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Contribution of historical information to a realistic seismicity and hazard assessment of an area. The Ionian Islands earthquakes of 1767 and 1769: historical investigation

Introduction

In countries with a rich history, such as Europe, the historical research is useful to a number of different scientists, among which are seismologists. For Greece, especially, which is known to have suffered the destructive effects of earthquakes since antiquity, the detailed knowledge of historical earthquakes is useful for seismic hazard assessment which will lead to the reduction of seismic risk and the mitigation of damage and human losses from future earthquakes.

The present study is part of a joint effort of the European countries towards the thorough historical investigation of pre-instrumental earthquakes. The first part is concentrated in historical research carried out in order to assess the results of such earthquakes in relation to buildings and people.

The historical research is mainly directed towards the collection of information on the studied subject. Often, the available information is poor, and therefore the historian must look at the historical archives in order to enrich his data set. The new information, published or unpublished, is translated, when needed, to the contemporary language and its contents are added to the already existing archives. Then, in collaboration with seismologists and relevant scientists, the seismological information is assessed and evaluated.

The Ionian islands were chosen for study for different reasons, the most important of which is their location at the western borders of Greece, and near the Italian territory. The domination of the Venetians in the 18th century, the state of which was perfectly organized, implies that information

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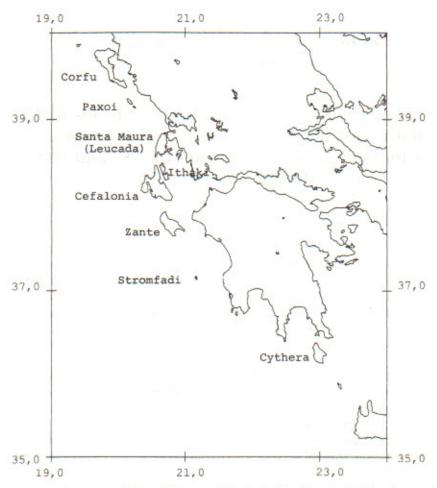


Fig. 1 - The territory of Central Greece and the Ionian Islands under the Venetian occupation (18th century).

can also be located in the archives of this state. Additionally, the inhabitants kept their own historical records and thus the set of information is expected to be richer.

The Ionian islands suffered and are still suffering from destructive earthquakes, which have become a part of the life of the inhabitants. The Cefalonia 1767 and Leukada 1769 earthquakes are known to have caused major damage in all the islands, and they point to a good example for further research.

This historical research was directed towards any information relative to the Ionian islands in the 18th century and the results of the information collected are presented in the process of the present study.

Political, administrative, social and economic aspects of Greece in the 18th century

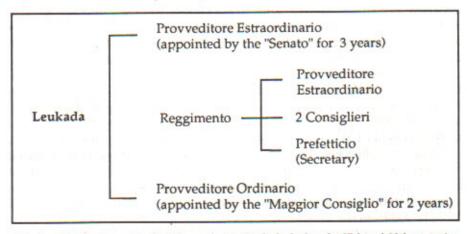
Political and administrative situation

In the 18th century the mainland and the Aegean islands were occupied by the Ottoman empire which had installed rulers in all the major cities of Greece. These rulers had full political and economic authority, thus affording no freedom to the inhabitants.

The Ionian area of Western Greece includes the islands of Corfu, Paxoi, Leukada, Ithaci, Cefalonia, Zante, Stromfadi and Cythera (Fig. 1). During the 18th century this area was under the domination of the Venetian state. This domination was imposed gradually on the islands. More specifically, Corfu and Paxoi were occupied in 1360, Cythera in 1363, Zante and Stromfadi in 1479-1485, Cefalonia and Ithaca in 1500, Leukada in 1684. In 1797, following the fall of the Venetian state, the islands passed under French occupation.

The situation in the area can be summarized in the following features. Venice practised absolute power through the *Provveditore Generale da Mar*, who resided in Corfu. Additionally, in every island there was a Venetian ruler (*Provveditore Ordinario*), who remained in this position for a certain time period (usually for two years, Tab. 1). The top administrative posts in all the islands were taken up by Venetian officials, or locals of noble birth. The election of the latter was performed always with the approval of the central authorities.

The dispute which existed to a lesser degree in the previous centuries between the nobles (nobili) and the middle class (cittadini) was intensified during that period. Sensitive to their class conscience, the middle class demanded and eventually managed to be included in the Board of Nobles.



Tab. 1 - The Venetian administrative system in Leukada during the 17th and 18th centuries.

However, at the same time, the friction between the middle class and the peasants often resulted in popular uprisings. Most of the time the reason was the miserable living conditions of the peasants, who often suffered abuse by government officials, and had to bear heavy direct and indirect taxation.

During the studied period several countries, especially European, interested in the political stability of Eastern Europe, placed embassies and consulates in the major cities of Greece. Amongst them were England, Russia, Denmark, America, Ragusa, etc. Venice, in its turn, had placed 30 consulates and subconsulates in Greece and the countries of Eastern Mediterranean.

Social and economic situation

In spite of the aforementioned unfavourable circumstances, the islands in the 18th century are characterized by a remarkable economic bloom, related to the general political changes in Europe, with direct impact on the Western Mediterranean. Thus, in spite of the limitations and the interventions of the Venetians, trade and shipping was developed and productivity was increased, as a result of taking advantage of the fertile soils of the islands and the customary handicraft of the locals (e.g. salt-pans and hatcheries in Leukada, bread production in Cefalonia, etc.).

The Venetians were interested in the increase of the population of the islands, and in some cases (e.g. Leukada) brought additional inhabitants from the mainland. As a result, the population of the islands increased slowly but steadily (Tab. 2). Some negative factors, which did not allow a more rapid increase and, consequently, a more general development, were piracy (which had increased dangerously), epidemics (which were a real curse in many cases) and finally earthquakes, which often caused major damage and loss of human life.

At the same time the mainland suffered the Turkish yoke. The Turks did not allow any administrative rights to the Greeks, imposed unbearable taxes on the farmers, and the economic conditions of the inhabitants were very poor. Such conditions contributed to the Greek revolution of 1821. For all these reasons the population of the mainland (Tab. 2) fell dramatically.

In the Ionian islands the inhabitants also developed their own local art. Many of the islanders were well educated and built the well known library of Zante. The structures on the islands were mainly old, stone built, with thick walls and small openings. The architecture was influenced by the regular earthquakes, but the real anti-seismic structures were only the public buildings and churches. The majority of the people were too poor to afford basic luxuries, or even to properly restore their houses which were damaged by earthquakes. Also, due to their strong religious beliefs, they were more interested in the restoration of their churches, and for this they often required financial aid from the Venetians.

The history of Greece in antiquity and byzantine times attracted many adventurous travellers from the countries of Europe and also from the Americas. Many of them were only interested in the antiquities of Greece, which they later sold at remarkable prices in their countries. Most travellers were British and French, and the rest came from countries of Western Europe. The Ionian islands, due to their position near Europe and their political freedom to some degree, were visited more often than the mainland.

Ionian Islan	nds							
Corfu	22,170 (160)2)	27,056 (1	616)	20,000	(1675)	44,333	(1766)
Cefalonia	50,000 (163		70,000 (1	660)	47,000	(1715)	21,659	(1766)
Zante	28,492 (167		25,000 (1	675)	25,325	(1766)	30,000	(1770)
Leukada	9,000 (168		12,000 (1	760)	11,760	(1766)	15,000	(1778)
Cythera	6,000 (176		6,183 (1	766)	8,000	(1787)		
Ithaki	2,500 (162		2,500 (1	760)				
	DOM: N							
Greek Main	nland							
Patras			10,000	(1765)		30,000	(1767)	
Mistras		= 15	-18,000	(1799)				
Tripolitsa		≈ 15	5-20,000					
Nauplion		= 7	7-10,000					
Methoni			≈ 4,000					
Coroni			≈ 1,500					
Navarino (1	Pilos)		≈ 1,000					
Vostitsa (Aiyio)			2,000	(1765)		4,000	(1799)	
Arkadia (Kiparissia)			≈ 5,000					
Kalamata			≈ 2,500					
Korinthos			≈ 5,000					
Athens			10,000	(1788))			

Tab. 2 - Population of the Ionian islands and major cities of the Greek mainland in the 17th and 18th centuries.

Historical research on earthquakes

For the study of historical earthquakes all the relevant information concerning the period investigated is gathered. The present study is mainly directed towards the search for published or unpublished sources referring to the Cefalonia 1767 and Leukada 1769 earthquakes, or to other earthquakes of the same period. In addition, all other monographs, published papers, books, etc. referring to the political, administrative, social and economic situation of the period, were searched for a better knowledge of the situation of the suffering areas. The geologic and seismotectonic features of the area are also important, since they are a useful tool for the calibration of the results.

In the process of the study different kinds of sources were collected. Each

one was attributed to a source list, according to its contents, and the information the sources contained was evaluated both partly and as a whole. As a consequence, all the references are listed in the different types of sources.

Catalogues

The catalogues of earthquakes usually refer to a certain time period and a specific area. The catalogues of historical earthquakes contain information on events before 1900, i.e. the pre-instrumental earthquakes. The information is derived from descriptions of reporters of the time, references in newspapers, monographs, monastery notes, etc. The catalogues are distinguished into classical compilations (references, section 1) and modern catalogues (references, section 2).

In modern catalogues the focal parameters of the earthquakes are derived from collection and evaluation of all the available macroseismic information, which is often calibrated using the 20th century instrumental catalogues.

Compilations

In this section two categories of sources are listed. The former is the methodological published sources (references, section 3), concerning archive guides, sources inventories, geological and geophysical studies, etc. Apart from the published sources of information of general character, more detailed ones were devoted exclusively to the studied earthquakes. Their importance is based on the following fact: their authors derive their information from unpublished archive material of the period in which these earthquakes occured. This is why their witness reports are so relevant and consistent.

The second category is specific sources and concerns the direct original unpublished sources. In the case of earthquakes which occured in the Ionian Sea during the 18th century, as well as of the history of the islands during this period, ample archive material has been saved, most of which was unknown. Expecially for the two studied earthquakes four unpublished sources were found (Tab. 3). For further research in this material and in particular for the earthquakes of 1767 and 1769, the existing local archives of the Ionian islands as well as churches, monasteries and private archive collections contain such information.

The 1767 Cefalonia and 1769 Leukada earthquakes

Sources

This section contains all the available information about the 18th century earthquakes of Cefalonia and Leukada. The information contained in the modern catalogues was poor, due to the fact that it was limited in the meizoseismal area. Thus, for the 1767 Cefalonia earthquake the research was directed towards the original sources. As far as the 1769 Leukada earthquake

Sources for the 1767 earthquake

1. Letter

Sender: The villagers of Comilio

Recipient: Provveditore estraordinario di Santa Maura

(Lorenzo Moro)

Date: September 22, 1767

Abstract: A major earthquake occurred at 2 hours before noon. Comilio was completely destroyed. All the houses collapsed, most of them from their foundations. The churches

were destroyed. Panic spread amongst the inhabitants.

From: Historical Archive of Leukada, Reggimento Lorenzo Moro, f. 3, no. 381

Letter

Sender: The villagers of Athani

Recipient: Provveditore Estraordinario di Santa Maura

(Lorenzo Moro)

Date: September 22, 1767

Abstract: A major earthquake occurred at sunrise. Almost all the houses in Athani were destroyed. All the churches were also destroyed, and we were therefore not able to follow the service. We kindly request the hasty restoration of damage.

From: Historical Archive of Leukada, Reggimento Lorenzo Moro, f. 3, no. 382

Letter

Sender: The villagers of Ayios Petros

Recipient: Provveditore Estraordinario di Santa Maura

(Lorenzo Moro)

Date: [September 22, 1767)

Abstract: On September 22 a major earthquake occurred. In Ayios Petros all the churches and houses collapsed. Two people were seriously injured. The wine barrels fell over and our wine crop was destroyed. We kindly request you to restore the damages as

From: Historical Archive of Leukada, Reggimento Lorenzo Moro, f. 3, no. 383

4. Letter

Sender: Elderly inhabitants of Dragano

Recipient: Provveditore Estraordinario di Santa Maura

(Lorenzo Moro)

Date: [September 22, 1767]

Abstract: All the houses of the village collapsed from their foundations because of the earthquake. The grain crops and wine barrels were destroyed and buried under the ruins.

We kindly request you to quickly restore the damage.

From: Historical Archive of Leukada, Reggimento Lorenzo Moro, f. 3, no. 384.

Tab. 3 - Specific unpublished historical sources.

is concerned, the information was more systematic, because, not only has this event been studied in the XIX century, but also the required sources have already been confined.

Besides, there is very little information about this earthquake from the area of Western Greece, where they were expected to be felt with rather high intensities. The available archives of that period are very few (most of them were transferred to Ankara and Constantinople, or were destroyed). Thus the available information is limited to few reports: both earthquakes were felt in the towns of Naupaktos and Rion, whereas the Cefalonia 1767 earthquake was felt in Meteora (Ambraseys, personal communication).

The whole set of sources was completed with those of the Venice State Archives provided by the Italian researchers (Daltri e Albini, 1991), which have already been systematically studied. From these sources it made clear the excellent administrative structure of this state in the 18th century. After an earthquake a whole bureaucracy was initiated, beginning from the locals who asked for financial aid for the restoration of their houses and churches, and, through the Provveditore Generale da Mar, leading to the Venetian Senate, which was the final authority to decide if this request would be satisfied (Tab. 4).

For a better use in the future of this set of information, and in order to obtain a systematic data bank, the contents of the sources concerning earthquakes were computerized.

Research problems

From the research made, certain problems arose, which are listed below:

a) In the case of Zakinthos the information to hand is limited due to the fact that the rich archive material of the island was destroyed during the earthquake of 1953. The existing historical archives of the island contain material of the 19th and 20th centuries, but hardly anything on the 18th century. This important absense of material is somewhat alleviated by the rich bibliography up to 1953. Specifically, numerous written studies utilized archive material (references, section 3), which was later destroyed. In this way the knowledge on this subject is more or less completed.

b) The second serious problem concerns the part of Western Greece facing the Ionian islands, where the studied earthquakes might have been felt. The relevant archive material on this area is insufficient. This aforementioned serious lack of material can be substituted up to now by the archive material saved by monasteries of the area, which involves documents, books of the time, notes and short chronicles.

Conclusions

The historical research concerning earthquakes is not a limited task. Together with the required information, relevant interesting material can be revealed, which was unknown up to date.

1769 Oct 02/13	Marin Marin	Dona Dona	Letter with a preliminary estimation of damage	
1,05 00.02, 10	Marin	Dona		
1,05 00.02, 10	Marin	Dona		
1769 [Oct]			Letter with supplementary information on damage	
1/05 [OCI]	Marin	Dona	List of public and private buildings	
***************************************	William	Dona	(submitted by the locals)	
1769 [Oct]	Marin	Dona	List of damage reported by the	
			officiating priests	
1769 Oct 05/16	Marin	Dona	Request of the local authorities of	
			Amaxiki for financial aid	
1769 [Oct]	Costa	Dona	Request for financial aid	
1769 Oct 07/18	Marin	Dona	Letter concerning the damage	
1769 Oct 11/22	Dona	Senate	General report on the earthquake results	
1769 Oct 17/28	Dona	Senate	Supplementary report	
1769 Oct 21/Nov 01	Dona	Senate	Supplementery dispatch	
1769 Oct 24/Nov 04	Papadopoulo	Marin	List of damage in public buildings	
41 41 41 41 41	Marin	Dona	Letter	
1769 [Nov]	Marin	Moro	List of necessary materials for restoration of public buildings	
1769 Nov 13/24	Dona	Senate	Dispatch	
1769 Dec 19/30	Dona	Senate	Dispatch concerning damage in Cefalonia	
1770 Jan 07/18	Senate	Dona	Decisions taken with regard to the event	
1770 Jan 07/18	Senate	Dona	Supplementary decisions	
1770 Sep 08/19	Dona	Senate	Final working report	

Tab. 4 - Diary of correspondence after the 1769 Leukada earthquake.

The detailed study of the two Ionian historical earthquakes of 1767 and 1769 provided an almost complete information set of wide subjects, which is of interest not only to the historian and the seismologist, but also to the civil engineer, the architect and the town planner.

The importance of this study is evident after the seismological interpretation has been carried out, and the effects of the earthquakes have been assessed in terms of macroseismic information. Such studies are therefore indispensable for all the historical earthquakes, especially for

countries with high seismicity, such as Greece.

The problems that arise are not negligible, but the experience derived can be very helpful for the future research of other earthquakes of the same or other historical periods. The already existing derivatives will make the research easier and therefore the present study can act as a pilot study towards this aim. The future researcher can profit from this experience, direct his research with the aim of avoiding the existing problems, and thus his study will not start from zero.

There is another important aspect of such studies. The historical research at home and abroad is an initiative for researchers from different countries to collaborate and present common results.

Acknowlegdements

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