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Climate, risk, catastrophe and crisis on both sides of the Atlantic during the Little Ice Age (LIA). A proposed Research Project

Clima, risco, catástrofe e crise em ambos os lados do Atlântico durante a Pequena Era do Gelo (PEG). Um projeto de pesquisa proposto

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Resumo: Este artigo descreve o recente projecto de investigação (2018-2021) com o mesmo nome, financiado pelo Governo espanhol. Focando-se nos fenómenos climáticos associados à Pequena Idade do Gelo (LIA na sigla inglesa), nas suas consequências financeiras, sociais e culturais, e nos principais esforços para resistir e responder a os seus efeitos desastrosos, o projecto tem um vasta equipa multidisciplinar de investigadores dos países ibéricos e mesoamericanos. O projecto também tem em consideração investigação conduzida anteriormente entre 1993 e 2016 na Universidade de Alicante.
Palavras-chave: Pequena Idade do Gelo; Extremos climáticos; Seca; Cheias; Terramotos; Erupções; Furacões; Crises; Risco; Catástrofe; Resiliência.

Abstract: This paper describes the current research project (2018-2021) bearing the same name, and financed by the Spanish Government. Focusing on the climatic phenomena associated with the Little Ice Age (LIA), their financial, social and cultural effects, and the main efforts to resist and counteract their disastrous effects, the project has an extensive multidisciplinary team of researchers from Iberian and Mesoamerican countries. The project also takes into account previous research carried out from 1993 to 2016 at the University of Alicante.
Keywords: Little Ice Age; Climate extremes; Drought, Floods; Earthquakes; Eruptions; Hurricanes; Crisis; Risk; Catastrophe; Resilience.

Introduction

In 2017, a research project with the same name as this paper, obtained funding from the Spanish Government in the corresponding competition convened by the State Programme for Promotion of Scientific and Technical Investigation of Excellence under the auspices of the Ministry of Science, Innovation and Universities[3]. A three-year term was allocated for this purpose. The emergence of the COVID 19 pandemic in Spain, which led to the declaration of a «state of alarm» resulting in total confinement of the population, also put an end to research activities from March to June 2020, which required a reorganisation of the original time frame, resulting in a request to the Ministry for an extension—which was duly granted—, thus postponing the completion date until 30 September 2021, instead of 30 December 2020.

It is common knowledge that the Little Ice Age (LIA) was a global climate phenomenon that led to unforeseen changes affecting a considerable portion of the planet, mainly Europe, North America and China; but also Iceland, New Zealand, and the Andes (ALBEROLA ROMÁ, 2014; BRADLEY; JONES, 1992; GRIBBIN; LAMB, 1979; GROVE, 1988; LAMB, 1972, 1982, 1988; LE ROY LADURIE, 1967, 2004, 2006, 2009; PFISTER, 1992, 2002). This phenomenon prevailed from the mid-14th century to the mid to late 19th century, depending on the zone, and it was characterised by a return to more rigorous climatic conditions —after the milder Mediaeval Climate Optimum—, a marked drop in temperatures which were enormously variable. Experts are in agreement on the irregular nature of this behaviour, highlighting the longer and extremely severe winters, followed by short, wet springs. This change was disastrous for agriculture and for contemporary society in general, as apart from the climate extremes, the populace also suffered famine and disease resulting in subsistence and demographic crises.

The idea behind this multidisciplinary international research group was motivated by an endeavour to further knowledge of climate history, but also of the concomitant disasters associated with climatic, natural and biological hazards, in addition to reflecting on the social construct of risk and prevention, all of which was a long-term phenomenon on a global scale.

The aim was to achieve this purpose using comparative studies carried out on both sides of the Atlantic (the Iberian Peninsula and Mesoamerica) and also during the period of the LIA. Making use of as many documented sources as possible is an essential premise for any historical study, which is why

these need to be located so that in subsequent phases of the study they can be catalogued, analysed, and assessed, extracting results and comparing the impact of extraordinary events of every kind[4]. Having ascertained their extent, chronology and impact in specific territories, the next step will be to discover the response to these episodes from various perspectives, namely, political and administrative, social, economic, scientific and technical, and religious and cultural aspects, on both sides of the Ocean. We believe that this is the first time that an analysis of this type has been carried out, and it is hoped that the results will contribute to creating common goals, strategies and tools that will assist future R+D+I and provide relevant information on the historical perspective contrasted with current administrative actions.

Background to the research

In the early nineteen nineties, the first signatory to this paper, a member of the Modern History Department at the University of Alicante (Spain) set up a line of research into the impact of catastrophic phenomena of an atmospheric or hydrometeorological origin —cold fronts and heatwaves, droughts, inundations and flash floods—, geological —earthquakes, volcanic eruptions— or biological —agricultural plagues, diseases, epidemics— in Modern Age societies and economies (ALBEROLA ROMÁ, 1993), an historic period which included the climate oscillation known as the Little Ice Age. The line of research was also designed to analyse responses provided by different sources regarding the powerful effects of those phenomena, as well as defining the main facets of the capacity for resilience shown in the face of these events. Throughout the decade of the nineties, the first results began to materialise in the form of articles and books (ALBEROLA ROMÁ, 1995, 1996, 1998, 1999).

Assuming that until the creation of a «social construct of risk», exposure to it was inherent in all historic societies (BECK, 1998), it was not untoward that we should decide to concentrate our research efforts on the behaviour of climate and nature, but also to include the imprint left on societies in different periods of History. Over time, this line of research was further refined, resulting in a series of projects financed by the Spanish Government, having been awarded grants through public competition[5]. The results of the work of a multidisciplinary team led by Dr. Alberola, have provided further knowledge of a subject to which scant study has been accorded in Spain, but yet one which is of enormous interest; not merely because of the increased historical body

of knowledge, but because of the implications that such knowledge has—or should have—for the contemporary determination of natural risk in Spanish territory. In 2004, professors Armando Alberola and Jorge Olcina held the first of what have become the celebrated Seminars on History and Climate, designed as a meeting place and to provide a source of debate and diffusion for Spanish research relating to this theme. This year will be the fifteenth edition of the seminar, which is always held in Alicante, and which after ten years of existence, acquired an international role.

This line of research was reinforced and supported and numerous activities were developed as a result of the «History and Climate Research Group» (VIGROB-187, University of Alicante) which was set up in 2007. If, at the time, it was considered an «emerging group», it currently enjoys a «well established» status validated by hundreds of publications, various doctoral theses, and dozens of contributions to conferences, seminars, workshops and similar events.

From 1992 to 2016, and as a result of the numerous projects carried out, an enormous amount of documented information was located, compiled, ordered and digitalised from various manuscripts and printed sources, conserved in the archives and national, regional and local libraries, resulting in the creation of various databases. In principle, this information concerned the area of closest geographical scope, namely, the area of the Valencian Community, although progressively this was extended to the whole Spanish Mediterranean seaboard, and subsequently included the entire Iberian Peninsula excepting Portugal. In an initial phase, all the atmospheric and hydrometeorological episodes of an extraordinary nature that occurred in the 18th century were characterised and systematised along with their geological and biological causes. In subsequent phases, the Modern Age centuries were also studied. Thus, it was possible to determine and evaluate the economic and social impact of such episodes on societies that were basically agrarian —and which, as a result were susceptible to the vagaries of climate and very sensitive to all kinds of extreme episodes—, verifying the actions of different government administrations, mapping zones of historic risk and basically setting up a *proxy data* base with a view to helping create thermal and rainfall series and climatic reconstruction.

In addition to uncovering and analysing an important set of extreme episodes with a hydrometeorological or natural cause that occurred in the Modern Age, and including a list of events that hitherto were unknown in Spain, an in-depth study of new documented sources also brought to light the causes

and effects of natural catastrophes in Spain, with particular emphasis on the area of the Spanish eastern seaboard (ALBEROLA ROMÁ; MAS GALVAÑ, 2016); a new approach was taken in analysing relations between religious belief systems and social actions following the disasters, which included previously unknown cartographic sources, representing the land affected by extraordinary natural episodes, and with disastrous effects in the period under study (ALBEROLA ROMÁ; OLCINA CANTOS, 2009). This has given a complete time sequence of the destructive effects of the hydrometeorological extremes throughout most of the Iberian Peninsula —particularly in the Mediterranean zone— over the last seven hundred years. Furthermore, the means of prevention —if any— and the way in which such calamities were managed once they had occurred, were also examined in detail (ALBEROLA ROMÁ, 2020b).

From the perspective of the repercussions that these events had, and based on an analysis of the environmental conditions that affected agriculture and the work of peasants, emphasis was placed on the most extreme problems that affected them —and which still affect societies today— namely drought and excessive rainfall which ultimately directly caused the loss of harvests which in turn led to crises (ALBEROLA ROMÁ, 2020a). However, thermal contrasts were not neglected either, as these were notable during some periods of the 18th century. By paying special attention to the study of extreme atmospheric conditions—cold fronts and heat waves, droughts, extraordinary rainfall, flash floods and other inundations etc.— and by extension, to the society and economy of the time, this work aims to make a connection with the present, bringing essential knowledge to the current debate on climate change, as unquestionably, any comment or reflection regarding this issue should be framed within the context of the «long history of climate» that is, in a diachronic long term analysis of the way in which societies and individuals interact with the manifestations of meteorology; with horizons in which climate evolves and imposes conditions, and where humans manage to deal with their precarious lives, cope with environmental demands and deploy strategies to adapt to their environment.

At a time when our society is practically at the mercy of climate change, it is particularly relevant to analyse some episodes of exaggerated heat and cold, long periods of drought and the onset of torrential rains, accompanied by flash floods and inundations; hail and ice; fierce electrical storms and squalls, gales and shipwrecks; of earthquakes and volcanic eruptions; not to mention terrifying plagues of locusts—all of which bear witness to persistent extremely

dry periods and the predominance of warm southern winds in our area— or demographic calamities caused by disease and epidemics closely linked to existing environmental conditions.

In terms of the different political institutions and how they responded to these phenomena, we are beginning to discover the details of the instruments and mechanisms employed to deal with them; in particular, those of the *Consejo de Castilla* (Council of Castile) from the second half of the 18th century; management and supervision of disasters caused by hydrometeorological excesses, earthquakes, plagues and epidemics; as well as the methods employed to address them, especially in terms of repairing infrastructures of all kinds. Also, numerous examples have come to light which reflect the impotence with which society of the time faced the disastrous consequences of extreme climate and environmental episodes, and their immediate recourse to popular religion, establishing rituals in order to obtain divine pardon and to deal with unfortunate events such as torrential rains and powerful flooding—such as *pro serenitate* rogations—, for inclement droughts —*pro pluvia* rogations, along with penitential processions— or plagues of locusts, having recourse to ecclesiastical rituals (like exorcisms and *conjuros* or incantations), and also special relics of saints (ALBEROLA ROMÁ, 2011; GALVAÑ, 2012, 2017b). It is important to recall the scientific and pseudo-scientific thought prevalent in the 16th to 18th centuries which, together form a whole «catastrophe literature» (ALBEROLA ROMÁ, 2009).

It is clear that the tragic consequences that flash floods and inundations created particularly on the Mediterranean seaboard, but also the length and breadth of Spanish territory, were directly related to the general vulnerability to which the land was exposed, and it goes without saying, to the specifics of each population. We note the same relation in responses to these problems. Preventive measures were evident in some initiatives and in some of the projects undertaken throughout the century, although with varying results. Thus, the action taken in widening and dredging water sources, removing or changing the location of hydraulic infrastructures, deviating the course of rivers, and moving the site of urban settlements subject to repeated flooding came up against habitual economic penury and it was practically impossible to carry out such projects, in the best of cases, until the late 18th century.

There have been several contributions in this regard including *Quan la pluja no sap ploure. Sequeres i riuades al País Valencià en l`Edat Moderna* (ALBEROLA ROMÁ, 2010), *Clima, naturaleza y desastre. España e Hispanoamérica durante*

la Edad Moderna (ALBEROLA ROMÁ, 2013), *Riesgo, desastre y miedo en la península Ibérica y México durante la Edad Moderna* (ALBEROLA ROMÁ, 2017) and *Clima, desastres y convulsiones sociales en España e Hispanoamérica, siglos XVII-XX* (ARRIOJA DÍAZ VIRUELL; ALBEROLA ROMÁ, 2016). Equally relevant are the works of dedicated to *La Pequeña Edad del Hielo en España* (ALBEROLA ROMÁ, 2014) and the *Tratado de climatología* by professors Gil Olcina and Olcina Cantos (2017).

In addition, specialist journals have also coordinated monographic issues such as *Afers. Fulls de recerca i pensament* (ALBEROLA ROMÁ, 2011; MAS GALVAÑ, 2011a), *Relaciones. Estudios de historia social* (ALBEROLA ROMÁ, 2012; MAS GALVAÑ, 2012) and *Revista de Historia Moderna* (MAS GALVAÑ 2017b), which have published articles and book chapters, and proposed methodological considerations on the possibilities that certain sources provide, such as epistolary works, newspapers or other journals of a local and much more specific nature which contribute climatic *proxy-data*. This is because, in recent years, efforts have been made to locate and make use of documented sources which until now have scarcely been used. This is the case of the aforementioned diarists[6], and recovery of lines of thought initiated some time ago which offer considerable possibilities, such as correspondence and daily press of the 18th and early 19th centuries (ALBEROLA ROMÁ, 2010, 2015; MAS GALVAÑ, 2013, 2016, 2017a). We believe that these last, in particular, correspondence, require further methodological consideration and professor Cayetano Mas (MAS GALVAÑ, 2013) has dedicated particular attention to these sources along with his scientific exploration of Andean high altitudes (MAS GALVAÑ, 2011b, 2015, 2017c).

From an examination of abundant and varied documented, printed and iconographic sources, some which have to date scarcely been used or not at all, it has been possible to discover and classify the aforementioned episodes of severe winters or summers, persistent droughts and extraordinary rainfall, earthquakes, plagues and epidemics, and to create a hierarchy of the catastrophic effects suffered. And in this context, the data from civil and ecclesiastical archives, basically those referring to the numerous *pro pluvia* ceremonies which were concentrated on specific periods, has enabled confirmation of the approximations made by dendrochronology and identification of prolonged periods of drought, interrupted in autumn and spring by copious and intensive rainfall, accompanied by flash floods and inundations with disastrous consequences and which recurred with striking frequency (ALBEROLA ROMÁ,

2010, 2016, 2017). With respect to the drop-in temperatures experienced during the LIA, several freezing winters have been documented with heavy snowfall occurring during the mid-16th century, the two first decades and the latter years of the sixteen hundred —*the Maunder Minimum*—, the mid-18th century and the final quarter of the century during the so called time of the *Maldá anomaly* (ALBEROLA ROMÁ, 2014; BARRIENDOS; LLASAT, 2009; ALBEROLA ROMÁ, 2020a).

The project «on both sides of the Atlantic»

The aforementioned lines of work, and the results are continued in this research although as mentioned, they offer innovations, and new researchers from various disciplines and origins have joined the project[7].In fact, the time frame continues to be the LIA, but the geographic area of the work is extended to both sides of the Atlantic—the Iberian peninsula and Mexico-Central America— applying comparative methodologies and making the most of the international nature of this particular research group. To date, there has been no global study for this extensive historical period which, in addition to determining climatic oscillations and their effects in the form of waves of heat or cold, extreme hydrometeorology and natural or biological events with catastrophic effects, also includes the consequences and effects on agriculture —so inevitably linked to climate variations— and by extension, to the economy and society of the 16th to 18th centuries on both sides of the Atlantic. As historians, we are aware that our goal should be to highlight relations between the history of climate and human history.

It is important to recall that some variables had different effects, depending on which side of the Atlantic they occurred; in addition to the fact of opening up a window on the Pacific Ocean in order to analyse the behaviour of hydrometeors and the consequences of these on the territory and their inhabitants. This presupposes a clear extension of the range of extraordinary events, the impact of which are subject to analysis, evaluation, cataloguing and comparison, including both meteorological phenomena —cyclones, freezes, hurricanes, persistent droughts, intense rains, freshets and floods, hail, cold fronts, heatwaves etc.— and geological —volcanic eruptions, earthquakes— or biological —epidemics and plagues. Also, logically, the study covers the responses from a political-administrative, social, scientific and religious and cultural perspective. Unquestionably, the fact that all these territories

were part of the Spanish monarchical structure, make this an easier task. We consider that this type of analysis will help to create objectives, strategies and tools to develop future R+D+i while not losing sight of the fact that the current authorities will be provided with relevant information from a comparative historical perspective. This is unfortunately a pressing need as increasingly frequent earthquakes and hurricanes illustrate today.

Developing a project of this kind, requiring comparative methods has necessitated a three way reflection on theory and method. Firstly, consideration of historical climate development: also, relations between mankind and the natural environment, and in the final instance, links between these three components; namely, scientific knowledge, public policies and situations of risk. What is striking about extreme climatology and biology in Mexico and Central America is the fact that, despite its impact on the history of mankind, specialist studies have simply referred to them as manifestations of disaster and above all, as causes capable of altering social and economic structures. Therefore, a research study was proposed to highlight the way in which climate variability registered across the globe during the LIA and led to the emergence of these natural and biological phenomena, and ultimately, brought about situations that led to structural alterations.

If the aforementioned research projects had focused on analysing the effects of the complex climatic events experienced in the Iberian Peninsula during the Little Ice Age, in order to compare these with events in Mexico and Central America, a detailed examination of the documented sources available in these places is needed, which to date have been largely unexplored. It is clear, in terms of research on the European side of the Atlantic, that there is a need to seek further sources of documented information. On the American side, it is important to highlight developments in the historic and social study of risks and disasters in Mexico, initiated in the wake of the seismic events of 1985, which, in recent years, have been producing excellent results. In this regard, this project has continued with the task of completing the catalogues of natural hazards, taking as a reference those compiled by Dra. García Acosta and her collaborators (ESCOBAR OHMSTEDE, 2004; GARCÍA ACOSTA, 2001; GARCÍA ACOSTA; PÉREZ CEVALLOS; MOLINA DEL VILLAR, 2003; GARCÍA ACOSTA; SUÁREZ REYNOSO, 1996), in line with their impacts and responses, as well as formulating theoretical and methodological proposals designed for their study and analysis. Analysis of historic documentation for climate characterisation during the extensive period of the LIA has been notably lacking, except for

some contributions from the fields of dendrochronology (STAHLE; BURNETTE; VILLANUEVA-DÍAZ, 2012; STAHLE; COOK; BURNETTE, 2016), sedimentology (CUNA *et al.,* 2014) and atmospheric mechanics (MENDOZA *et al.*, 2005), however, this situation has been somewhat attenuated by publication of some fairly recent works (ALBEROLA ROMÁ; CAMPOS GOENAGA, 2020; ALBEROLA ROMÁ; ARRIOJA DÍAZ-VIRUELL, 2019, 2020; GARZA MERODIO, 2014). As a result, further study of the regional effects of the major processes of atmospheric oscillation is essential—ENSO, NAO, WeMo— and is currently discovering historic references to events that occurred prior to the 19th century, obtained from documented sources —such as «chronicles of the Indies»— and other indirect references —from dendrochronology and sedimentology. Based on this, it is possible to analyse the effects of extreme atmospheric episodes deriving from development of these templates for low frequency atmospheric oscillation.

In any case, a comparative analysis and the extended period of these disasters will give new meanings and explanations to the conclusions drawn to date, both of a quantitative and qualitative nature, referring to high prices and scarcity of foodstuffs; to mortality and migration; to rebuilding and relocating populations; to decision making in both political and social orders; to creating strategies for adapting and developing the areas studied; and to the practice of protective rituals which are closely linked to popular religiosity (FLORESCANO, 1978; FLORESCANO; SAN VICENTE, 1985; GARCÍA ACOSTA, 1988, 1993). The main goal of this project will be not only to describe each of the disasters associated with the hazards mentioned and which are identified on both sides of the Atlantic, but also to analyse them comparatively over that extensive time sequence.

Existing historical studies of disasters have shown that, as processes, they are the product of an accumulation of risks and vulnerabilities relating to or deriving from the type of society and economy that has developed with the passage of time, and not from the presence of natural hazards of increasing frequency and magnitude (GARCÍA ACOSTA, 2018). Furthermore, the complex and multifaceted relation between nature and culture gave rise to multiple and diverse ways of coping, interacting and preventing these. Historical studies of disasters have begun to consider, although still only on a reduced scale, aspects relating to so called resilience to natural or biological threats and hazards: the adaptation, strategies and practices at local level and the lessons learned in this regard. The possibility of carrying out comparative studies and over

the long term, in different Latin American and European regions, and taking into account not only the major disasters but also those known as «invisible disasters» will not only enable these issues to be documented but also in the best of cases, will begin to translate these into locally and culturally defined public policies.

The predominant and specific goal of the project is knowledge of how climate conditions have evolved. The aim is to establish, by collecting documented references and analysing instrumental historical series of meteorological data —when and where these are available—the evolution of climate fluctuations in the territories selected in order to study them in a chronological sequence that coincides with the LIA. Following a systematic search of the American archives, along the same lines as the model employed in Spain, a large database will be created containing indirect or *proxy* information on both sides of the Atlantic based on «official» sources of civil, ecclesiastic or private origin (ALBEROLA ROMÁ; MAS GALVAÑ, 2016) which in turn will lead to the compilation of a catalogue of exceptional meteorological events, thus providing a calendar of their frequency in the different regions or territories studied. In this way it will be possible to ascertain whether the extreme hydrometeorological episodes have changed, from modern times, as well as the ways in which they were engendered and developed with respect to the present day, which ultimately, will help to advance improvements in the prognosis for atmospheric hazards. Based on the transformation of *proxy data* into quantitative indicators using regression techniques, it will be feasible to create thermal and pluviometric series which will assist climate reconstruction of the territories under study and compare them in order to study, as appropriate, any differences or coincidences that occurred during the LIA.

Another essential aim of the project is to establish the association between the impacts of extreme episodes of a hydrometeorological or natural origin and existing crops in the various regions studied. For this purpose, it will be necessary to establish the territorialisation of the frequency with which extraordinary hydrometeorological events occurred, so that it will be possible to distinguish degrees of risk according to the different geographic zones. Despite the fact that the 16th-19th centuries were characterised by the predominance of a basically agrarian economy, it would be interesting to analyse the repercussions of these episodes on urban settings, either because this is where such events occur, or because they are indirectly affected by what rural areas have suffered. Efforts to combat the effects of drought during this historical period did not manage

to conclude with the construction of major hydraulic infrastructures such as dams of varying size, channelling systems and canals for irrigation or large aqueducts. Reducing this type of atmospheric risk on both sides of the Atlantic did not begin to have much effect until well into the second half of the 19th century.

The impact of plagues, particularly locusts, is closely linked to rural communities which were totally dependent on agricultural harvests. Those affecting the Iberian Peninsula, especially those suffered in the 18th century, are well documented, and therefore, the project proposes to research in detail those corresponding to the 16th and 17th centuries —which have not been studied— to the same degree -in order to compare them with those experienced on the other side of the Atlantic. In this case, more wide-ranging studies are required, following in the footsteps of Gibson and Florescano's pioneering work (1969) or more recently, that of Isabel Campos Goenaga (2011) and Luis A. Arrioja Díaz-Viruell (2019) cited previously, and concerned with Yucatán and Guatemala respectively[8]; not to mention the first comparative analysis carried out by Alberola Romá and Arrioja Díaz-Viruell (2019), The procedure would also be employed to study diseases and epidemics along the same lines. For the Iberian Peninsula, we have studies on the incidence of the plague during the16th and 17th centuries and Tertian fevers —malaria— for the 18th century which should be linked with a view to comparing the data emerging in Mexico and Central America, taking into account that Florescano has already made the connection between the emergence of diseases and climate conditions and agricultural production; an aspect that was also highlighted by Alberola Romá (2012, 2014; ALBEROLA ROMÁ; BERNABÉ GIL, 1999).

The link between disasters associated with natural hazards and the history of science is an aspect that has only recently been addressed by those interested in these themes. In the case of earthquakes, we know that the first attempts at discovering how and why they occurred were made by Greek philosophers; also, we know that during the Renaissance, Aristotelian thought regarding their origin was recovered which, with the development and expansion of Enlightenment ideas, particularly in America, led to various theories which, little by little, resulted in more accurate explanations: Wegener's theory of tectonic plates dates from the early 20th century, but it was not until mid century that it was universally accepted. The same could be said of developments in the knowledge of volcanic eruptions (PETIT-BREUILH, 2004). How the history of science and its association with hazards and disasters has

developed on both sides of the Atlantic in the four centuries considered in this project is a particularly interesting theme, which merits further research. Also, the response to the catastrophe, once it had occurred, is equally of interest. In this regard, it is essential to study the relation between climatic, geological or biological risk and the evolution of a territorial organisational model of the Spanish monarchy in the Iberian Peninsula and America, as it was responsible for responding to the problems resulting from these events, and it goes without saying, the impact of hurricanes or tropical cyclones, both in the intertropical areas of the western Pacific and the Caribbean coastline of Central America. In this regard some findings have already been published (ALBEROLA ROMÁ; GARCÍA ACOSTA, 2021; ALBEROLA ROMÁ, 2020; GARCÍA ACOSTA; PADILLA LOZOYA, 2019; PADILLA LOZOYA, 2018).

It is clear that all the extreme events with catastrophic consequences had enormous repercussions in the society of the time, and these were manifested in different ways. As is logical, what is considered «ordinary», namely that which does not deviate from what is considered the «norm», fails to raise any interest or concerns. The «extraordinary» leaves its mark on that which is termed «memory», and goes on to occupy a prominent position in the history of peoples. And this memory is conserved by means of extensive and varied historical sources which testify to the reverberations of these events in the society of the time. A good way of measuring their impact, apart from official recordings, is a reading of printed documents published and which, apart from announcing the news, also viewed the problem from a number of perspectives but always juxtaposing providential concepts and scientific arguments, which vied with each other at all times in such documents. Scientific and technical reports are also important. The rise of the popular press from the 18th century onwards, adds elements of interest when these events begin to be mentioned in newspapers. But references from the private diaries of individuals or correspondence between people of some significance are also important.

In the final instance, it is essential to recall the role that popular religion played at all times in society. Following the excellent results obtained in the Iberian Peninsula, rogations in American lands were also subjected to analysis, as they are a fundamental source for our objectives, and one which continues to remain virtually unexplored to date. Rogations were used for very different reasons, although usually they were used as an extraordinary resource to deal with particularly significant catastrophes such as long periods of drought —*pro pluvia* rogations— flash floods and inundations —*pro serenitate* rogations—

freezing conditions and hail, earthquakes, etc. In this regard, rogations, localised and analysed and appropriately addressed to obtain climate indices have become an effective tool for identifying the difficulties experienced by agriculture, and have contributed to setting and delineating the limits of these crisis periods, especially those that were localised and with a brief cycle. It also helped to include new data on popular religion, as the recourse to relics, processions, *conjuros* and exorcisms were, among other rituals, predominant practices in a society dedicated to sacred and hallowed ritual such as that of the Modern Age. On both sides of the Atlantic, practices in which pagan and magical beliefs combined with religion for requesting assistance and solutions to their difficulties were a constant in society. In the case of America, the pre-Hispanic origin is clear and evangelisers adapted practices to their own interests creating a singular type of religiosity, as occurred in the Old Continent, despite the fact that the social reality differed from the Spanish peninsula in that the populations came from different and complex forms of organisation. As a result, it is important to address this subject on the basis of historical and anthropological methods[9].

Ultimately, as mentioned, this project aims to progressively catalogue natural hazards—meteorological, geological and biological—as a complement to those already collated, in an iconographic data bank containing images associated with the different research themes, based on an archive of historical cartography already in existence —plans, maps, letters, designs etc.— of the areas affected by the events analysed, in order to evaluate the knowledge of the territory and its changes and comparisons over the passage of time. This will be complemented with the prior creation of a lexicographic corpus, as for some methods of exploitation of subjective sources, an analysis of their content often renders excellent results.

Final consideration

Immersed as we are at the present time in a debate on the impact that climate change will bring about, and with the knowledge —still scant—that we have available on geographic areas, we consider it appropriate and opportune to propose this project. This work aims to improve and increase scientific knowledge of processes and mechanisms that regulated climate in the past, as well as providing information which will lead to the design of options for adapting and mitigating the climate change that we are currently undergoing.

To achieve this aim, there is a need to carry out retrospective analyses using History as an essential tool, since it contributes to placing value on the knowledge accumulated, and on cultural resources and heritage, while having a prominent role in the construction of collective identities.

This project, which is international and comparative, is designed to analyse the effects of the Little Ice Age in Mexico and Central America, placing them in relation to events experienced in the Iberian Peninsula. When it is concluded, we shall be in a position to determine the magnitude of climate oscillations, and capable of distinguishing and evaluating extreme episodes, verifying the incidence of plagues and epidemics, and learning the consequences that they had for agriculture, and by extension, their effects on the economy and society from the 16th to the 19th centuries. This retrospective recovery, apart from adding to historical knowledge of the modern age, could be employed as a useful tool for detecting areas and situations which continue to be «at risk», as well as the recurrence of extreme events, the mode in which destructive effects are addressed and mitigated, and in short, substantiating the progress made throughout history as a result of science, technology and political actions.

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Notas

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[3]The project reference is HAR2017-82810-P, Ministry of Science, Innovation and Universities (Spanish Government) and runs from 31 January 2017 to 30 September 2021. It is financed by the Spanish Government and the research developments and progress are available at https://blogs.ua.es/historiaclima/.

[4]In this regard, were studied all kinds of events that had catastrophic consequences of an atmospheric and hydro meteorological origin —such as persistent droughts, intense rains, flash flooding and inundations, hail, ice, cold fronts and heatwaves, cyclones, hurricanes—, geological —volcanic eruptions, earthquakes— or biological —epidemics and plagues.

[5]The projects concerned are «Climate, economy and society in 18th century Spain» (2002-2005; BHA2002-01551, MCYT); «Natural catastrophes, science, technology and politics in Mediterranean Spain in the 18th century I» (2006; HUM2006-8769, MEC);

«Risk and natural disaster in 18th century Spain. Extreme meteorological episodes and their effects through official documents, popular religion and scientific reflection» (2010-2012; HAR2009-11928, MICINN); «Climatic oscillations and agrarian crises in the Spanish Levant during the Little Ice Age (LIA)» (HAR2013-44972-P, MINECO) and «Climate, risk, catastrophe and crisis on both sides of the Atlantic during the Little Ice Age (LIA)» (2017-2021; HAR2017-82810-P, MINECO).

[6]Regarding this issue, see the innovative studies on climate extremes in modern Valencia based on examination and analysis of Valencia diaries from the 16th and 17th centuries (ALBEROLA ROMÁ, 2016, 2020).

[7]The team of researchers on this project includes the group of University of Alicante professors who were part of the earlier endeavours (Dr. Armando Alberola, as PI, Dr. Cayetano Mas, as PI2, and Dr. Jorge Olcina), together with doctors Adrián García Torres (University of Clermont-Auvergne, Francia) and Antonio Carrasco (Universidad de Alicante), and including renowned specialists in the Atlantic and American fields such as Dr. Virginia García Acosta (CIESAS, Mexico; unquestionably the greatest expert in historical disasters in that country), Dr. Raymundo Padilla (Universidad de Colima, Mexico), Dr. Luis Alberto Arrioja Díaz-Viruell (Centro de Estudios Históricos at «El Colegio de Michoacán», Zamora, México), Dr. Alain Musset (EHESS, Paris) and Professor José Damiao Rodrigues (University of Lisbon). Dra. Isabel Campos Goenaga (National Anthropology Coordinator of the INAH Mexico) was also a member of the project team until her death in September 2019.

[8]The monograph coordinated by professor Luis A. Arrioja, in the journal *Relaciones. Estudios de Historia y Sociedad*, and which was dedicated to this issue in 2012 makes essential reading, and is expressively entitled *De langostas y otros flagelos* – [*Of locusts and other scourges*] (nº 129, winter 2012, vol. XXXIII) (MAS GALVAÑ, 2012).

[9]In this regard to see an initial contribution to these matter in the monograph coordinated by professors Alberola and Mas, the *Revista de Historia Moderna* dedicated its issue n. 35 (MAS GALVAÑ, 2017b) to this subject. DOI: https://doi.org/10.14198/RHM2017.35.

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