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Reconstitution of the Climate in the Municipality of Guimarães (Northern Portugal): A Regional Approach Based on Historical Information and the Record of Measured Data

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Abstract: Climate change is a global phenomenon that has become a focus of concern for society, mainly due to its impacts on daily lives. Despite being a global issue that affects the entire planet, these effects are not felt in the same way in all regions, so the analysis of processes from a regional or local perspective allows a better adaptation of populations to the new reality, as well as being used as a supporting tool for decision making when implementing mitigation measures. For the present analysis, a region in Northern Portugal was chosen, which is in the Mediterranean region, considered one of the hot spots for climate change. In this region of Entre Douro e Minho, more specifically in the municipality of Guimarães, the climate of the last centuries was reconstructed based on documentary information and recent data collected and modeled for the region under study. The results show a successive alternation of hot and dry periods with colder and wetter ones, where climate instability seems to be the dominant trend over the last thousand years. Currently, with the advent of a new period of climatic instability, which, unlike the periods verified previously, now have an anthropic origin, there is a tendency for a new period to occur, in which conditions will tend to be hotter and drier. Knowing this trend in advance allows informed decisions to be made to mitigate some problems that can be associated with these conditions, such as the increase in the risk of wildfires, the proliferation of invasive species, the decrease in agriculture and forests productivity, or even the occurrence of extreme weather events.

Keywords: climate change; regional change approach; regional impact; climate reconstitution

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1. Introduction

Climate change is a reality that is currently almost unanimously accepted, both by the scientific community and civil society in general [1]. There are several scenarios that scientists presented over the last years, with the dissemination of simulations that range from the wildly optimistic, with minor changes in the climate, to those being completely catastrophic, which are based on the occurrence of extreme events, increasing both in frequency and severity [2]. Recently, global scenarios gained ground, presenting future developments interconnecting and relating the planet as a whole, remembering that climate change is not a problem exclusive to some countries, but rather being a problem affecting everyone, without looking at statutes or preferences [3]. These global models allow us to understand how different parts of the globe will react to global changes and how each geographic region will adapt itself to the new reality [4]. It is already a certainty that climate change will affect the entire planet, but the severity affecting each region is not the same at each moment, with regions feeling already more intensively the effects, while others may even feel some positive actions resulting from the current adaptation processes of the entire system [5]. An example of these alleged regional positive effects is the decreasing severity of the climate during the winter in regions, such as Scandinavia, Northern Canada, or Alaska, allowing the improvement of the conditions for agriculture development in these regions [6–8]. However, similar to what happened in 2021, these changes also increased the risk of large-scale forest fires, such as those that occurred in Alaska, Sweden, and Russia [9–11]. Thus, although it is possible to identify some momentaneous positivity at a regional level, the global panorama seems to be negative, with the effects felt being more harmful than advantageous [12,13].

The analysis of climate change from a regional scale perspective does not seem to be unreasonable at all, since there are several arguments justifying this approach [14]. This proximity perspective allows for the analysis of the specificities inherent to a region and, above all, if included in the climate change evolution models or the creation of regional or local scenarios, may allow, e.g., to support decision making in the adoption of local-level measures for the prevention and mitigation of climate change impacts [15–19]. The dimension of the scope of this analysis can be diverse and adaptable to the objective for which it is intended [20–22].

This regional or local approach implies, for a better understanding of the impacts that climate change may have, to know the climatic past of the region, establishing the sequence of climatic events over the most extended possible period [23–25]. However, in Portugal, the recording of climatic parameters only began continuously and methodically in the 19th century, just in some locations, such as Lisbon and Porto. Therefore, the knowledge of climatic conditions for other regions and the period prior to the beginning of the meteorological records must be conducted indirectly. This situation can be indirectly assessed, e.g., by analyzing historical documents in which descriptions of the climate were recorded, associated with some significant events, such as a battle, or even, as was common in the medieval period until the beginning of the Modern Age, to demand divine intervention to solve problems, such as violent storms or lack of precipitation [26–31]. In other words, this was conducted to solve all kinds of events that could jeopardize the success of crops and, therefore, the livelihood of the populations [32]. Processions, prayers, and masses, with the objective "*ad petendam pluviam*" or "*ad petendam serenitate*", were often recorded in the archives of churches and religious orders, usually by registering the payment received for the realization of the religious act, indicating as well its objective or intention, allowing for the inference of the succession of local or regional climatic events, framed by the global knowledge for the historical period, may allow for the reconstruction of the regional climatic scenario [33–38].

The combination of different types of data therefore allows for the reconstruction of the evolution of the climate of a region and, with this reconstitution, to anticipate certain developments, e.g., establishing a relationship between specific climatic conditions with the occurrence of a particular type of event [39,40]. The evolution of the forest in Portugal, which reached the lowest known area in the transition from the 19th to the 20th century, may be related to climatic factors, closely associated with periods of high instability, which occurred in the years immediately after the Little Ice Age, associated with a growing demand for forest-based raw materials and fuels, which gained impetus with the Industrial Revolution in Portugal [41–45]. Establishing a climatic data timeline for the different localities of a region allows for the establishment of a relationship between the specificities of each locality, resulting in the sum of the set of timelines that allows for the detailed characterization of the entire region. For example, for Entre Douro e Minho (Northern Portugal), despite a specific geographical unit between the three districts that make up the region, Viana do Castelo, Braga, and Porto present significant differences between the coastal and the innermost areas.

An approach focused on the different locations in the region allows for the establishment of overlapping areas where conditions are similar, which can be determined using an assumption of continuity while allowing the visualization of the changes across the territory. Therefore, a case study is characterized in this article, for which the municipality of Guimarães is selected (Figure 1). The selection of this territory is due to its geographical location, located at the center of the region, allowing for the establishment of a starting point for creating a characterization network of regional scope, supported by the establishment of climatic history. Thus, information was collected, both based on the historical documentary record, actual climate records, and modeled data, to establish a climate history for the municipality of Guimarães. Subsequently, based on this climate history, processes associated with climate change are analyzed, namely, the perception that populations had over time about climate change.

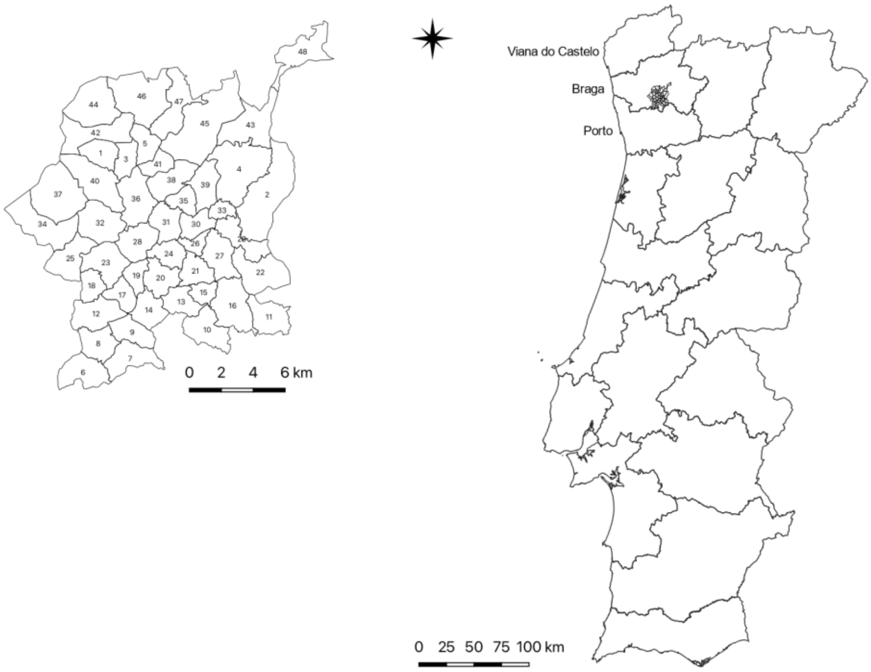

Figure 1. The municipality of Guimarães is in Northern Portugal, in the district of Braga, and is divided into 48 parishes as follows: 1—Sande (São Martinho); 2—União das freguesias de Atães e Rendufe; 3—Caldelas; 4—São Torcato; 5—Barco; 6—Lordelo; 7—Moreira de Cónegos; 8—Guardizela; 9—União das freguesias de Conde e Gandarela; 10—União das freguesias de Tabuadelo e São Faustino; 11—União das freguesias de Serzedo e Calvos; 12—Serzedelo; 13—Polvoreira; 14—Nespereira; 15—Pinheiro; 16—União das freguesias de Abação e Gémeos; 17—Selho (São Cristóvão); 18—Gondar; 19—Candoso (São Martinho); 20—União das freguesias de Candoso São Tiago e Mascotelos; 21—Urgezes; 22—Infantas; 23—Selho (São Jorge); 24—Creixomil; 25—Ronfe; 26—União das freguesias de Oliveira, São Paio e São Sebastião; 27—Costa; 28—Silvares; 29—Mesão Frio; 30—Azurém; 31—Fermentões; 32—Brito; 33—Aldão; 34—União das freguesias de Airão Santa Maria, Airão São João e Vermil; 35—Penselo; 36—Ponte; 37—União das freguesias de Leitões, Oleiros e Figueiredo: 38—União das freguesias de Prazins Santo Tirso e Corvite; 39—União das freguesias de Selho São Lourenço e Gominhães; 40—União das freguesias de Sande Vila Nova e Sande São Clemente; 41—Prazins (Santa Eufémia); 42—União das freguesias de Sande São Lourenço e Balazar; 43—Gonça; 44—Longos; 45—União das freguesias de Souto Santa Maria, Souto São Salvador e Gondomar; 46—União das freguesias de Briteiros São Salvador e Briteiros Santa Leocádia; 47—União das freguesias de Briteiros Santo Estêvão e Donim; 48—União das freguesias de Arosa e Castelões.

2. The Historical Evolution of the Climate in the Region of Entre Douro e Minho

2.1. Framework

To characterize the climate in the Entre Douro e Minho region, which comprises the districts of Porto, Viana do Castelo, and Braga, and where Guimarães is located, the lack of data allows an appreciation of the conditions in more remote times. However, this assessment can be inferred by using indirect data, such as documentary records, which describe extreme meteorological events in several situations, or that are outside the average climate. Examples are found in the processions "*for the weather*" registered in the region and in Galicia, which, given the geographical continuity, suffers the same events, with populations acting in the same way. In the absence of measured data, which only began to be collected in the mid-19th century, these descriptions and events allow a glimpse of the evolution of the climate on a regional scale.

2.2. Prehistory—Middle Age

The characterization of the climate in the long period between prehistory, mainly from the Bronze Age to the historical period corresponding to the barbarian invasions, is, in fact, very scarce in references, with no records that can be considered as enlightening. For example, Strabo (63 BC–24 BC), in the Book III of his "*Geographia*" (translation by Deserto and Pereira (2016), available at https://eg.uc.pt/handle/10316/44662, accessed on 3 January 2022), does not present concrete references to the climate of the region, presenting only a few references to the physical characterization of the territory, reporting at a certain point that the western region of the peninsula located North of the Tagus River is "*a fertile region and crossed by large and small rivers, all of them flowing from the eastern parts, parallel to the Tagus*". With this statement, it can be inferred that the availability of water in the territory was abundant, and, perhaps, it can be imagined that the climate could be wetter than the climate of the Mediterranean coast of the peninsula and even the one verified in the inner regions of the peninsula, where the distance to the sea and the mountain ranges would make it difficult for moisture to enter and for precipitation to occur. Strabo refers to the Lusitanians and Galicians as peoples who predominantly inhabited the mountains, from where they devoted more time to plundering than to agriculture, most likely because it would be difficult in places with poor soil and with more difficult access to water. However, nowhere in the work of Strabo can there be found any climate description of any part of the Iberian Peninsula.

With the arrival of the Romans, these native populations were forced to abandon the "*Castros*", located on the top of the mountains, and went to inhabit the lower and flatter areas of the valleys, which were also more fertile, where they began to follow a more Romanized livelihood, and where agriculture became the main activity of the populations [46–48]. Although without references, probably, the prevailing weather conditions during the period of the Roman occupation of the peninsula remained stable, similar to what probably occurred during the Bronze and Iron Ages [49]. In the Roman period, archaeological finds abound, evidencing widespread agriculture practices, with the installation of the "*villae*" as preferential settlement units for the occupation of the territory, which is at the genesis of the most significant urban centers in the region, as is the case of Guimarães [50]. However, the field of hypotheses continues since there are no direct descriptive references about the prevailing climate in these periods. Later, in the period corresponding to the end of the Roman Empire, coinciding with the arrival of the barbarian hordes to the Iberian Peninsula, there are some references to the climate, albeit very incipient and recorded much later. Bernardo de Brito, General Chronicler and Monk of the Order of S. Bernardo, in his work "*Monarchia Lusitana*", in the Second Part (consulted the version edited in Lisbon at the Monastery of São Bernardo, in the year 1609, available in the digital collection of the Biblioteca Nacional de Portugal, at http://purl.pt/14094, accessed on 9 January 2022), presents some references. For example, Chapter XVII of Book V refers to "*the entry that people from Germany made into Portugal and other parts of Spain*", referring to the period when the Vandals, Suevi, and Visigoths arrived in the Iberian territory. The author, reporting how these peoples entered the region of Galicia and Northern Portugal, stated that "*the Germans dwelt in these parts for nearly twelve years, and there were many, who, being fond of the climate and fertility of the land, allowed themselves to be settled in it, first as lords, and after the Romans returned to charge it, subjects like any other of the natives*". This reference, which goes back to the end of the 4th century or the beginning of the 5th century, seems to indicate a good climatic condition, favoring agriculture. In Chapter III of Book VI of the same chronicle, the wars between Ataces, King of the Alans, with Hermeneric, King of the Suevi, and the arrival of Atawulf, King of the Goths, are described, "whose weapons feared as invincible, and much more the old hatred with which they persecuted each other, to which was added that they found the place and climate improved from everywhere else they had seen after leaving their lands". Once again, the author briefly refers to the climate. These few references indicate some climatic stability, with favorable conditions for agriculture and the settlement of populations in the region. The same must have occurred during the period of the Muslim occupation of the peninsula, which began in 711 ACE. During this period, there are no references to the Entre Douro e Minho region, where there was no real implantation of the new lords, but rather a succession of incursions and looting, keeping the agrarian structure in the previous format, so that a certain continuity of climate stability could be assumed. The developments and prosperity achieved in the following years in the rest of the Iberian Peninsula during the Muslim occupation are well known, which would have hardly been achieved without the assumed climate stability.

2.3. The Medieval Warm Period

The Medieval Warm Period almost superimposes with the Reconquest of the Iberian Peninsula by the Christian armies, which in the Northern region initiated practically immediately after the invasion [51,52]. For some authors, the Medieval Warm Period can be framed between the years 800 to 1200 ACE, as is the case for Broecker (2001), while, for others, such as Crowley and Lowery (2000), the Medieval Warm Period is in between the years 1000 and 1300 ACE, but that does not seem to be a very relevant issue at all [53,54]. However, it is the occurrence of this period that justifies, for example, events, such as the colonization of Iceland and Greenland by the Scandinavians, as reported by Hughes and Diaz (1994), Kuijpers and Mikkelsen (2009), or Ogilvie and Jónsson (2001) [55–57].

These climatic conditions, apparently more favorable for the Nordic peoples, can also be indirectly inferred by the activity of those peoples, for example, in the repeated attacks performed over three centuries on the European coasts, where they attacked communities and monasteries, which were filled with riches, along with prosperity based on agriculture. For example, this supposed prosperity in regions in the British Isles would only be possible with a marked improvement in meteorological conditions. Moreover, these are not the usual characteristics of a markedly Atlantic climate located so far up North. Thus, it is entirely expectable that the climate would be warmer and drier than in the preceding period, characterized by specific climatic stability. Thus, it is very likely that, in the Mediterranean region, the effects of the increase in temperature and the decrease in precipitation led to periods of drought. In the case of the Northwestern regions, where the Entre Douro e Minho is located, the conditions have not significantly worsened. Even the temperature rise potentiated a particular improvement to the observed conditions and benefited some crops, such as vines and cereals.

2.4. The Little Ice Age

The Little Ice Age is a period of climate change, defined by some authors as occurring between 1250 and 1850 ACE, as is the case for Crowley et al. (2008), while other authors, such as Brönnimann et al. (2019), point to an interval between 1350 or 1450 and 1850 ACE, with several authors agreeing that volcanic eruptions triggered the process [58,59]. This period is characterized by being more humid and colder than the previous one. There are several references to extremely cold occurrences registered in this period, for example, the military campaign from 30 January to 15 February 1658, historically known as the March Across the Belts (in Swedish, *Tåget över Bält*), where the Swedish army invaded the Danish islands, crossing the frozen sea and occupying a group of islands using the hardships of winter [60].

Perhaps one of the first references to the Entre Douro e Minho region emerges in the História Seráfica da Ordem de Frades Menores de S. Francisco na Província de Portugal, written by Manoel da Esperança and published by António Craesbeck de Mello, in 1666.

The author describes, in Chapter V of the Second Part, the foundation of a convent in 1360 (http://purl.pt/20706, accessed on 13 December 2021), stating that, "in the primacy of Braga, where the Bishopric of Britonia previously confined, now known only by the name preserved in the parish and place of Bertiandos, are achieving incomparable favours from the Author of Nature in the freshness, fertility and climate of one of the famous villages of Entre Douro e Minho, called Ponte de Lima". Apparently, in 1360, the hardships of the climate did yet not seem to have affected the region. However, this apparent verified stability seems to have significantly changed in the following centuries.

In the case of the Entre Douro e Minho region, the upcoming centuries were marked by profound variability, with an alternation of periods characterized by climatic extremes, with periods where high precipitation events predominated, interspersed with periods of severe droughts. These periods were identified by Silva (2019) through the analysis of existing documentary records in several locations in the Entre Douro e Minho region, namely, in Guimarães, where the author identified the existence of "*pro pluvial*" and "*pro serenitate*" processions, where the inhabitants implored the Divine for the rain to fall, or, in the opposite situation, for the sun to shine when the periods of excessive precipitation did not allow for the ordinary course of agricultural work [61]. The author divided the periods covered by his research, focused on the interval from 1600 to 1855, into different phases, depending on the occurrences described in the historical documents, summarized in Table 1.

Table 1. Periods depending on the occurrences and the climate conditions in the Entre Douro e Minh (adapted from [61]).

Time Period	Climate Status
1600–1625	Climate normality
1626–1679	Heavy rainfall
1680–1716	Alternating periods of intense cold and episodes of drought
1717–1731	Climate normality
1732–1781	Strong rainfall variability
1782–1789	Heavy rainfall
1790–1827	Strong rainfall variability and episodes of intense cold
1828–1841	Heavy rainfall
1842–1855	Strong rainfall variability

From the data presented in Table 1, it can be observed that climate variability lasts for about 250 years. This inference is mainly supported by the permanent difficulty in ensuring the success of crops, being imaginable by the occurrence of scarcity periods for the populations, which must indeed be at the origin of much of the immigration that occurred during this period to the most diverse parts of the Portuguese Empire, with Brazil leading the search for a destination where the living conditions could be better. This period seems to have been marked by several periods of scarcity that were recorded, for example, by António José Ferreira Caldas, in his work edited in 1881, "*Guimarães: Apontamentos para a sua História*" (https://www.csarmento.uminho.pt/site/s/arquivo-digital/item/93797, accessed on 24 January 2022), in which the author states that "*in 1855, feeling in Guimarães a great shortage of necessities, the municipal council, in a session of April 2, asked the authorization of the government to take out a loan, half for public works and the remaining to purchase grain, which would be sold to the population without profit*".

The period between the end of the Medieval Warm Period and the beginning of the Little Ice Age was characterized by significant instability and climatic variability caused by alternating meteorological events. This transition period, in addition to the difficulties caused by climate variability, was also buffeted by the arrival of the Black Death, which peaked in the years 1347 to 1352 ACE, causing millions of casualties in Europe [62]. Regarding this period, no records allow for a more accurate assessment of the state and evolution of the climate, so it can only be inferred, indirectly, based on historical events, such as the occurrence of pandemic outbreaks, or the analysis of social events, such as popular uprisings caused by the carelessness with which populations were treated by their rulers.

2.5. The Modern Period (1855–2004)

The most extended series of available meteorological data in Portugal are those corresponding to Lisbon, which began in December 1855, and remains under continuous monitoring to date. These data can be consulted on the IPMA website (Instituto Português do Mar e da Atmosfera, https://www.ipma.pt/pt/oclima/series.longas/list.jsp, accessed on 20 December 2021). However, it does not seem to be convenient to use this data series to assess the climate of the Guimarães region, since the distance of approximately 350 km and the evident differences between the climate types would have been altered right from the beginning, with an increment in the parameters, such as the temperature in Lisbon. At the same time, regarding the precipitation, it was expected that, for the Entre Douro e Minho region, higher values could be found. In this way, and in the absence of data in a closer region, the data referring to Porto in Serra do Pilar (Vila Nova de Gaia) was collected uninterruptedly from January 1863 onwards. These parameters, once again, primarily at minimum temperatures, but also maximum temperatures, since the dominant wind from the North quadrant in summer, locally known as "Nortada", has a significant effect on the thermal sensation, should contribute to a more negligible difference in the calculation of the average temperature between the two locations.

This same assumption was already established at the beginning of the 20th century by João Monteiro de Meira, in a monograph entitled "*O Concelho de Guimarães*", presented in 1907 to the Escola Médico-Cirurgica do Porto (https://www.csarmento.uminho.pt/site/s/arquivo-digital/item/93894, accessed on 20 December 2021), where the author compared the meteorological data obtained in Porto since, as he says, "in Guimarães there is no observatory that could provide the necessary meteorological data", so he used the data collected in Braga by Professor Rev. J. Kempf at Colégio do Espírito Santo. The author justified this use "given the extreme proximity of the two cities, and the analogy of their geographical situation". Subsequently, João de Meira compared the data with those collected by Ricardo Jorge, also a physician who, from an early age, devoted himself to studying the impacts of climate on the health of populations. Additionally, Paul Choffat, in 1904, in a report on the water supply to the city of Guimarães, resorted to the data collected by Professor Rev. J. Kempf, referring to the author in his report that "not knowing meteorological observations in the city, I had to go to Professor Rev. J. Kempf, from Colégio do Espírito Santo in Braga, who since 1888 made these daily observations in that city" (https://www.csarmento.uminho.pt/site/s/rgmr/item/54219#?c=0&m=0&s=0&cv=0, accessed on 20 December 2021).

From the data available from Serra do Pilar, daily observations were made continuously from 1 January 1863 until 2004. An exception occurred in 1920 and 1921, where there were months without any record. With the daily data, the monthly average values were calculated for the maximum, minimum, and average temperatures, and the monthly cumulative rainfall. The annual average values for temperatures and cumulative values for precipitation were subsequently calculated based on these calculations. Figure 2 shows the evolution of annual average temperatures from 1863 to 2004. For 1920 and 1921, the average values of the previous five years and the five subsequent years were used to complete the missing data.

As can be observed for this period of 141 years, the average annual temperatures follow a trend, since, in the first years, roughly until 1899, the temperature shows a successive downward tendency and approaches the average, which is 14.48 °C. However, from 1900 onwards, and until roughly the beginning of the 1980s of the 20th century, the temperature seems to follow a constant and stable tendency, with little or even no variability around the mean, which changes from 1989, in a very marked way, with the progressive increase in the annual average temperatures, indicating a tendency of increase in the temperatures that were notoriously verified since that moment. Figure 3 shows the projection of data referring to the cumulative annual precipitation.

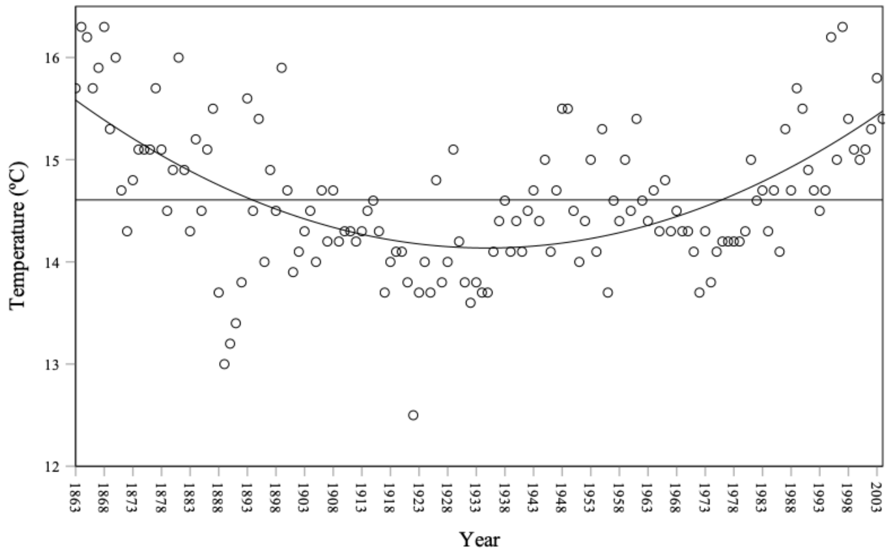

Figure 2. Projection of annual average temperatures for 1863–2004 (adapted from https://www.ipma.pt/pt/oclima/series.longas/list.jsp, accessed on 20 December 2021).

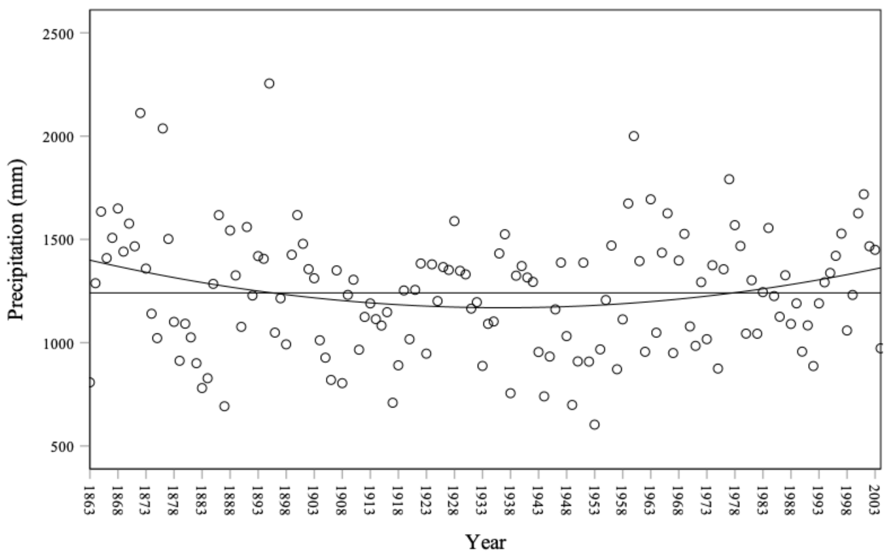

Figure 3. Projection of cumulative annual precipitation for 1863–2004 (adapted from https://www.ipma.pt/pt/oclima/series.longas/list.jsp, accessed on 20 December 2021).

There is a similar pattern from the projected trend curve to the one observed in Figure 2 for the temperatures. There was also more significant variability around the mean, which was 1239 mm for the period in question, with a standard deviation of ±298.12 mm. The maximum value verified was 2255.30 mm, and the minimum value was 603.50 mm; that is, a difference between the extremes of 1651.80 mm.

3. Perception and Concern of the Population Regarding the Climate

People always have a very personal perception of the impacts that changes in climatic conditions have on their daily lives, especially in the most remote periods, when these conditions were decisive to the success of agricultural activity. This direct relationship between climate stability and agriculture was extensively addressed by Silva (2019). The author makes a careful analysis of the documents from several archives, where those of the *Colegiada da Nossa Senhora da Oliveira* (Guimarães), in which there were dozens of processions, prayers, and masses requesting divine intervention to calm the bad weather when it exceeded in time and severity, but also when the lack of rain foretold the failure of the crops. Another author from Guimarães, a devout defender of local history and curiosities, devoted a significant part of his life to collecting many of these records and listing them. Alberto Vieira Braga, in 1943, published "*Cercos e Clamores*", which is part of a larger work entitled "*Curiosidades de Guimarães*" (available for consultation in the library of the *Sociedade Martins Sarmento*, Guimarães, Portugal), presenting an extensive list of these events, demonstrating the importance that climate had for the daily living of populations, which were dependent on the success of crops for their subsistence (Table 2).

Table 2. List of processions, prayers, and masses held to ask for divine intercession to improve weather conditions from the 16th to the 20th centuries, recorded by Alberto Vieira Braga, in 1943, in the work "*Cercos e Clamores*".

Parish	Date	Motive
Real Colegiada de Nossa senhora da Oliveira	21/09/1663	Procession *pro tempore*
	s.d./12/1751	Procession and prayer for convenient weather to collect the fruits that perished in the fields with the heavy rain
	09/05/1831	Prayers to ask for the Sun because all the lands needed to be ploughed
	19/11/1838	Prayers to ask for the Sun because the harvests were about to be completed
	01/10/1841	Prayers to ask for the Sun because the copious rains did not allow the harvests to occur, and many grapes were lost because of the great winds
	29/06/1843	Prayer for God to reveal the Sun
	23/10/1846	Prayer for God to reveal the Sun
	30/07/1847	Prayer for God to reveal the Sun
	03/09/1854	Procession because of the calamities of time
	29/04/1876	Procession *ad petendam pluviam*
	06/1893	Procession *ad petendam pluviam*
	08/1908	Procession *ad petendam pluviam*
	06/1928	Procession *ad petendam pluviam*
	08/1929	Procession *ad petendam pluviam*
	06/1933	Procession *ad petendam pluviam*
S. Domingos	17/10/1737	Prayer and procession to lessen the rains that lasted for so many days to collect the fruits that were in danger of being lost
	08/08/1744	Prayer because of the sterility and dryness of the weather, and for the lack of rain, indispensable for the ripening of the fruits
	11/05/1775	Prayers for the calamity of the weather and changing prices of groceries
	27/07/1780	Procession to appraise the wrath of God
	24/09/1845	Procession to ask for good weather
	17/09/1854	Procession *ad petendam pluviam*
	12/08/1898	Procession because of the drought
	18/08/1901	Procession because of the drought

Table 2. *Cont.*

Parish	Date	Motive
S. Francisco	09/10/1822	Procession asking for the Sun
	05/10/1835	Prayers for the bad weather to cease
	10/09/1854	Procession *ad petendam pluviam*
	11/07/1898	Procession *ad petendam pluviam*
Misericórdia	s.d./s.m./1595	Procession *pro tempore*
	s.d./09/1601	Procession *pro tempore*
	s.d./09/1635	Procession *pro tempore*
	02/10/1822	Prayers because of the heavy rain that prevented crops from being harvested
	22/05/1831	Prayers for raining for more than two months
	14/10/1836	Prayers for God to produce good weather
	26/06/1870	Procession *ad petendam pluviam*
	18/07/1887	Procession *ad petendam pluviam*
Campo da Feira	11/09/1768	Procession because of the lack of sunshine to harvest the crops
	23/07/1780	Prayers and procession *ad petendam pluviam*
	29/09/1787	Prayers and procession for the great need of the Sun
	22/10/1822	Procession asking for the Sun to allow harvesting
	20/08/1824	Prayers for the drought
	03/06/1831	Prayers to ask for the Sun
	03/10/1845	Procession to ask for good weather
	11/08/1847	Procession *ad petendam pluviam*
	10/11/1859	Procession *ad petendam pluviam*
	19/08/1864	Procession *ad petendam pluviam*
	24/04/1868	Procession *ad petendam pluviam*
	09/07/1868	Procession *ad petendam pluviam*
	22/06/1870	Procession *ad petendam pluviam*
	27/04/1879	Procession *ad petendam serenitatem*
	23/04/1879	Procession *ad petendam pluviam*
	02/08/1898	Procession because of the drought
S. Sebastião	29/04/1829	Procession because it was sunny for three days
São Roque da Serra	26/01/1840	Procession for God to allow the rain to stop, because it has not stopped falling for four months
	06/10/1841	Procession because of the continuous rains, which did not allow harvesting
	02/01/1842	Procession so that God would reveal the Sun and the crops could be harvested
Azurém (S. Pedro)	05/08/1847	Procession for God to produce rain
	11/07/1898	Procession to ask for the end of the drought

Table 2. *Cont.*

Parish	Date	Motive
Costa (Santa Marinha)	10/09/1875	Procession *ad petendam pluviam*
	09/09/1878	Procession asking for the Sun
	25/04/1879	Procession for God to grant the serenity of time, agitated for more than six months by a wild winter
	17/08/1881	Procession *ad petendam pluviam*
	04/08/1890	Procession for God to produce rain
	27/04/1896	Procession *ad petendam pluviam*
	11/07/1898	Procession *ad petendam pluviam*
	05/08/1901	Procession because of the drought
Creixomil (S. Miguel)	29/05/1831	Procession and prayers asking for the Sun, as there were still many lands to be plowed
	14/07/1898	Procession to ask for the end of the long drought
S. Torcato	05/05/1896	Procession *ad petendam pluviam*
	11/07/1898	Procession asking for rain
Multiple parishes at once	23/04/1821	Prayers because of the rains, which had not stopped for two or three months, preventing farmers from sowing seeds
	03/08/1847	Procession for God to produce rain
	06/05/1896	Procession *ad petendam pluviam*
	26/07/1898	Procession because of the great drought
	18/08/1901	Procession *ad petendam pluviam*

From the analysis of Table 2, it can be observed that there is a succession of concerns with the meteorological conditions occurring in each moment. Requests for divine favors oscillate between opposites, either asking for the rain to stop, or asking for the rain to fall, as a way of responding to the needs related to the success of crops, which guaranteed sustenance (or its lack) for the populations. Alberto Vieira Braga, in the work entitled "*De Guimarães: Tradições e Usanças Populares (da terra, do trabalho, da mulher, do amor, do casamento, da morte, do céu,-vária.)*", published by *Livraria Espozedense Editora* (Esposende, Northern Portugal), in 1924 (https://www.csarmento.uminho.pt/site/s/sms/item/172041#?c=0&m-=0&s=0&cv=0, accessed on 22 January 2022), presented a compilation of the popular sayings commonly used in Guimarães. As can be seen in the work in question (pages 426 and after), there is a significant number of popular sayings referring to the months of the year and their climatic characteristics, also presenting indications of their connection to agriculture (Table 3).

Table 3. Popular sayings collected by Alberto Vieira Braga in his work "*De Guimarães: Tradições e Usanças Populares*".

Popular Sayings	Month	Indication/Meaning
Good days in January will be paid off in February.	January and February	The lack of rain in January prevents the growth of plants, harming the crops.
For part of February, save some firewood.	February	Indication of the occurrence of cold episodes during February.
When it does not rain in February, there is no good meadow and no good rye.	February	Another association of the occurrence of precipitation with crops.
Water in March is worse than a stain on the cloth.	March	This time there is an indication of a period when rainfall is harmful to crops.

Table 3. *Cont.*

Popular Sayings	Month	Indication/Meaning
Brown and windy March makes the year beautiful.	March	The designation "brown" can indicate the occurrence of cloudiness and mist, indicating some precipitation. Very useful for watering crops in full growth.
Save bread for May, firewood for April, and the best firebrand, for the month of Saint John.	April, May, and June	Reference to cold episodes in April.
Weak is the May that does not break a crust.	May	The indication that it is common to rain in May.
Weak is the May that does not burn a chip (oak chip).	May	Indication of the occurrence of cold periods in May.
Brown May, a year full.	May	The same meaning used for the previous popular saying.
End of August, it gives the cold on the face.	August	The indication of the cooling of the final days of August, indicating the approach of the end of summer.
In August, boil the corn on the cob.	August	The indication of common occurrence of periods of high temperatures in August.
Wherever the year goes, the month of August will heat up.	August	The indication of natural heating during the month of August, which corresponds to the peak of the summer.
In September, the mountains burn, and the springs dry up.	September	Clear indication of a period of warm temperatures and the absence of precipitation.
If in October is taken time to plough the land, it will have little to barge.	October	The indication that, in October, the rains begin and that, after this, harvesting cereals become difficult.

As can be inferred from the popular sayings collected by Alberto Vieira Braga, there seems to be a tendency towards certain meteorological events, which allowed the creation of a certain constancy in the organization of agricultural practices. The author, probably because he did not find any relevant information on the subject, does not reveal anything about the period in which these popular sayings emerged, which resulted from the empirical knowledge of the populations acquired during the final period of the Little Ice Age, consolidating itself throughout the 18th and 19th centuries, being therefore common and current at the beginning of the 20th century, when the author gathered the information. It should be noted that some of these popular sayings are still widely known in Guimarães and, most likely, in neighboring territories. The prayers presented in the same work by Alberto Vieira Braga used to calm the weather shall also originate from the same period, as is the case of the two prayers presented in Table 4: one to calm the thunderstorm and another to mitigate the rain.

Table 4. Prayers uttered to calm the thunderstorm, dedicated to Santa Bárbara, and another to calm the rain, dedicated to Jesus Christ, both collected by Alberto Vieira Braga in his work "De Guimarães: Tradições e Usanças Populares".

Prayer to Santa Barbara to Calm the Thunderstorm	Prayer to Ask for the Sun
Santa Barbara got dressed and put on shoes, and walked away, Our Lady found and asked her: Barbara, where are you going? -To slow down the thunderstorm, that the sky is excited, send her to the weedy hill, where there is no bread or wine, neither the breath of a baby.	Give us Sun, give us Sun. Oh! My Father. Oh! My Jesus, no matter how much you suffered in the Holy Cross.

When analyzing the perception that people have about the climate, especially those who have higher habilitations and education, and, therefore, a more extraordinary ability to consistently describe climatic conditions, as is the case of parish priests, there is a certain inconsistency regarding the certainty of the content of these descriptions. In 1842, the Municipality of Guimarães launched an inquiry to obtain a characterization of all the parishes. This inquiry contained a paragraph for each parish about the prevailing climate. At that time, Guimarães was constituted by 85 parishes, as mentioned by Alberto Lameiras, in 1998, when he presented the work "*Breves Notas Introdutórias*" in the compilation that makes the "*Inquérito Paroquial de 1842*" (https://www.csarmento.uminho.pt/site/s/rgmr/item/59117#?c=0&m=0&s=0 &cv=0, accessed on 29 January 2022). As mentioned by the author, out of a total of 88 parishes, "*eight currently belong to the municipality of Fafe (Arões, S. Romão, Arões, Santa Cristina and Agrela, Fareja, Freitas, Passos, Travassós and Vila Cova), six to the municipality of Vizela (Infias, Tagilde, S. Miguel, S. João, S. Paio and Santo Adrião) and one to Póvoa de Lanhoso (Sobradelo da Goma). The parishes of Corvite and Lobeira are currently integrated into the parishes of Ponte and Atães, respectively. There are parishes that currently have another name: Matamá is Infantas, Paraíso is Selho, S. Jorge and Pentieiros is Tabuadelo. The parishes of Airão, S. João, Briteiros, Santa Leocádia, Fermentões, Infantas, Matamá, Sande, S. Lourenço, Tabuadelo and Santo Adrião de Vizela did not responded to the survey*". Table 5 presents a compilation of the results of this survey regarding item 2, referring to climate.

Table 5. Results of the survey conducted by the Municipality of Guimarães in 1842.

Parish	Climate Characterization
S. Cristóvão de Abação	The climate is hot in summer and moderately cold in winter, without great cold and humidity, being windy in the higher part of the parish.
S. Tomé de Abação	The climate is cold in winter, with wind, snow, fog, and frost, but even until May, and heat that can be extreme in the summer. Autumn can be comparable to winter, and so can spring, with thunderstorms from the south being fearsome because of lightning and hail.
Santa Maria de Airão	The climate is temperate.
S. Mamede de Aldão	The climate is cold with snow and mists.
Santa Marinha de Arosa	The climate is temperate.
Santa Maria de Atães	Hot weather from spring until the end of the summer. During winter, there is rain, hail, and some mists.
S. Pedro de Azurém	Nothing to report.
Salvador de Balazar	The climate in winter is very cold and windy, with frequent snow and frost, also in the spring, with hail, mists, and thunderstorms. Summer is variable but, when there is no wind, it can be too hot. Autumn is rainy and cold.
S. Cláudio de Barco	The climate is temperate, with hot summers and cold winters.
Santo Estevão de Briteiros	The climate is temperate.
S. Salvador de Briteiros	The climate is temperate.
S. João Baptista de Brito	Winter with cold climate, windy, with frequent snow. Summer can be hot, and autumn can be similar to winter.
S. João das Caldas	The climate is temperate with some wind and thunderstorms.
S. Miguel das Caldas	The climate is temperate, with occasional storms of rain and hail.
S. Tomé de Caldelas	The climate is temperate, windy, and with a long cold season. Thunderstorms may occur in any season, with rain and hail.
S. Martinho de Candoso	The climate is temperate.
S. Tiago de Candoso	Nothing to report.
S. João Baptista de Castelões	The climate is temperate.
S. Miguel de Cerzedo	Nothing to report.

Table 5. *Cont.*

Parish	Climate Characterization
S. Martinho do Conde	The climate is cold and humid.
Santa Maria de Corvite	The climate is temperate.
Santa Marinha da Costa	The climate is temperate.
S. Miguel de Creixomil	The climate is temperate.
Salvador de Donim	The climate is temperate.
S. Paio de Figueiredo	The climate is temperate.
Salvador de Gandarela	The climate is temperate.
Santa Maria de Gémeos	The climate is cold, windy, and affected by rain and thunderstorms. Snow and ice can settle in the winter.
S. Pedro Fins de Gominhães	The climate is cold in winter and hot in summer.
S. Miguel de Gonça	The climate is temperate with a cool breeze.
S. João Baptista de Gondar	The climate is temperate.
S. Martinho de Gondomar	The climate is temperate.
Santa Maria de Guardizela	The climate is irregular and undergoes great changes, being hot in summer and cold in winter.
S. Martinho de Leitões	The climate is cold, windy, with snow, hail and frost, not only in the winter season, but even in the spring.
Santiago de Lordelo	The climate is temperate.
S. Vicente de Mascotelos	The climate is temperate.
S. Romão de Mesão Frio	The climate is cold with snow.
S. Paio de Moreira de Cónegos	The climate is cold and humid.
Santa Eulália de Nespereira	The climate is temperate.
S. Vicente de Oleiros	The climate is temperate.
S. Miguel do Paraíso	The winter is cold and, in the summer, the heat is temperate.
S. João Baptista de Penselo	The climate is temperate.
Santa Eulália de Pentieiros	The winter is very cold, with snow, frost, fog, thunderstorms, dew, and hail.
Salvador de Pinheiro	The climate is temperate, but it is very prone to snow, fog, and frost.
S. Pedro de Polvoreira	The climate is temperate.
S. João de Ponte	The climate is temperate.
Santa Eufémia de Prazins	The climate is temperate.
Santo Tirso de Prazins	The climate is temperate.
S. Romão de Rendufe	The climate is cold.
S. Tiago de Ronfe	The climate is temperate.
S. Clemente de Sande	The climate is temperate.
S. Martinho de Sande	The climate is temperate.
Santa Maria de Vila Nova de Sande	The climate is temperate.
S. Cristóvão de Cima do Selho	The climate is temperate, except in winter because it is the colder season with snow.
Santa Maria de Silvares	Nothing to report.
Santa Maria de Souto de Sobradelo	The climate is temperate.
Santa Maria de Souto	The climate is temperate.

Table 5. *Cont.*

Parish	Climate Characterization
Salvador do Souto	The climate is temperate.
S. Salvador de Tagilde	The climate is temperate.
Santo Estêvão de Urgeses	The climate is temperate.
S. Mamede de Vermil	The climate is cold, windy with snow, frost, and hail.
S. Jorge de Cima do Selho	The climate is temperate, except in winter, with frequent thunderstorms.
S. Lourenço de Cima do Selho	The climate is cold, with snow and mists.

This apparent climatic normality reported by the parish priests in 1842 does not allow a perception of the period to which they refer in their short texts. If, in some cases, they seem to carefully explain the climate and its relationship with crops and impacts on agriculture, on the other hand, they seem only to show the will to fulfil the task imposed by the local civil authority, without great care with the information provided. As can be seen in the compiled answers, most of them refer in a very simplistic way to the climate as being "temperate" or "mild", but, on the other hand, in contiguous parishes, there are references to episodes of cold, with snow, and damage to crops. This ambiguity may be related, first, to the lack of knowledge that some parish priests might have about the region because they were newcomers; or, secondly because it was simply a subject that would cause them no interest at all. However, this compilation can be understood as a reliable source of climate on an even closer scale, the scale of the parish.

On the other hand, João Lopes de Faria, also an author from Guimarães, who dedicated himself to the study of aspects related to local history, collected and compiled thousands of events that he considered important in a work entitled "*Efemérides Vimaranenses*" (https://www.csarmento.uminho.pt/site/s/archsms/page/consulta-efem-rides-jlf, accessed on 29 January 2022). In this collection, it is possible to find several references to situations in which the climatic aspects are highlighted (Table 6).

Table 6. Records related to climatic factors collected by João Lopes de Faria in the work "*Efemérides Vimaranenses*" (u.d.: unknown day).

Date	Climatic Factors
03/02/1684	Extraordinary amount of snowfall
11/02/1695	Heaviest snow fall ever observed
11/01/1821	Heavy rain that caused great damage
u.d./01/1826	Very cold month with a lot of snow
20/02/1828	Great thunderstorm
23/02/1838	Great flood of the Ave River caused by a great storm
02/03/1838	Heavy rain
26/01/1840	Heavy rain
u.d./02/1841	Heavy rain causing great damage
21/02/1843	Great thunderstorm
26/03/1844	Heavy rain
13/02/1853	Large amount of snowfall
17/02/1853	Large amount of snowfall
21/03/1858	The atmosphere was covered with hot fog and the light rain began, which lasted two hours.
08/03/1864	Great thunderstorm

Table 6. *Cont.*

Date	Climatic Factors
06/02/1870	A wild hurricane with torrential rain and thunder
25/01/1880	Large amount of snowfall
31/01/1881	Heavy rain
02/02/1883	Heavy rain
22/03/1883	Heavy rain and cold
18/03/1888	Heavy rain
28/03/1888	Snowfall
22/03/1896	Heavy rain
02/02/1902	Heavy snowfall
11/02/1906	Snowfall
01/03/1908	Snowfall
09/02/1912	Thunderstorm
27/01/1915	Heavy snowfall

The apparent succession of events seems, once again, to indicate a certain inconsistency in meteorological phenomena, which can be justified by the transition phase that occurred after the end of the Little Ice Age, as mentioned by several authors, such as Akasofu [63] or Serrano et al. [64]. In fact, this sequence of events that was presented in the previous tables seems totally in agreement with the sequence of events presented by Oliva et al. [41] and which are summarized in Table 7.

Table 7. Phases of the Little Ice Age according to Oliva et al. (adapted from [41]).

Period	Description
1300–1480	Increasing cooling with moderate climate fluctuations
1480–1570	Relatively warmer conditions
1570–1620	Gradual cooling
1620–1715	Period of the coldest climate of the entire Little Ice Age, mainly during the Maunder Minimum, with temperatures approximately 2 °C below the temperatures that are verified today
1715–1760	Warmer temperatures and a lower frequency of extreme events
1760–1800	Weather deterioration and increased occurrence of extreme events (e.g., cold and heat waves, floods, and droughts)
1800–1850	Highly variable climatic conditions alternating with periods of stability
>1850	Gradual rise in temperature

Oliva et al. (2018) referred to the coldest period of the Little Ice Age, which was characterized by the occurrence of droughts, floods, and very severe cold and heat waves, and the post-Little Ice Age period was also characterized by the progressive increase in temperatures, which led to substantial changes in geo-ecological dynamics, mainly by altering directly related and temperature-dependent processes, such as precipitation and wind [41]. It was during this sequence of events that, with the climate as a motto, populations evolved and adapted over the centuries, evidencing in their uses and customs a certain climatic instability, which was verified cyclically [48]. The analysis of past data allows to us envision solutions to the current situation, and can serve to find past practices that, if properly updated and adjusted, could contribute to the mitigation of the problems that nowadays arise, in a climate change scenario with an anthropogenic origin [65].

4. Climate Reconstitution

The process of climate reconstruction is always complex, mainly when it is based on the uncertainty caused by the quality of the available data. If the reconstitution process is based on data collected by measurement, which is only possible in the Modern Era, this reconstitution presents a lower degree of uncertainty. It allows the development of models to analyze the needs of ecosystems and societies. On the other hand, when going back in time, there is no access to measured climatic data, and it becomes necessary to use indirect data, often of a descriptive nature, based on the historical bibliographic record, as is the case in the present work. In this situation, the uncertainty of the climatic reconstitution is great, as several problems can arise, namely, firstly, by the lack of relevant data, or even their total absence, for a given region, and, secondly, because, even when they exist, may be compromised in some way by the lack of rigor with which they were recorded. However, as previously presented by Nunes and Ferreira Dias (2022), interdisciplinarity is essential to advance the study and understanding of climate change, and, above all, from this relationship between the Natural Sciences and the Human Sciences can emerge relevant information for the development of models revealing the evolution of processes [65]. Thus, in Figure 4, the climatic reconstitution for the region under study is presented based on the information collected and previously analyzed.

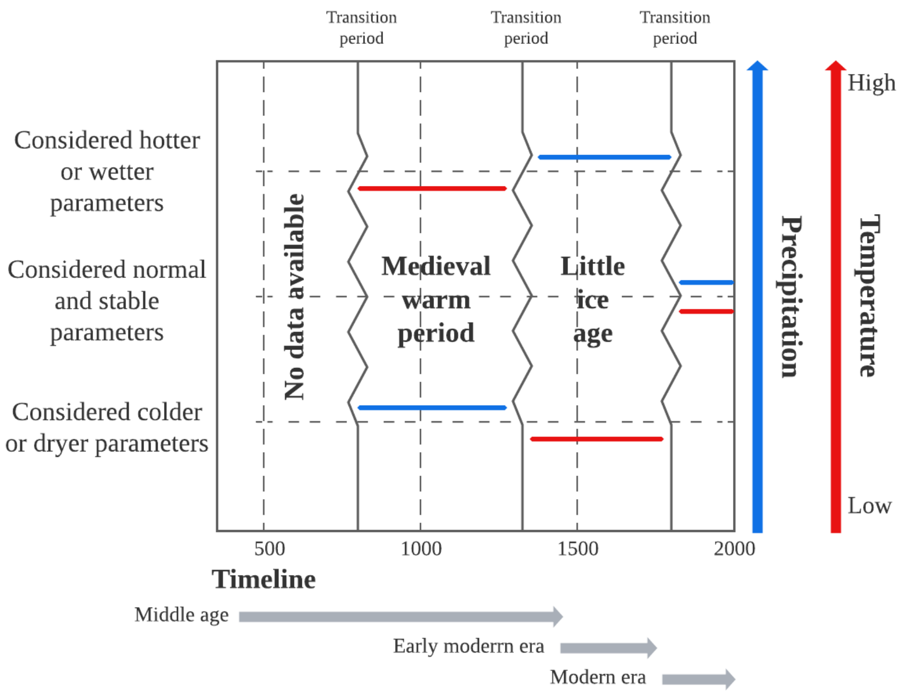

Figure 4. Climate reconstitution from Medieval to Modern Era.

The complete lack of bibliographic data, only possible from the beginning of the Classical Era with the arrival of the peoples from the Eastern Mediterranean Sea to the Iberian Peninsula, does not allow for the classification of the climate of the region in this way. As mentioned earlier, the first descriptions of the Iberian Peninsula are due to Strabo, who does not make any reference to the climate. The description of the inhabitants of the western region of the peninsula, the Galicians and the Lusitanians, as not practicing agriculture but more devoted to pastoralism and supplementing their diet with acorn bread, must be more related to politics, demonstrating how these peoples were barbaric, uncivilized, and, above all, that they did not cultivate wheat, which at the time was the hallmark of Mediterranean cultures. This reference does not indicate that the climate was not predisposed to agricultural practices, since the development that occurred with the arrival of the Romans is well known. This is confirmed in Guimarães by the many "*villae*" founded and which are the basis of the organization of the territory to date. This long period of climate stability, which, in the Guimarães region, would be framed in a Mediterranean-type climate with a strong Atlantic influence, lasted until the 8th or even 9th century, when the region, similar to what occurred throughout the Northern hemisphere, started to have a warmer and drier climate, characteristic of the Medieval Warm Period. This new period lasted until the 14th century, with the climate radically changing, giving rise to the Little Ice Age. During this time, the climate alternated between extremely humid periods with other dry and extremely cold periods, recorded in abundant references, mainly in the 17th and 18th centuries, until the middle of the 19th century. With the end of the Little Ice Age, the records pointed to a period of rising temperatures, but with the occurrence of some more extreme events, such as snowfall and thunderstorms. The 20th century presents itself as a period of climatic stability, practically in its entirety. However, at the end of the 20th century and during the 21st century, there is a tendency towards a new period of instability, with the climate tending markedly towards an increase in the average temperature and a decrease in the precipitation, which is felt more sharply in certain months of the year.

5. Conclusions

Climate change is a current concern of society, mainly due to the global-scale effects that are felt. These processes affect regions of the planet in different ways. However, with the effects being felt differently, the knowledge and understanding of the processes on a smaller scale, of a regional or local type, are necessary in order to make decisions at a local level, in the sense of allowing the adaptation of populations and the normal development of society to the new scenario of climate change. The historical regional climate reconstruction allows for the analysis of how populations adapted to the fluctuations and impacts they have been subjected to over the centuries. The analysis of case studies, such as the one chosen for the present work, allows us to understand that the climate in the region of Entre Douro e Minho, and more specifically, in Guimarães, suffered several fluctuations over the last centuries, alternating between hotter and drier with others cooler and wetter periods. As mentioned throughout the article, it is worth noting that the harshest periods dominated a large part of the time, as evidenced by the numerous documental records analyzed in this study. The changes verified in recent years seem to follow a trend towards a certain climatic instability, similar to what occurred in the previous historical periods. However, contrary to what occurred in the past, where the alternation of cycles had natural causes, the processes currently taking place are related to the effects of anthropogenic activity on the climate.

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References

1. Jones, H.P.; Hole, D.G.; Zavaleta, E.S. Harnessing to help people adapt to climate change. *Nat. Clim. Chang.* **2012**, *2*, 504–509. [CrossRef]
2. Anderson, K.; Bows, A. A new paradigm for climate change. *Nat. Clim. Chang.* **2012**, *2*, 639–640. [CrossRef]
3. Schneider, S.H. What is 'dangerous' climate change? *Nature* **2001**, *411*, 17–19. [CrossRef] [PubMed]
4. Turner, W.R.; Bradley, B.A.; Estes, L.D.; Hole, D.G.; Oppenheimer, M.; Wilcove, D.S. Climate change: Helping nature survive the human response. *Conserv. Lett.* **2010**, *3*, 304–312. [CrossRef]
5. Franzke, C.L. Nonlinear climate change. *Nat. Clim. Chang.* **2014**, *4*, 423–424. [CrossRef]
6. Hinzman, L.D.; Bettez, N.D.; Bolton, W.R.; Chapin, F.S.; Dyurgerov, M.B.; Fastie, C.L.; Griffith, B.; Hollister, R.D.; Hope, A.; Huntington, H.P. Evidence and implications of recent climate change in northern Alaska and other arctic regions. *Clim. Chang.* **2005**, *72*, 251–298. [CrossRef]

7. Kurz, W.A.; Dymond, C.; Stinson, G.; Rampley, G.; Neilson, E.; Carroll, A.; Ebata, T.; Safranyik, L. Mountain pine beetle and forest carbon feedback to climate change. *Nature* **2008**, *452*, 987–990. [CrossRef] [PubMed]
8. Bolte, A.; Hilbrig, L.; Grundmann, B.; Kampf, F.; Brunet, J.; Roloff, A. Climate change impacts on stand structure and competitive interactions in a southern Swedish spruce-beech forest. *Eur. J. For. Res.* **2010**, *129*, 261–276. [CrossRef]
9. Mollicone, D.; Eva, H.D.; Achard, F. Human role in Russian wild fires. *Nature* **2006**, *440*, 436–437. [CrossRef]
10. Johnstone, J.F.; Chapin, F.S.; Hollingsworth, T.N.; Mack, M.C.; Romanovsky, V.; Turetsky, M. Fire, climate change, and forest resilience in interior Alaska. *Can. J. For. Res.* **2010**, *40*, 1302–1312. [CrossRef]
11. Koca, D.; Smith, B.; Sykes, M.T. Modelling regional climate change effects on potential natural ecosystems in Sweden. *Clim. Chang.* **2006**, *78*, 381–406. [CrossRef]
12. Parmesan, C.; Yohe, G. A globally coherent fingerprint of climate change impacts across natural systems. *Nature* **2003**, *421*, 37–42. [CrossRef] [PubMed]
13. Xie, S.-P.; Deser, C.; Vecchi, G.A.; Collins, M.; Delworth, T.L.; Hall, A.; Hawkins, E.; Johnson, N.C.; Cassou, C.; Giannini, A. Towards predictive understanding of regional climate change. *Nat. Clim. Chang.* **2015**, *5*, 921–930. [CrossRef]
14. Giorgi, F.; Mearns, L.O. Approaches to the simulation of regional climate change: A review. *Rev. Geophys.* **1991**, *29*, 191–216. [CrossRef]
15. Lehner, B.; Döll, P.; Alcamo, J.; Henrichs, T.; Kaspar, F. Estimating the impact of global change on flood and drought risks in Europe: A continental, integrated analysis. *Clim. Chang.* **2006**, *75*, 273–299. [CrossRef]
16. O'Neill, B.C.; Kriegler, E.; Riahi, K.; Ebi, K.L.; Hallegatte, S.; Carter, T.R.; Mathur, R.; van Vuuren, D.P. A new scenario framework for climate change research: The concept of shared socioeconomic pathways. *Clim. Chang.* **2014**, *122*, 387–400. [CrossRef]
17. Zomer, R.J.; Trabucco, A.; Bossio, D.A.; Verchot, L.V. Climate change mitigation: A spatial analysis of global land suitability for clean development mechanism afforestation and reforestation. *Agric. Ecosyst. Environ.* **2008**, *126*, 67–80. [CrossRef]
18. Wilby, R.L.; Dawson, C.W.; Barrow, E.M. SDSM—A decision support tool for the assessment of regional climate change impacts. *Environ. Model. Softw.* **2002**, *17*, 145–157. [CrossRef]
19. Bruckner, T.; Petschel-Held, G.; Toth, F.L.; Füssel, H.-M.; Helm, C.; Leimbach, M.; Schellnhuber, H.-J. Climate change decision-support and the tolerable windows approach. *Environ. Model. Assess.* **1999**, *4*, 217–234. [CrossRef]
20. Santoro, F.; Tonino, M.; Torresan, S.; Critto, A.; Marcomini, A. Involve to improve: A participatory approach for a Decision Support System for coastal climate change impacts assessment. The North Adriatic case. *Ocean Coast. Manag.* **2013**, *78*, 101–111. [CrossRef]
21. Hannah, L.; Midgley, G.F.; Millar, D. Climate change-integrated conservation strategies. *Glob. Ecol. Biogeogr.* **2002**, *11*, 485–495. [CrossRef]
22. Riahi, K.; Grübler, A.; Nakicenovic, N. Scenarios of long-term socio-economic and environmental development under climate stabilization. *Technol. Forecast. Soc. Change* **2007**, *74*, 887–935. [CrossRef]
23. Robinson, J.B.; Herbert, D. Integrating climate change and sustainable development. *Int. J. Glob. Environ. Issues* **2001**, *1*, 130–149. [CrossRef]
24. Smith, M.D. An ecological perspective on extreme climatic events: A synthetic definition and framework to guide future research. *J. Ecol.* **2011**, *99*, 656–663. [CrossRef]
25. Giorgi, F.; Jones, C.; Asrar, G.R. Addressing climate information needs at the regional level: The CORDEX framework. *World Meteorol. Organ. Bull.* **2009**, *58*, 175.
26. Izdebski, A.; Pickett, J.; Roberts, N.; Waliszewski, T. The environmental, archaeological and historical evidence for regional climatic changes and their societal impacts in the Eastern Mediterranean in Late Antiquity. *Quat. Sci. Rev.* **2016**, *136*, 189–208. [CrossRef]
27. Su, Y.; Fang, X.; Yin, J. Impact of climate change on fluctuations of grain harvests in China from the Western Han Dynasty to the Five Dynasties (206 BC–960 AD). *Sci. China Earth Sci.* **2014**, *57*, 1701–1712. [CrossRef]
28. Xoplaki, E.; Fleitmann, D.; Luterbacher, J.; Wagner, S.; Haldon, J.F.; Zorita, E.; Telelis, I.; Toreti, A.; Izdebski, A. The Medieval Climate Anomaly and Byzantium: A review of the evidence on climatic fluctuations, economic performance and societal change. *Quat. Sci. Rev.* **2016**, *136*, 229–252. [CrossRef]
29. Fragoso, M.; Carraca, M.d.G.; Alcoforado, M.J. Droughts in Portugal in the 18th century: A study based on newly found documentary data. *Int. J. Climatol.* **2018**, *38*, 5522–5541. [CrossRef]
30. Brázdil, R.; Kiss, A.; Luterbacher, J.; Nash, D.J.; Řezníčková, L. Documentary data and the study of past droughts: A global state of the art. *Clim. Past* **2018**, *14*, 1915–1960. [CrossRef]
31. Hardwick, J.; Stephens, R.J. Acts of God: Continuities and change in Christian responses to extreme weather events from early modernity to the present. *Wiley Interdiscip. Rev. Clim. Chang.* **2020**, *11*, e631. [CrossRef]
32. Domínguez-Castro, F.; Santisteban, J.I.; Barriendos, M.; Mediavilla, R. Reconstruction of drought episodes for central Spain from rogation ceremonies recorded at the Toledo Cathedral from 1506 to 1900: A methodological approach. *Glob. Planet. Change* **2008**, *63*, 230–242. [CrossRef]
33. Hiram, É. Les cérémonies religieuses face à la météorologie. *Histoire Urbaine* **2011**, *3*, 31–52. [CrossRef]
34. Olcina, A.G. Sequía de 1846–50 e hipótesis de cambio climático por deforestación en el sureste ibérico. *Estudios Geográficos* **2007**, *68*, 91–117.

35. Wiśniewski, P. A Nineteenth-Century Processional from the Archive of the Bonifratres in Cracow (Kraków). A Contribution to Research into Latin Monody. *Roczniki Humanistyczne* **2020**, *68*, 73–86. [CrossRef]
36. Sánchez, P.J.C. Remojar al santo. Las rogativas pro pluvia a San Ginés en Robleda (Salamanca). *Cahiers du PROHEMIO* **2010**, *11*, 459–477.
37. Olcina, A.G. Clima e hipótesis de cambio climático en la región geográfica del sureste ibérico. *Investig. Geogr.* **2009**, *49*, 5–22. [CrossRef]
38. Barriendos, M. Les variations climatiques dans la péninsule ibérique: L'indicateur des processions (XVIe–XIXe siècle). *Revue Dhistoire Moderne Contemporaine* **2010**, *3*, 131–159. [CrossRef]
39. Prentice, I.C.; Webb, T., III. BIOME 6000: Reconstructing global mid-Holocene vegetation patterns from palaeoecological records. *J. Biogeogr.* **1998**, *25*, 997–1005. [CrossRef]
40. Dias, A.T.; Hoorens, B.; Van Logtestijn, R.S.; Vermaat, J.E.; Aerts, R. Plant species composition can be used as a proxy to predict methane emissions in peatland ecosystems after land-use changes. *Ecosystems* **2010**, *13*, 526–538. [CrossRef]
41. Oliva, M.; Ruiz-Fernández, J.; Barriendos, M.; Benito, G.; Cuadrat, J.; Domínguez-Castro, F.; García-Ruiz, J.; Giralt, S.; Gómez-Ortiz, A.; Hernández, A. The little ice age in Iberian mountains. *Earth Sci. Rev.* **2018**, *177*, 175–208. [CrossRef]
42. Mörner, N.-A. The approaching new grand solar minimum and little ice age climate conditions. *Nat. Sci.* **2015**, *7*, 510. [CrossRef]
43. Schneider, W.; Salameh, E. Historical Course Follows Climate Change: Patterns of the Northern Hemisphere—From Peoples' Migration until the Industrial Revolution (3rd–18th Century). *Open J. Geol.* **2018**, *8*, 1167–1194. [CrossRef]
44. Abrantes, F.; Rodrigues, T.; Rufino, M.; Salgueiro, E.; Oliveira, D.; Gomes, S.; Oliveira, P.; Costa, A.; Mil-Homens, M.; Drago, T. The climate of the Common Era off the Iberian Peninsula. *Clim. Past* **2017**, *13*, 1901–1918. [CrossRef]
45. Amorim, I.; Barca, S. Environmental History in Portugal. *Environ. Hist.* **2012**, *18*, 155–158.
46. Millett, M. Roman Interaction in North-Western Iberia. *Oxf. J. Archaeol.* **2001**, *20*, 157–170. [CrossRef]
47. Nunes, L.J.; Meireles, C.I.; Pinto Gomes, C.J.; Almeida Ribeiro, N. Historical development of the portuguese forest: The introduction of invasive species. *Forests* **2019**, *10*, 974. [CrossRef]
48. Nunes, L.J.; Raposo, M.A.; Pinto Gomes, C.J. A historical perspective of landscape and human population dynamics in Guimarães (Northern Portugal): Possible implications of rural fire risk in a changing environment. *Fire* **2021**, *4*, 49. [CrossRef]
49. Figueiral, I. Evidence from charcoal analysis for environmental change during the interval late Bronze Age to Roman, at the archaeological site of Castro de Penices, NW Portugal. *Veg. Hist. Archaeobot.* **1995**, *4*, 93–100. [CrossRef]
50. Díaz, P.; Menéndez-Bueyes, L.R. Chapter 3. Gallaecia in Late Antiquity. The Suevic Kingdom and the Rise of Local Powers. In *Culture and Society in Medieval Galicia*; Brill: Leiden, The Netherlands, 2015; pp. 146–175.
51. Gil Garcia, M.J.; Ruiz Zapata, M.B.; Santisteban, J.I.; Mediavilla, R.; López-Pamo, E.; Dabrio, C.J. Late holocene environments in Las Tablas de Daimiel (south central Iberian peninsula, Spain). *Veg. Hist. Archaeobot.* **2007**, *16*, 241–250. [CrossRef]
52. Morellón, M.; Valero-Garcés, B.; González-Sampériz, P.; Vegas-Vilarrúbia, T.; Rubio, E.; Rieradevall, M.; Delgado-Huertas, A.; Mata, P.; Romero, O.; Engstrom, D.R. Climate changes and human activities recorded in the sediments of Lake Estanya (NE Spain) during the Medieval Warm Period and Little Ice Age. *J. Paleolimnol.* **2011**, *46*, 423–452. [CrossRef]
53. Broecker, W.S. Was the medieval warm period global? *Science* **2001**, *291*, 1497–1499. [CrossRef] [PubMed]
54. Crowley, T.J.; Lowery, T.S. How warm was the medieval warm period? *AMBIO J. Hum. Environ.* **2000**, *29*, 51–54. [CrossRef]
55. Hughes, M.K.; Diaz, H.F. Was there a 'Medieval Warm Period', and if so, where and when? *Clim. Chang.* **1994**, *26*, 109–142. [CrossRef]
56. Kuijpers, A.; Mikkelsen, N. Geological records of changes in wind regime over south Greenland since the Medieval Warm Period: A tentative reconstruction. *Polar Rec.* **2009**, *45*, 1–8. [CrossRef]
57. Ogilvie, A.E.; Jónsson, T. "Little Ice Age" research: A perspective from Iceland. *Clim. Chang.* **2001**, *48*, 9–52. [CrossRef]
58. Crowley, T.J.; Zielinski, G.; Vinther, B.; Udisti, R.; Kreutz, K.; Cole-Dai, J.; Castellano, E. Volcanism and the little ice age. *PAGES News* **2008**, *16*, 22–23. [CrossRef]
59. Brönnimann, S.; Franke, J.; Nussbaumer, S.U.; Zumbühl, H.J.; Steiner, D.; Trachsel, M.; Hegerl, G.C.; Schurer, A.; Worni, M.; Malik, A. Last phase of the Little Ice Age forced by volcanic eruptions. *Nat. Geosci.* **2019**, *12*, 650–656. [CrossRef]
60. Neumann, J. Great historical events that were significantly affected by the weather: 3, The cold winter of 1657–58, the Swedish Army crosses Denmark's frozen sea areas. *Bull. Am. Meteorol. Soc.* **1978**, *59*, 1432–1437. [CrossRef]
61. Silva, L.P.S. O Clima Do Noroeste de Portugal (1600–1855): Dos Discursos Aos Impactos. Ph.D. Thesis, Faculdade de Letras da Universidade do Porto, Porto, Portugal, 2019; 633p.
62. McEvedy, C. The bubonic plague. *Sci. Am.* **1988**, *258*, 118–123. [CrossRef]
63. Akasofu, S.-I. On the recovery from the Little Ice Age. *Nat. Sci.* **2010**, *2*, 1211. [CrossRef]
64. Serrano, E.; Oliva, M.; González-García, M.; López-Moreno, J.I.; González-Trueba, J.; Martín-Moreno, R.; Gómez-Lende, M.; Martín-Díaz, J.; Nofre, J.; Palma, P. Post-little ice age paraglacial processes and landforms in the high Iberian mountains: A review. *Land Degrad. Dev.* **2018**, *29*, 4186–4208. [CrossRef]
65. Nunes, L.J.; Ferreira Dias, M. Perception of Climate Change Effects over Time and the Contribution of Different Areas of Knowledge to Its Understanding and Mitigation. *Climate* **2022**, *10*, 7. [CrossRef]