previous years, therefore the wine price was high, 20, 25 and 30 florins a pail.

(**Corn-picking**) On the 20th, corn-picking began and was also scanty because of lack of rain in August, ...

Rain. On the 25th, it started to rain, and after the rain, which lasted one day, people could plough and sow, if they had seed.

November

... **Snow and cold.** On the 22nd, the first real snow fell and cold started, which lasted and froze the ground ...

December

Freezing weather. On the 2nd, it began to snow and on the 3rd it stopped. ...

Flour price. This month the price of wheat flour rose to 24 and 25 groschen, an "oka" (a Weight Measure = 1.54 kg), of corn meal to 45 kreuzer, the same as rye flour. ...

Year 1817**January**

Snow melting. Early in the month, when the south wind started blowing, ice and snow began to melt, but when the west wind started blowing, cold and snow took over ... On the 23rd, the south wind started blowing, snow melted, pleasant days set in, like the first days of March, and these continued till the end of the month.

February

Warm days. They even continued to the 12th, when rain started, mixed with snow, but the next day was bright. ...

Warm month. This month was warm with the sun shining ...

March

To the 20th, warm, so that people could plough fields, carry out vernal sowing, work in their gardens and sow.

Rain with ice. Today, snow and ice began to fall; cold set in and continued till ... (discontinuance)

June

Rain. The end of this month was rainy, but very beneficial.

July

... **Heavy hail.** As for the weather, till the 13th it was fair, and on this day heavy hail fell, not dense, to tell the truth, but as large as bigger hazelnuts. ... The, weather was mutable till the end of the month.

August

... **Rain and hail.** On the 22nd it rained heavily, but in neighbouring places it hailed ...

Year 1818**March**

... Almost throughout this month the weather was fair. ...

July

Hail. On 27th July, vineyards, that were promising a very good yield, were dreadfully beaten by hail. ... (Biber, 1997) ¹⁵

2.8. Location 8

The following few notes come from Osijek. This town is situated on the right bank of the Drava River, near its mouth into the Danube (45°33'41''N, 18°42'09''E; climatic type *Cfb*). In the Capuchin monastery, the chronicle notes were entered by Jovijan Hrvat, from 1803 till 1816.

1814

There was so great scarcity of wine that our monastery had to pay up to 546 florins for 22 pails of wine. ...

1815

The shortage of wine continued, one pail of common Hungarian wine cost 22 florins and over. The wheat price went up; at the end of February 1816, one "kila" (there were two measures: Slavonian kila = 186.7 l and Turkish kila = 393.6 l) was at 60 and more florins, and in April it cost 90 florins. ...

2.9. Location 9

In the same city, there is also a Franciscan monastery. Two notes come from its chronicle:

1813

18th January. The quarterly fair started. There were many sellers but few buyers because of high prices, as well as because of the new banknotes and corrupted money ...

... 26th December. This month was very bad because of frequent rains and ... (Bösendorfer, 1916; Sršan, 1993) ¹⁶

2.10. Location 10

Another source is also reliable, but, for the period concerned, it brings only short notes about the plague. These are the "Annals of the Monastery of Kreševo" (a small town 28 km west of Sarajevo; around 43°52'N, 18°03'E; climatic type *Cfb*), which were probably writ-

ten by the Franciscan friar Anđeo Šunjić, senior. The useful lines are as follows:

Anno Domini 1814

The month of January 1814

This year the plague has started to kill dreadfully – you can easily see it from the death register. ...

Anno Domini 1815

The month of January 1815

This year, too, the plague has reaped with its scythe ...

Anno Domini 1816

... The months of May and June 1816

The plague has not yet stopped killing. May God make this scourge recede from us; have mercy on us, oh, God! ... (Gavran, 2003) ¹⁷

2.11. Location 11

The next short note can be found in the "Annals of church and world events and weather change in Bosnia" written by the Franciscan friar Jako Baltić (1813-1887). He served all his life in the parishes of Central Bosnia (around 44°N, 18°E; climatic types *Cfb* and *Df*). The first part is a compilation of the period from 1754 to 1839, while the second one contains his own detailed witnessing from 1839 to 1882. This is why the years considered are so condensed:

Year 1811

... Derendelia became the vizier of Bosnia, a wicked man, "could there be anything worse in this world, his name recalls turpitude". ...

Year 1815

For three years, three God's scourges followed each other – plague, famine and soldiery. Quite a number of people starved, not in the parts of Travnik but in Dobretići and Kotor. The plague swept off four thousand souls, or better said: persons, in the parish of Travnik. All of Europe on a war footing. ... (Baltić, 1991) ¹⁸

2.12. Location 12

More to the west and south, on the Adriatic coast, there are several sporadic but useful

¹⁵ Biber, 1997, 210–239.

¹⁶ Bösendorfer, 1916, 235; Sršan, 1993, 132, 135, 332.

¹⁷ Gavran, 2003, 256–259.

¹⁸ Baltić, 1991, 73, 74.

records. A parish priest and headmen of Vir (a village 24 km northwest of Zadar; 44°18'10"N, 15°05'07"E; climatic type *Csa*) addressed the following desperate warning to the local authorities:

(12th March 1812)

*... This people is in great destitution because of hunger, all of them are needy and cannot live, and if the king does not feel pity on this people and if he does not give them food, this people is going to starve ... (Peričić, 1980)*¹⁹

(The king, mentioned in the letter, was Eugene Beauharnais, Napoleon's stepson and puppet viceroy of Italy.)

2.13. Location 13

Friar and then superior of the Franciscan monastery in Sinj (a small town 27 km north-east of Split; 43°42'10"N, 16°38'14"E; climatic type *Cfa*), Josip Glunčević chronicled for about fifty years – until 1822. Of his work, however, only a few last years survived. I. Marković, who turned over the leaves of the chronicle as late as the 1890's, narrates in his book about the 1816 famine (Marković, 1898).²⁰ Among other things it was interesting to excerpt the lines describing the weather during the visit of Emperor Francis I in 1818:

... (The emperor) was acquainted ... with the sad history of this monastery afflicted by war, famine and plague as well as an earthquake ...

... (The emperor) had 500 florins doled out to the poor, but there were few inhabitants of our district; those who were from other territories – Omiš, Imotski, Poljica, were more numerous, about 300.

All the time, while our Emperor Francis was in Split, from the 12th up to the 18th, we were exhilarated by everyday rain because scorching heat and drought had been burning for many days.

In Sinj, Francis arrived on 18th May, and proceeded from there on the 19th; it was cloudy with moderate rain, then, on the 20th, there was moderate rain again, and a north wind rose, ...

*But the queen left the port of Split on the 20th and set out for Dubrovnik, and nobody knew which day she would arrive there because the cold north winds whipped the sea and our land during those days. ... (Franciscan library)*²¹

2.14. Location 14

L. C. Pavišić (1851), describing the plague in Makarska (a small town 52 km to the south-east of Split; 43°17'38"N, 17°01'33"E; climatic type *Csa*) noted in July 1815:

*... In such circumstances, two months passed since the plague began, (on 17th May) without experiencing two successive good days anywhere. Foggy and cloudy continually, the bare mountain now hot, now foggy, the Moon hazed, and hot and annoying winds blew from the south; rain did not stop so that the roads were muddy, ... (Pavišić, 1851)*²²

2.15. Location 15

Romić, the parish priest of Bagalovići (a village 108 km to the southeast of Split;

43°01'24"N, 17°35'34"E; climatic type *Csa*), who kept the parish accounts book, made an entry which runs:

*... In the name of God, in Krvavac, on 6th August 1817, let it be known that this year I did not collect alms for the Church of the Blessed Mary because of two reasons, as follows: first, because of the great famine, ... (Jerković, 1939)*²³

2.16. Location 16

Further southwards, the death register of Ponikve (a village about 46 km to the north-west of Dubrovnik; 42°50'57"N, 17°37'16"E; climatic type *Csa*) gives evidence that the famine there, in 1817, was as terrible as it was in Istria. So, we read:

*... On 28th April, ... Jelena Balović, ... aged about 27; she was found dead by starvation, in the middle of the road near the small village of Duba, together with her son Nikola, about 2 years old. ... (Stipetić and Vekarić, 2004)*²⁴

¹⁹ Peričić, 1980, 4.

²⁰ Marković, 1898, 67.

²¹ Franciscan library in Sinj, MS. X

²² Pavišić, 1851, 31.

²³ Jerković, 1939, 23.

²⁴ Stipetić, Vekarić, 2004, 66.

There are many more incidental notes about weather and its consequences. For instance, French Marshal Auguste Marmont, during his campaign in May 1809 against the Austrian troops in the northern mountainous part of Dalmatia, mentioned diluvial rain (Marmont, 1856–1857).²⁵ On the other hand, the Swiss botanist Germar gave, parenthetically, evidence of food shortage in the Dalmatian highlands in 1811 (Germar, 1817).²⁶

3. CLIMATE AND VOLCANOES

Not only the geographical, but also the historical and societal characteristics of the Croatian lands make their climate scientifically interesting. Using data from the standard period 1961–1990 and following Köppen’s climatic classification we see that almost the entire territory of these lands is covered by two types of climates: *Cf* (temperate humid climate) and *Cs* (Mediterranean climate). Islets of *Df* (humid boreal climate) on the highest mountain peaks of the Dinaric Alps are only an exception. But the subtype *Csa*, with pronounced summer drought and mild wet winters forms a very narrow belt stretching from northern Dalmatia, along the coast, to its southernmost part, including the islands. The shore of Istria and part of the Dalmatian highland belong to the *Cfa* belt (temperate, humid, hot-summer climate), which, in many respects, compares with the width of *Csa*. The rest, i.e. the entire hinterland, belongs to *Cfb* (temperate, humid, warm-summer climate) (Penzar and Penzar, 2000; Šegota and Filipčić, 2003).²⁷ In this paper, every location of documentary evidence has been denoted climatically. What was the weather like, or better, what climate types did these areas belong to two hundred years ago?

Although there is disagreement not only in its duration, but also in the appropriateness of its name, the “Little Ice Age” (LIA) survived as an appellation for the period characterized by weather anomalies – cold winters being its more characteristic feature than cool summers. But it is also true that the LIA was not unchanging, just the opposite, it was charac-

terized by longer and shorter fluctuations. Additionally, although the LIA affected the whole of Europe, we have also knowledge of its regional variations (Grove, 1988; Jones and Mann, 2004; Matthews and Briffa, 2005).²⁸ As regards the first decades of the 19th century, they are considered without exception to be part of the LIA. What were the essential characteristics of this “Age” in Croatia? First of all, the periods of coldness were prolonged so that they occurred not only in winter, but also during autumn and spring. On the other hand, the Croatian lands experienced recurrent dry periods, too. But both of these weather extremes were not always of the same intensity, duration and spatial extent (Kužić, 1999).²⁹ This only confirms that sub-regional heterogeneity must not be disregarded.

Further, there is agreement about volcanic aerosol being an important forcing factor which governs climate change. To say the truth, scholars are divided over the timescale of radiative forcing from volcanoes. Taking into account the cumulative effects of eruptions, the greater part concedes an annual rather than a decadal scale of cooling (Rampino et al, 1988; Robock, 2000).³⁰ After having been spread in 1808/09, the X-volcano’s aerosol began to absorb and backscatter solar radiation causing the cooling of the lower troposphere and the earth’s surface. This could have (maybe) been dispersed when the Tambora eruption occurred in April 1815 and its aerosol blanketed the globe, continuing and reinforcing these weather anomalies. Some studies estimated an average temperature decrease of about 0.2 to 0.5°C or 0.4 to 0.7°C in the period considered (Fig. 2). This pattern may be exactly recognized in 1809 (texts 6, 7) as well as in 1816, in each of the three Istrian summarized texts (1, 2, 3) as well as in the two more detailed Slavonian chronicles (6, 7). But, during the second winter, both Istria and Slavonia enjoyed more-than-mild weather, which was interrupted by a wave of cold in April, while in Istria it deteriorated into drought (3, 6, 7). All in all, there is enough

²⁵ Marmont, 1856–1857, 139.

²⁶ Germar, 1817, 121., 145., 155.

²⁷ Penzar, Penzar, 2000, 222.; Šegota, Filipčić, 2003, 33–36.

²⁸ Grove, 1988, 411–419.; Jones, Mann, 2004; Matthews, Briffa, 2005

²⁹ Kužić, 1999, 375–398.

³⁰ Rampino, Self, Stothers, 1988; Robock, 2000

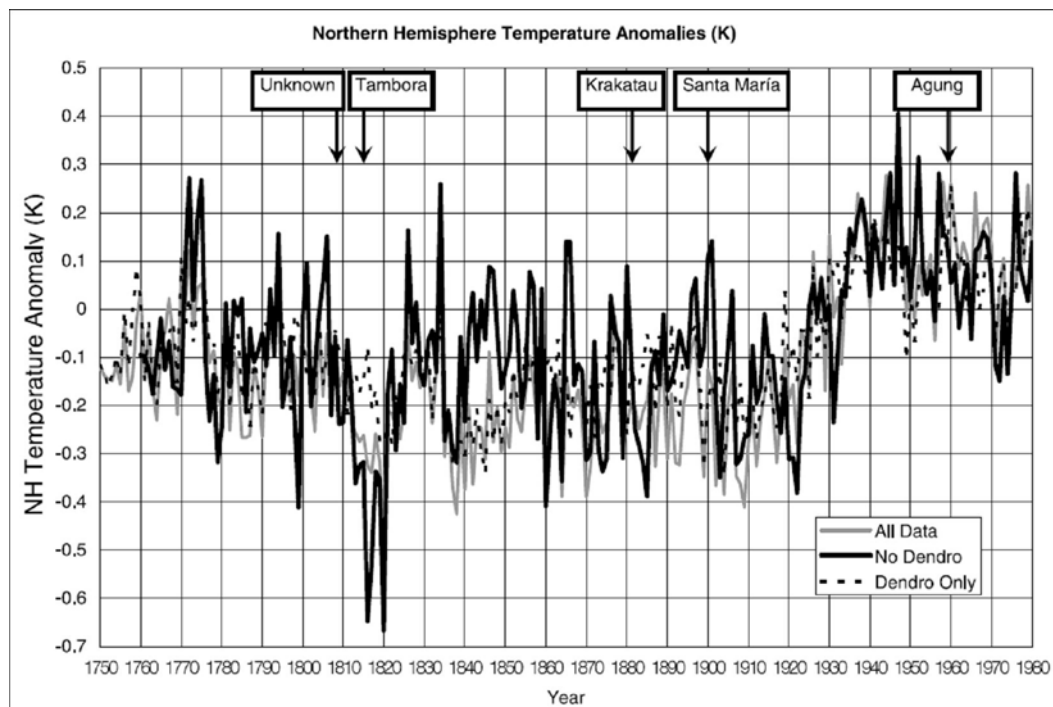


Figure 2. Temperature minima on the Northern Hemisphere caused by the Unknown and Tambora volcanoes (Mann et al., 1998; Robock, 2005).

Slika 2. Temperaturni minimumi na sjevernoj hemisferi koje su uzrokovali nepoznati vulkan i vulkan Tambora (Mann i dr., 1998; Robock, 2005).

Table 1. Basic weather characteristics of the individual regions during the period 1809-1818 according to descriptive sources.

Tablica 1. Osnovne vremenske prilike u pojedinim područjima u razdoblju 1809–1818. prema opisnim izvorima.

Year	Istra	NW Croatia	Slavonia	Dalmatia
1809			severe winter, cold January, rainy autumn	rainy May
1810			cold spring	
1811				
1812			cold winter	
1813	severe winter, cold and freezing from autumn to spring	rainy autumn	rainy December	
1814	severe winter, cold and freezing from autumn to spring			
1815	severe winter, cold and freezing from autumn to spring		rainy July and rainy from September to November	foggy, cloudy, rainy weather with south wind (<i>jugo</i>) in late spring
1816	severe winter, cold and freezing from autumn to spring, rainy year		cold February, rainy March, cold spring	
1817	dry January-mid April, snow at the end April, dry year		warm January and February, rainy summer	
1818				north wind in May

similarity between the same phenomena in distant regions (Tabs. 1–2).

Inundations deserve particular consideration because they do not always correspond to local weather circumstances, i.e. precipitation. The water level of both rivers mentioned in the Slavonian chronicles, the Sava and, especially, the Danube, whose springs, or the springs of their upper tributaries are in the Alps, (which is out of the scope of this paper)

depended mostly on the weather circumstances in those regions.

Interestingly and strangely, excepting Pavišić (1851), who mentioned foggy weather incidentally, the other chroniclers did not notice any kind of optical phenomena, such as coloured sunsets, dimmed sun or moon, although they ordinarily mentioned all astronomical apparitions. The description by Pavišić (1851) is in accordance with the same phenomena that

Table 2. Review of extreme weather events during the period 1809–1818 according to descriptive sources.

Tablica 2. Pregled ekstremnih vremenskih događaja u razdoblju 1809–1818. prema opisnim izvorima.

Date	Location	Weather description
1809		
25 January	Slavonski Brod	thunderstorm with strong hail
2 April	Slavonski Brod	thunder, lightning, rain with hail
August	Slavonski Brod	drought
From 28 September	Slavonski Brod	rain and the severe Sava flood
November	Slavonski Brod	continuous rain and the severe Sava flood
From 22 December	Slavonski Brod	mostly rainy and terribly muddy
1810		
3-25 February	Slavonski Brod	cloudy and cold
11 June	Slavonski Brod, Gromačnik, Varoš	hail
1813		
17 November	Slavonski Brod	the Sava flood
1814		
25 January	NW Croatia	thunderstorm with strong hail
September	Slavonski Brod	the Sava flood
1816		
26 January, 7 pm	Šaregrad	strong wind
29 January-4 March	Šaregrad	very cold weather
12-26 March	Šaregrad	rain with snow and the great Danube flood
30 March	Šaregrad	snow and severe cold
20 April	Šaregrad	spring frost
28 June, 4 pm	Šaregrad	shower of rain with hail which lasted half an hour
16 July, 4 pm	Šaregrad	hail
26 July, 6 pm	Slavonski Brod	storm and hail with hailstones as big as walnuts
August-7 September	Slavonski Brod	warm and dry weather, drought
1817		
12 March	Šaregrad	snow and cold with strong wind
10-12 April	Šaregrad	cold strong wind
13-14 April	Šaregrad	snow with strong wind
1-9 May	Šaregrad	warm
18 June	Šaregrad	heavy rain and severe wind causing great damage
13 July	Slavonski Brod	strong hail with hailstones as big as hazelnuts
22 August	Slavonski Brod	heavy rain and hail in neighbouring places
1818		
27 July	Slavonski Brod	hail
27 September, 8 pm	Šaregrad	storm with hail

were noted in other places (Lamb, 1970; Stothers, 1984).³¹ Thus, it is very likely to be related to the Tambora eruption.

4. BAD CROPS AND FAMINE

It is easy to understand the relation between weather, on the one hand, and both farming and cattle-breeding, on the other.

As can be seen from our sources, even in Slavonia, renowned for its abundance in cereals, there was shortage of food. This province, called “the granary” by all states which it was part of, went through its worse years in this time. It was not only food shortage – it reached real famine forms so that the local demographic effects do seem to have been serious. The proverbial flexibility of the peasants, who either changed crop or fell back to pig-breeding, proved to be ineffectual this time – everything failed, even the acorn crop (Gavrilović, 1977).³² What was most unfavourable for a grain-producer? Beyond question, it was continual rain during harvest time. It usually causes mouldiness, and this is just what occurred in 1809 and 1815. The second concern was an extended snow-cover, which postponed sowing time. The combination of a cool and dry spring was particularly harmful because it inhibited plant growth as the case was in 1810, 1812, 1816 and 1817. In the central and eastern parts of Slavonia, grape production, as one of the main substantial crops, was affected, too. Because of wet weather during ripening time, the yield came to naught, or wine was just a sour liquid (see 1809 and 1816). Besides, vineyards were damaged by frost or they were hail-beaten for several years successively (1809, 1810, 1817 and 1818).

Cattle suffered in two ways. Directly, it perished either in floods or of severe cold (1809 and 1816). Indirectly, it was affected by lack of roughage – especially hay for ruminants. When the year was extremely dry (as it was in 1809) or extremely rainy (1815 and 1816), the breeders could not prepare enough fodder for winter feeding. In pig-breeding, according to ancient usage, pigs were outside, in oak-woods, in summer so that no provender was

needed. Only in autumn they became more dependable on barley and corn. Although the course of weather in central Croatia was rather similar, the situation was much worse because the soil was generally less fertile, and, besides, this area was more populous than the other lands. Usually, when grain crop failure occurred, farmers could rely on the wine harvest and on production of wine, but, however, if late summer was too wet for the vine (as it was in 1813) this sequence of anomalies caused dearth and even famine (Antoljak, 1955).³³ The potato, that could have relieved dearth, was an unknown plant. As infrastructure was not yet developed, land transport was slow and too expensive. Furthermore, it was impossible to get supplies from abroad because between this area and the sea ports lay French territory, i.e. a state of war.

With the exception of Bosnia, the worst situation was in Istria and Dalmatia. It is visible from historical sources that most of the inhabitants of Istria were very vulnerable to weather anomalies, especially the peasants (Bertoša, 1989).³⁴ It can not be said that they did not try to diminish the consequences of extreme weather events. Learning from experience, farmers cultivated two or more kinds of crops in different patches of land in order to avoid total harvest failure. But this method was successful only in cases of local adverse weather, like hail. When an anomaly was of larger scale or when a sequence of anomalies occurred, the peasantry faced real distress. Severe conditions in some parts of Istria were noted as early as 1809, when the grain harvest failed. A few bad years followed, which afflicted also other districts – as already mentioned, wine suffered in 1813, and live stock perished of extreme cold in the same year. Then, after one or two milder years, evil years followed for three years consecutively. In all of Istria there was no wine, no olive oil, no grain, nor garden vegetables, and live stock had already been decimated. They could neither get grain from the Po River Valley (a traditional market for Istria) because it was also affected by weather.

Being notorious as a region of endemic famine, Dalmatia was going through an expe-

³¹ Lamb, 1970, 432, 512; Stothers, 1984

³² Gavrilović, 1977, 60, 71, 73, 77, 83.

³³ Antoljak, 1955, 94, 96, 126.

³⁴ Bertoša, 1989, 21, 23, 25.

Table 3. Official grain prices in the district of Split in the years 1817 and 1822.

Tablica 3. Službene cijene žita u splitskom okrugu u godinama 1817. i 1822.

	1817	1822	RATIO
grain (wheat)	8 f(lorins) 15 k(reuzer)	3 f 35 k	2.3:1
rye	5 f 45 k	2 f 37 k	2.2:1
barley	4 f 19 k	1 f 29 k	2.9:1
oats	3 f 54 k	1 f 11 k	3.3:1
millet	5 f 43 k	1 f 47 k	3.2:1
kind of millet (<i>holcus thorgum</i>)	3 f 09 k	1 f 10 k	2.7:1
corn	5 f 10 k	1 f 55 k	2.7:1
horse-bean	7 f 00 k	2 f 24 k	2.9:1

rience of intense misery among the poorer classes. The first in a series of crop failures – the one in 1809 - caused famine in the following year, in some parts of the region. By the end of the period considered, conditions were more and more unendurable (Marković, 1898; Peričić, 1980).³⁵ First of all, the percentage of arable land in Dalmatia was the lowest in all the lands. We should also be aware that two agricultural zones existed there: the coastland with the islands and the highlands (or hinterland), defined not only by climate and inherited usage but also by state decree. Venetia, which ruled there up to 1797, prohibited viticulture in the Dalmatian highlands so that wheat and corn were the only crops there. These zones should have been a complementary pair because highlanders were grain producers and cattle breeders while wine and olive oil were almost the only crops in the coastland. It was because of this conservatism that both coastland and highland peasants became much more vulnerable to bad weather so that this picture was often gloomier. Therefore, prolonged cold winters and rain during the grain harvest season had the same effect as in Slavonia. At the same time, long periods of cold weather and long-lasting snow covers postponed the removal of cattle from winter folds to summer mountain pastures. Extended drought and particularly cold winters often killed a large part of the cattle stock (Kužić, 1999).³⁶ For this reason, sheep and goat breeding was predominant, although ox-

en were the main draught and plough animals. All in all, since the grain harvest was hardly ever sufficient, people were directed to Ottoman Bosnia and its surplus of cereals. But when crop failure was of a larger scale, costly grain had to be imported from Russia or the Levant. This time, owing to political circumstances, people were hopelessly left to shift for themselves. After the French were driven out, the seaways became accessible so that famine in Dalmatia could be relieved by shipments from the Russian Black Sea ports. It could, but not everywhere, because the poor had no money to buy victuals. Thus, during his journey to south Dalmatia, Emperor Francis I had to be convinced of their wretchedness by witnessing with his own eyes to people kneading bread from bark (Pavišić, 1851).³⁷

A comparison of *official* grain prices between the bad year of 1817 and the good year of 1822 in the district of Split (Tab. 3, the measure is Venetian *staio* = 83 l) (Morović, 1977):³⁸

Finally, it should be emphasized that, since the potato was unknown in the Croatian lands until the time of French rule, it did not gain such significance as it had in Central European countries (Pfister and Brázdil, 2006).³⁹

5. DISEASES

The plague (*Yersinia pestis*) is one of most devastating diseases in European history. Since it had been introduced in the Croatian lands in

³⁵ Marković, 1898, 67, 68; Peričić, 1980, 4, 5, 20, 24.

³⁶ Kužić, 1999, 375–398.

³⁷ Pavišić, 1851, 42.

³⁸ Morović, 1977, 168.

³⁹ Pfister, Brázdil, 2006

1348, it did not stop appearing until its last catastrophic outburst in 1814/18. Although it raged much too often, pestilence had never an endemic form, but it usually sneaked in partly through commercial relations, partly as a consequence of military operations (Frari, 1840; Berić, 1950; Hrabak, 1989).⁴⁰ The plague mentioned in these records had been waiting at the door for almost a year – in 1813 it appeared in the central Balkans, coming from Constantinople. It is obvious that this pandemic should be connected to the eruption of the X-volcano in 1808/09. This lag of three or four years is not unusual, since the plague needed to spread from its endemic lair in the Near East.

So, it was the escort of the newly-appointed Bosnian governor, Ali-pasha Derendeli, who brought the deadly germs into Bosnia. The disease was smouldering until the pasha's soldiery crushed the rebels in 1814, marauded, and carried away their infected goods and chattels all over the province. But we have at least one report according to which tradesmen and smugglers also contributed to the spreading of plague. (Hajdarhodžić, 1975).⁴¹ As soon as it became known, the authorities in Slavonia and Dalmatia set up a blockade, localised single cases and, all in all, it seemed that the epidemic would be stopped at the other side of the frontier. But a sequence of bad harvests urged a lot of people from Dalmatia to barter in infected regions. The weather helped them, as well. Since it rained continuously, the carstic fields and plains were flooded so that some parts of the borderland were under no control. Eluding the blockade, barterers carried over the plague into the coastland of Makarska, where it burst out in spite of all countermeasures. However, with the greatest difficulty, by enforcing an absolute quarantine from May to September 1815, the government prevented a catastrophe.

Two figures, adduced for what they are worth, show the proportion of the death rate from the number of inhabitants in the city of Makarska and in the village of Tučepi (Dalmatia). We know, for instance, that the population of Makarska, which numbered 1,575 inhabitants, diminished to 1,025, while Tučepi lost 363 per-

sons out of 806 (Pavišić, 1851; Marković, 1898; Jerković, 1939).⁴² Not to mention the already quoted death toll in a parish in Bosnia.

From these examples, it can be stated with confidence that this epidemic swept off more than half of the townsfolk and probably a quarter of the peasants in Bosnia. What speaks in favour of this estimation? First of all, in Ottoman Bosnia there was neither organized sanitary service nor educated physicians. Second, neither government nor local authorities enforced any kind of protecting measures – not even when the disease was prevailing. The reason for that was a state of anarchy, as well as the peculiar fatalism related to the Moslem religion. Last, but not least, town dwellers could not easily get away as opposed to villagers who, if they made it, escaped to the woodlands and grasslands.

Finally, even in cases where the rate of death, which may be inferred from annals, is quite incredible, it must not be disclaimed as an exaggeration. According to contemporaries, as well as recent scholars, there were about 500,000 fatalities (Hajdarhodžić, 1975).⁴³ The sanitary and demographic catastrophe which befell Bosnia in the years 1814–1818 had no parallel in other European countries since the Black Death in the years 1347–1351.

Not every region suffered as badly as Bosnia. Although Istria and Dalmatia were regions known by endemic malaria, there can be little doubt that the death-rate trend, moving sharply upward in the second decade of the 19th century, was caused by weather – especially by winter extremes. As we can find in a number of works (economic, demographic, as well as in local histories), the year 1817 was the most calamitous. Having been tortured by hunger, Istria and Dalmatia were mostly being subjected to “trivial” diseases, which were nothing less perilous because of malnutrition and the weakened immune system of the population. In Istria, spotted typhus, dysentery, tuberculosis and fevers raged, and even common parasitic diseases became more lethal than usually. The same situation, or not much better, was in the other lands and regions (Ra-

⁴⁰ Frari, 1840, 296-299, 776-779.; Berić, 1950, 1-5.; Hrabak, 1989, 19-33.

⁴¹ Hajdarhodžić, 1975, 232-235.

⁴² Pavišić, 1851, 7, 10, 11, 32; Marković, 1898, 66, 67; Jerković, 1939, 23.

⁴³ Hajdarhodžić, 1975, 247, 248.

dossi, Pauletich, 1975–1976; Gavrilović, 1977; Peričić, 1980; Bertoša, 1989).⁴⁴

6. POLITICS AND SOCIETY

First of all, in order to give some insight into the political framework, it must be emphasized that in 1809 the Croatian lands and regions considered were divided between three, or two hostile empires, respectively. The French conquered Istria and Dalmatia in 1806 and southern central Croatia in 1809. As part of the universal belligerence, the British fleet and the pirates at its service blockaded the Adriatic coast. Confiscating and sinking ships, they made the shipment of victuals impossible not only for the French soldiery but also for the local population (Oršić, 1943).⁴⁵ Thus, every failed crop caused distress i.e. famine. The authorities were trying to help, but everything was insufficient, because the army had the advantage not only of food but also transportation. Having been blocked at sea, the French troops and the local population were forced to build roadways. After Napoleon was thrown out, Vienna regained Istria and Dalmatia in 1814, while keeping their sovereignty in northern central Croatia and Slavonia. At the same time, Constantinople (mis)ruled in Bosnia and Herzegovina. Thanks to their bureaucratic machinery, the Austrian court knew that weather incidents foreshadowed illness. But, instead of helping post-war recovery, the Court persisted in the existing artificial and inefficacious administrative division so that the situation was critically aggravated (Antoljak, 1955).⁴⁶ Thus, facing disaster, they tried to combat its effects but were not prepared to make the right moves. All was reduced to the desultory distribution of grain and the persecution of vagrants and offenders. The Court became seriously frightened when they learned that a large number of people had been moving to Ottoman Bosnia. It is necessary to mention that parts of Croatia and Slavonia along the border with Bosnia were under military administration as the Military Frontier. In normal circumstances the Military

Frontier stored and/or imported victuals to prevent shortage during periods of war or adversity. This time the stores were empty, which can be explained as evidence of war exhaustion, and, finally, the state went bankrupt and paper money was worthless. So, trying to show himself/themselves in a better light, emperor Francis I (1792–1835) visited the plagued and neglected provinces in 1816, 1817 and 1818 (Franciscan library; Antoljak, 1955; Radossi and Pauletich, 1975–1976; Peričić, 1980; Bertoša, 1989; Biber, 1997; Pfister and Brázdil, 2006).⁴⁷

Among the lands under Austrian rule, Dalmatia, and especially the city of Split, suffered long-term damage because the government prohibited commercial relations with Bosnia, scared by a possible epidemic, so that at a certain time the busy port of Split became lethargical and remained in such a state for the next three decades (Peričić, 1993).⁴⁸

On the other side, Bosnia had not even the sultan's sympathy – the newly-assigned Bosnian governor was only in charge of breaking the neck of rioters, the sooner the better. Having done this ruthlessly, he was recalled – in other words – condemned to death. Nobody in Constantinople really cared about their subjects from this distant province. The Sublime Porte left the disaster to recover spontaneously.

In every single Croatian land, the peasantry was the most numerous class of society. Their status was quite different; thus, in northwestern Croatia and in most of Slavonia the peasants were villeins, bound to the earth, in the Military Frontier they were free landowners but also soldiers for life, in Istria they were share-croppers. In Dalmatia there were partly share-croppers, partly free (serving the local militia) and partly villeins. Christian peasants in Bosnia did not own the land on which they lived and, moreover, they were legally second-class subjects.

It could not be said that there was no social solidarity. A closer insight into the sources gives evidence that, even between different classes

⁴⁴ Radossi, Pauletich, 1975–1976, 322, 323.; Gavrilović, 1977, 85, 87; Peričić, 1980, 24, 25; Bertoša, 1989, 23, 25, 44.

⁴⁵ Oršić, 1943, 322, 323.

⁴⁶ Antoljak, 1955, 124–127.

⁴⁷ Franciscan library in Sinj, MS. X; Antoljak, 1955, 94, 96, 126.; Radossi, Pauletich, 1975–1976, 323; Peričić, 1980, 4, 5, 20; Bertoša, 1989, 7; Biber, 1997, 231; Pfister, Brázdil, 2006

⁴⁸ Peričić, 1993, 129, 130, 148, 149.

as well as between the city and the village, social solidarity was practiced. But it was neither organized nor of long duration and thus, it was not efficient enough. On a local scale, the peasants helped one another as long as they had anything to share. Some great landowners, having estates in distant regions, provided victuals for the villeins; the country clergy waived the tithe, etc. An example of salutary support is the shipment of 12.000 pounds of bread sent by the merchants of Trieste to the starving inhabitants of the Makarska region in 1815. However, in many other cases, the merchants were remembered for their speculative activities and the impudent prices of grains (Pavišić, 1851; Oršić, 1943; Gavrilović, 1977; Bertoša, 1989).⁴⁹ The latter noted a case in Istria where the craved grains from the stores had been exported by merchants to Spain.

7. DEMOGRAPHICAL DATA

With the intention of obtaining some exact data, a number of tables of death and birth rates from the different Croatian lands and regions are presented (Bertoša, 1989; Gabričević, 1984; Gabričević, 2002; Krivošić, 1991; Ivasović, 2001; Bezić-Božanić, 1984; Andreis, 1998; Krivošić, 1990).⁵⁰ The first censuses were conducted in both military organized areas in order to provide military information (the number of males for conscription) as early as the 1500's and general censuses were not undertaken until the last quarter of the 18th century. The population of Bosnia was never listed individually until the end of the Ottoman rule. Since the existing censuses in the other lands were irregular in space and time, they proved not very useful. Hence, it was found that church registers were the best sources of statistical data, including the series of crises which, without exception reinforcing one another, stroke the whole population in each and all the lands, both village and city. However, it

is noticeable that death-rate peaks as well as birth-rate bottoms do not correspond either in time or in magnitude. The main difference is in magnitude but this is just the difference between country and cities. Whenever and whichever actions were undertaken, the countryside was more neglected than the cities. The second difference, in time, is the consequence of the environment. It is obvious that crises in the country were either smaller or had a time-shift depending on soil quality.

The similarity between regions is also obvious. The pattern of mortality from famine was age-specific: the older and the younger the individuals, the more likely they were to die (Bertoša, 1989).⁵¹

Some tables differ greatly and should, therefore, be explained separately. The great mortality peak in Varaždin in 1806 is to be connected with the passing through of a large number of sick soldiers who infected the local population with some kind of typhus-like disease (Gabričević, 2002).⁵² In Dubrovnik, an enormous death-rate peak occurred in 1806 when the city was standing the merciless siege of the Russians and the marauding Montenegrins. The death-rate increase in 1817 is slight, compared with the other tables, which may be explained by the city's importance and its favourable littoral position that made food delivery easier (Krivošić, 1990).⁵³ The table of the village of Kaštel Stari shows two mortality peaks – the first one is even higher than the second one in 1817. The increased death rate in 1812 was caused by a typhus-like disease that carried off weaker persons so that the disastrous year of 1817 started with a reduced population base. During these years, the little place of Komiža on the island of Vis changed three rulers, which influenced local demography. The first peak occurred during the French rule. The following low death-rate lev-

⁴⁹ Pavišić, 1851, 29.; Oršić, 1943, 87, 110.; Gavrilović, 1977, 65, 68, 72, 78, 80; Bertoša, 1989, 6, 31, 50.

⁵⁰ A-Gračičće,

B-Piće, Bertoša, 1989, 16, 37;

C-Župa Brdovec, Gabričević, 1984, 283, 296;

D-Varaždin, Gabričević, 2002, 189, 190, 210;

E-Križevci, F-Križevci-sela, Krivošić, 1991, 189, 190, 210;

G-Kaštel Stari, Ivasović, 2001, 160, 161;

H-Komiža, Bezić-Božanić, 1984, 61;

I-Veli i Mali Drvenik, Vinišća, Andreis, 1998, 235;

J-Dubrovnik, Krivošić, 1990, 125, 126, 139, 140.

⁵¹ Bertoša, 1989, 23.

⁵² Gabričević, 2002, 188.

⁵³ Krivošić, 1990, 115, 116.

Table 4. Number of born and deceased persons in the Croatian lands in the period 1806–1820.

Tablica 4. Broj rođenih i umrlih osoba u hrvatskim krajevima u razdoblju 1806–1820.

YEAR	1806	1807	1808	1809	1810	1811	1812	1813	1814	1815	1816	1817	1818	1819	1820
A - GRAČIŠĆE															
BORN					34	41	44	50	30	35	46	22	31	59	47
DECEASED					59	27	17	19	24	39	23	96	16	11	13
B - PIČAN															
BORN					65	69	51	65	56	35	58	26	41	88	66
DECEASED					63	48	36	32	38	40	34	185	23	40	23
C - PARISH OF BRDOVEC															
BORN	93	153	143	127	120	146	133	139	113	120	74	83	101	154	147
DECEASED	178	120	91	91	130	105	113	80	190	106	179	184	112	85	76
D - VARAŽDIN															
DECEASED	654	258	207	279	298	194	300	292	226	283	458	331	221	199	232
BORN	205	336	244	292	273	333	268	334	304	275	260	208	281	318	318
E - KRIŽEVCI															
BORN	42	83	65	59	45	68	56	74	72	62	64	47	63	75	66
DECEASED	98	103	52	66	83	31	83	53	44	68	124	56	52	46	45
F - KRIŽEVCI - VILLAGES															
BORN	78	70	77	79	51	88	76	87	81	59	59	39	102	101	109
DECEASED	73	49	49	40	40	38	63	54	78	63	130	74	69	55	80
G - KAŠTEL STARI															
BORN	22	20	35	26	23	27	22	14	22	20	18	13	20	20	17
DECEASED	25	14	17	13	17	35	52	35	33	19	20	40	16	11	14
H - KOMIŽA															
BORN	44	71	72	77	67	63	57	67	70	61	60	26	38	74	74
DECEASED	48	21	79	28	37	34	26	40	26	26	76	124	62	20	36
I - VELI AND MALI DRVENIK, VINIŠĆA															
BORN	31	27	25	31	39	21		19	35	35	37	22	27	27	41
DECEASED	30	9	33	20	23	28		11	20	33	27	105	24	22	16
J - DUBROVNIK															
BORN	140	127	160	167	125	97	108	76	70	117	94	78	74	85	86
DECEASED	269	88	70	88	66	82	84	77	115	70	91	108	81	57	62

el was a feature of the period when this island was a British naval base and a market for confiscated shiploads. The second peak, i.e. the rude reality, appeared shortly after the island was returned to Austria in 1815.

What about war losses? The participation of soldiers from the Croatian lands in both the French and the Austrian army is confirmed, but they were mostly Military Frontier dwellers. Therefore, the losses in the other regions were not so high to be recognizable from the total death-rates. Furthermore, since the birth-rate value was influenced not only by nutritional factors but also by the absence of

males who were of military age, it is less significant for our conclusions.

Finally, it is evident that the deadly synergy between famine and infective diseases explains why the population in the Croatian lands that did not directly participate in the Napoleonic wars declined.

All locations mentioned in the diagrams are showed in Figure 1.

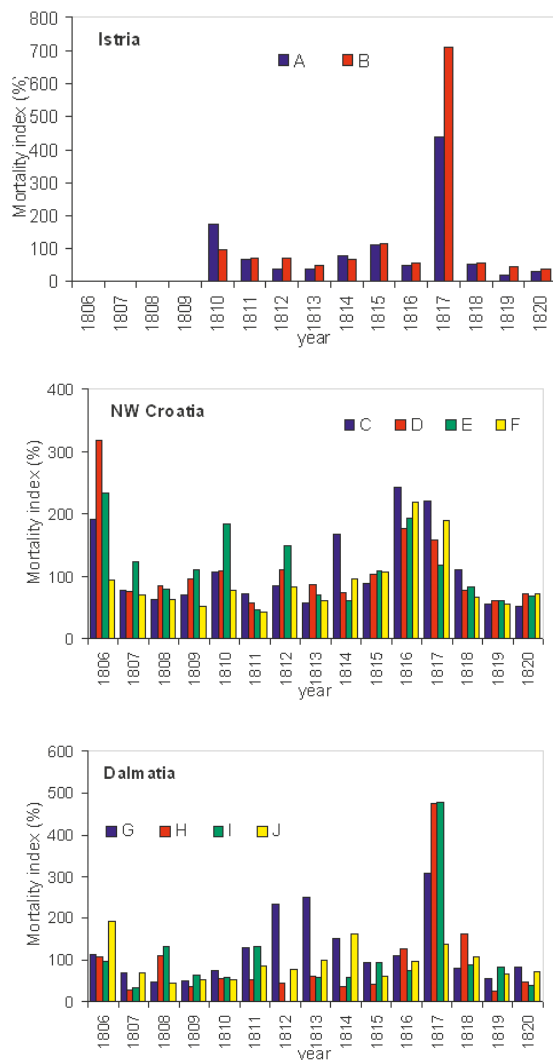


Figure 3. Mortality growth as a consequence of volcano eruptions, extreme weather conditions, famine, diseases and societal events in the Croatian lands in the period 1806–1820.

Slika 3. Povećanje smrtnosti kao posljedica vulkanskih erupcija, vremenskih ekstremnih prilika, gladi, bolesti i društvenih prilika u hrvatskim zemljama 1806–1820.

8. CONCLUSION

At the beginning of the 19th century the Croatian lands, as part of Europe, i.e. the northern hemisphere, were still ruled by the “Little Ice Age”. Although during this period not all the areas were uniformly weathered, i.e. geographical and temporal variations were apparent, the years following 1809, and especially 1815, were characterised by pretty the same anomalies all over Europe. The results of research in recent decades concede the conclu-

sion that volcanic eruptions have been an important cause of weather and climate variations on timescales ranging from days to years depending on their characteristics. In this case, it is more than obvious, because two very large eruptions were registered at the time – the first one in 1808/09 of an unknown volcano and the second one in 1815 of the Tambora volcano in Indonesia. The gases ejected into the stratosphere and transformed into aerosol affected both hemispheres and brought about several years of disrupted weather patterns, most notably colder and wetter weather in Central Europe and the Mediterranean. Doubtlessly, the first to be vulnerable to weather extremes were agriculture and cattle-breeding – that is to say, the rural milieu. Moreover, it was enough to experience two or more successive harvest failures and the whole society was in distress. After or during famine, the next link of the misery chain was usually a variety of epidemic diseases.

The Croatian lands at the beginning of the 19th century had a typically pre-industrial economy. Due to their relatively undeveloped infrastructure, as well as due to internal political hindrances, food distribution was a serious problem. The cities and towns, even those on the Adriatic coast, were modest in size so that most of the population lived off agriculture production, not only peasants but also, though indirectly, owners of large estates and merchants. In some regions, the main agricultural product was bread-grains, in others wine and oil, and all of them were, as said, very susceptible to weather extremes. Thus, the whole society was extraordinarily vulnerable. But this was not the only cause. The advent of hunger indicates an anomaly in society as well, because sustenance crises result from the interaction between nature and society. The war is an anomaly in itself, but it is the state strategy and efficiency, if they exist at all, which are more responsible. In the lands under the Austrian rule we met reactions of two kinds. In case of famine, the authorities proved to be only palliative, but in the case of plague they reacted promptly and with an iron fist. It may be true that they feared the loss of soldiers and tax incomes. In Ottoman Bosnia and Herzegovina there was just nothing to prevent the catastrophe. Anyway, both cases provide a clear picture of the situation in the relevant states.

Both Š. Peričić and M. Bertoša took a significant step when taking into consideration climatic anomalies as a factor which any common historian, let alone an economic historian, must not lose sight of. But knowing some of these volcanologists' works I have tried to point out that the volcano eruptions considered were the true originator, namely, the first ring of a calamity chain. If this hypothesis is correct, the universal, domino effect on weather, agriculture, epidemics and politics, is far-reaching, elevating the potential role of volcanism to a fundamental weather-forcing factor and demonstrating the tight link between nature and human affairs in the Croatian lands and regions (Fig. 3.). Having translated all available historical proxy data such as: chronicles, reports, memoirs, epitaphs and death-register entries, I hope they will be useful in future research. Without regard to inter-annual and interdecadal considerations, future work should also deal with the analysis of weather extremes such as heat/cold waves, droughts, floods, etc. in this part of the Mediterranean and in Central Europe and their socio-economic impacts. This would diminish the obvious European regional unbalance in historical climatology.

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