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THE MARCH 2021 THESSALY EARTHQUAKES AND THEIR IMPACT THROUGH THE PRISM OF A MULTI-HAZARD APPROACH IN DISASTER MANAGEMENT

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Abstract

In early March 2021, when Greece was struggling with the evolving third wave of the COVID-19 pandemic with the highest numbers of daily cases and fatalities from its initiation, Thessaly was struck by a seismic sequence, which included the 3 March, Mw = 6.3 mainshock, its strongest Mw = 6.1 aftershock the following day and numerous large aftershocks. The mainshock caused extensive damage to houses and infrastructure, while the aftershock aggravated damage and caused widespread concern among residents. Based on post-event field surveys in the affected area, it is concluded that the old unreinforced houses with load-bearing masonry walls in the northeastern part of the Thessaly basin suffered the most, while the recent constructions remained intact. As a result, hundreds of homeless were in need of immediate temporary sheltering, which immediately mobilized the Civil Protection authorities to manage the emergency situation. This emergency had something unique, which made its management a challenge: the implementation of the earthquake emergency response actions was incompatible with the measures to limit the further spread of the SARS-CoV-2 virus in the community during the evolving third pandemic wave. Many of the actions have been adapted to the unprecedented conditions through a prism of a multi-hazard approach to disaster management and their impact. Among others, more and different types of emergency shelters were used to prevent overcrowding, emergency supplies distribution processes were modified to prevent transmission through hands *and surfaces, places for the identification and isolation of suspected COVID-19 cases were designated in emergency shelters and extensive and regular screening testing of the local population was conducted for the detection of SARS-CoV-2 virus. From the analysis of the daily reported COVID-19 cases in the earthquake-affected area during the pre- and post- disaster periods as well as from results of rapid testing during the post-disaster period, it was found that the viral load of the earthquake-affected villages was not increased, despite the difficult and unprecedented conditions. It can be suggested that the adaptation of the measures to the new conditions has worked beneficially to reduce the spread of the new virus among those affected and the involved staff. For this reason, this approach could be considered as good practice and important lesson learned, which can be applied to similar future compound emergencies in areas with similar geoenvironmental and epidemiological characteristics.*

Keywords: *Thessaly; earthquake emergency; COVID-19 pandemic; compound emergencies; multi-hazard management*

Περίληψη

Στις αρχές Μαρτίου 2021, όταν η Ελλάδα πάλευε με το εξελισσόμενο τρίτο κύμα της πανδημίας COVID-19 με τους υψηλότερους αριθμούς ημερήσιων κρουσμάτων και απωλειών από την έναρξή της, η Θεσσαλία επλήγη από μια σεισμική ακολουθία, που περιλάμβανε τον κύριο σεισμό μεγέθους M_w = 6.3 στις 3 Μαρτίου, τον ισχυρότερο μετασεισμό με μέγεθος M_w = 6.1 την επόμενη ημέρα και πολλούς μεγάλους μετασεισμούς στη συνέχεια. Ο κύριος σεισμός προκάλεσε εκτεταμένες βλάβες σε κατοικίες και υποδομές, ενώ ο μετασεισμός επιβάρυνε τα ήδη πληγέντα κτήρια και επέτεινε την ανησυχία του τοπικού πληθυσμού. Με βάση έρευνες πεδίου στην πληγείσα περιοχή διαπιστώθηκε ότι οι παλαιές μη ενισχυμένες κατοικίες με φέρουσα τοιχοποιία στο βορειοανατολικό τμήμα της Θεσσαλικής πεδιάδας επλήγησαν περισσότερο από τις σύγχρονες κατασκευές, που παρέμειναν ανέπαφες. Αποτέλεσμα ήταν να προκύψουν εκατοντάδες άστεγοι και χιλιάδες πληγέντες, γεγονός που κινητοποίησε άμεσα τις υπηρεσίες Πολιτικής Προστασίας για τη διαχείριση της έκτακτης ανάγκης. Αυτή η έκτακτη ανάγκη είχε μια ιδιαιτερότητα, που καθιστούσε τη διαχείρισή της πρόκληση: η εκπόνηση των απαιτούμενων δράσεων για τη διαχείριση των επιπτώσεων του σεισμού ήταν ασύμβατες με τα μέτρα περιορισμού περαιτέρω διασποράς του ιού SARS-CoV-2 στην κοινότητα κατά τη διάρκεια του τρίτου πανδημικού κύματος. Πολλές από τις δράσεις προσαρμόστηκαν στις πρωτόγνωρες συνθήκες υπό το πρίσμα πολυκινδυνικής προσέγγισης στη διαχείριση του κινδύνου καταστροφών και των επιπτώσεών τους.

Μεταξύ άλλων, χρησιμοποιήθηκαν περισσότεροι και διαφορετικού τύπου χώροι φιλοξενίας σεισμόπληκτων για την αποφυγή συνωστισμού, τροποποιήθηκαν οι διαδικασίες διανομής ειδών έκτακτης ανάγκης για την αποφυγή της μετάδοσης μέσω χεριών και επιφανειών, προβλέφθηκαν χώροι για την αναγνώριση και απομόνωση ύποπτων κρουσμάτων με λοίμωξη COVID-19 σε χώρους φιλοξενίας σεισμοπλήκτων και εκπονήθηκε μαζικός και τακτικός έλεγχος πληγέντων για την ανίχνευση πιθανών κρουσμάτων. Από τη ανάλυση των ημερήσιων κρουσμάτων COVID-19 στη σεισμόπληκτη περιοχή κατά την προ- και μετα- καταστροφική περίοδο, αλλά και των αποτελεσμάτων του προγράμματος μαζικού και τακτικού ελέγχου των σεισμόπληκτων με τη μέθοδο των ταχέων τεστ κατά τη μετακαταστροφική περίοδο, διαπιστώθηκε ότι το ιικό φορτίο της σεισμόπληκτης περιοχής δεν αυξήθηκε, παρά τις δύσκολες και πρωτόγνωρες συνθήκες. Μπορεί να ειπωθεί ότι η προσαρμογή των μέτρων στις νέες συνθήκες λειτούργησε ευεργετικά για τον περιορισμό της διασποράς του νέου ιού μεταξύ των πληγέντων και του προσωπικού των αρμόδιων υπηρεσιών. Για το λόγο αυτό μπορούν να θεωρηθούν ως καλή πρακτική και σημαντικό μάθημα, που μπορεί να εφαρμοστεί και σε παρόμοιες μελλοντικές σύνθετες έκτακτες ανάγκες σε περιοχές με παρόμοια γεωπεριβαλλοντικά και επιδημιολογικά χαρακτηριστικά.

Λέξεις – Κλειδιά

Θεσσαλία, έκτακτη ανάγκη από σεισμό, πανδημία COVID-19, σύνθετη έκτακτη ανάγκη, πολυκινδυνική διαχείριση

1. INTRODUCTION

On 3 March 2021 (10:16:10 UTC) an earthquake struck the Region of Thessaly located in the central part of Greece (Fig. 1). The earthquake occurred in an area characterized mainly by normal faulting along NW-SE striking faults that belong to the Northern Thessaly fault zone (Caputo and Pavlides, 1993) (Fig. 1). Based on the Seismological Laboratory of the Department of Geology and Geoenvironment of the National and Kapodistrian University of Athens (SL-NKUA), the magnitude has been assessed as Mw = 6.3 and its focal depth as 19 km. Based on the provided focal plane solution (SL-NKUA) (Fig. 1), the 3 March event was generated by the activation of an NW-SE striking normal fault.

The main shock was felt in Thessaly basin and its surroundings, from Athens in the south to the northern borders of Greece. Fortunately, it caused no fatalities, while only 3 people were slightly injured due to partially collapsed buildings with load-bearing masonry walls in Damassi village. The Disaster Management Special Units (EMAK in

Greek) of the Hellenic Fire Service managed to rescue 6 people from the rubbles in the earthquake-affected villages of Mesochori and Magoula. On 4 March 2021, (18:38:19 UTC), another earthquake struck the same area with magnitude Mw = 6.1 and focal depth of 15 km (SL-NKUA) (Fig. 1). Based on the provided focal plane solutions, the parameters of the second earthquake were similar to those of the first earthquake (Fig. 1). More specifically, it was also generated by the rupture of a NW-SE striking normal fault.

The mainshock induced extensive secondary environmental effects comprising mainly liquefaction phenomena in river beds, lateral spreading along river banks, slope failures including rockfalls and landslides along abrupt slopes and ground cracks mainly in areas with preexisting instability (Lekkas et al., 2021; Valkaniotis et al., 2021). Moreover, it caused damage to buildings in many residential areas of the northern part of Thessaly Basin (Lekkas et al., 2021).

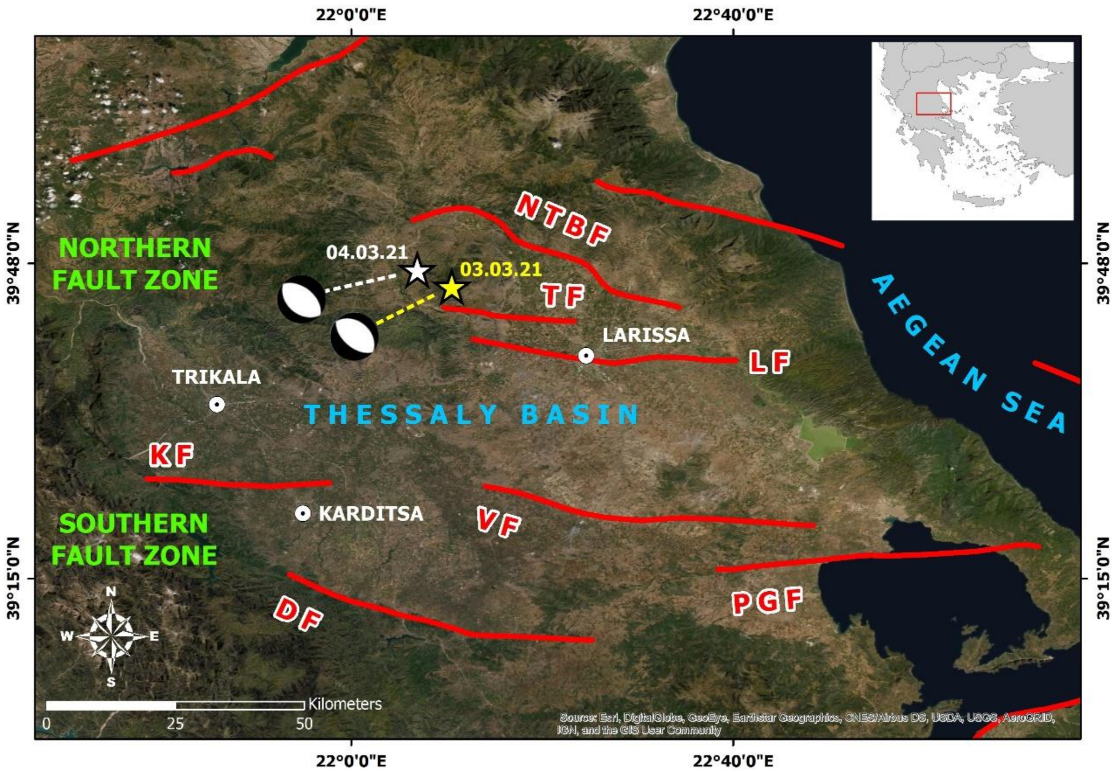

Fig. 1: The seismogenic sources of Thessaly Basin based on the Greek database of seismogenic sources (Caputo et al., 2012). Its northern fault zone comprises the North Tyrnavos Basin fault (NTBF), the Tyrnanos fault (TF), the Larissa fault (LF), while the southern fault zone includes the Karditsa fault (KF), the Vasilika fault (VF), the Pagasitikos Gulf fault (PGF) and the Domokos fault (DF). The yellow star corresponds to the 3 March 2021, Mw = 6.3 earthquake epicenter and the white star to the 4 March 2021, Mw = 6.1 earthquake epicenter. The focal plane solutions for both earthquakes were provided by SL-NKUA.

This seismic sequence raises many questions on several scientific issues, including the causative fault, the earthquake triggering process and fault interactions, surface fault expression and blind faulting, type and distribution of earthquake environmental effects and building damage, among other important questions on the seismic hazard of the earthquake-affected area. The significance of this seismic sequence lies not only in these questions about geological hazards, but also in its occurrence amid an evolving biological hazard, which is the COVID-19 pandemic.

The COVID-19 pandemic knocked on the door of Greece in late February 2020 (Fig. 2), affecting activities in all sectors of the daily life including the disaster risk reduction and management among others. Until early March 2021, when the mainshock struck Thessaly, Greece counted 198271 laboratory-confirmed COVID-19 cases and 6592 fatalities according to the official daily reports of COVID-19 epidemiological surveillance of the National Public Health Organization (NPHO), which are freely available online in the NPHO (2021) website. The early March 2021 Thessaly seismic sequence was not the first, which tested the readiness and effectiveness of the state mechanism in managing the effects of an earthquake disaster amid the pandemic. It was preceded by the 21 March 2020, Mw = 5.7 Epirus (Northwestern Greece) earthquake (e.g., Lekkas et al., 2020a), which coincided with the initiation of the pandemic in the country (Fig. 2), and the 30 October 2020, Mw = 7.0 Samos (Eastern Aegean Sea) earthquake (e.g., Lekkas et al., 2020b; Papadimitriou et al., 2020; Cetin et al., 2021), which was generated within the second wave of the pandemic (Fig. 2). The seismic sequence of Thessaly occurred amid the evolving third pandemic wave (Fig. 2).

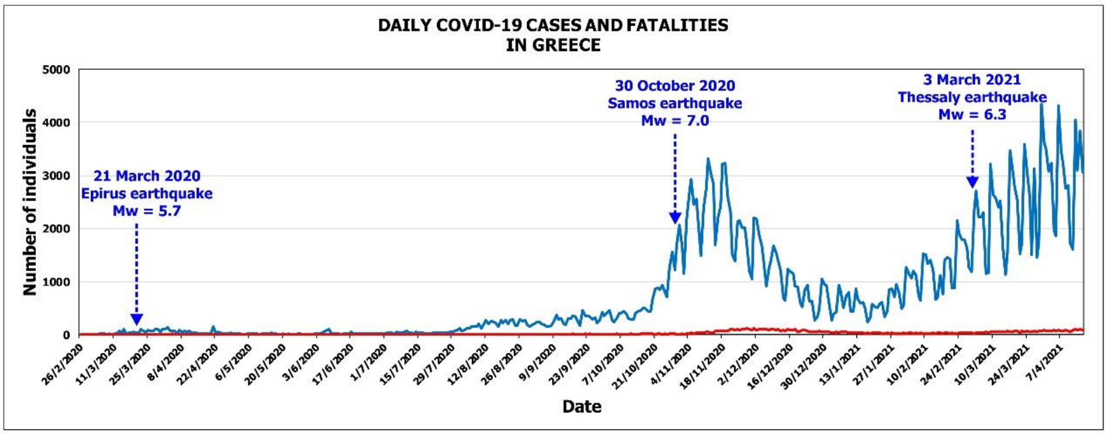

Fig. 2: The evolution of the pandemic in Greece through the daily COVID-19 cases and fatalities. The Epirus earthquake occurred in the first wave of the pandemic, the Samos earthquake in the second wave and the early March 2021 Thessaly seismic sequence in the third wave (Data for daily COVID-19 cases and fatalities from the daily reports of COVID-19 epidemiological surveillance of the National Public Health Organization, which are available in the NPHO (2021) website.

The main element of the third pandemic wave in Greece is the highest numbers of daily confirmed COVID-19 cases, intensive care unit (ICU) patients and fatalities since the pandemic initiation in the country. Since the completion of the second wave in mid-January 2021, the above daily numbers have never reached the low levels of the first wave. This fact shows that there is a great viral load in the community, which has a strong potential to cause, if not drastically reduced, a resurgence of the pandemic with adverse effects on public health and the proper functioning of society. Recent viral mutations, which tend to prevail in the community and make the spread of the virus easier, may also contribute to this resurgence.

The epidemiological characteristics that prevail in Greece at the beginning of spring 2021 made the response to the earthquake emergency and the management of the induced effects a challenge. This is attributed to the fact that many actions planned and effectively applied to pre-pandemic disasters related to natural hazards are now incompatible with the pandemic mitigation measures. In particular, each action of the earthquake emergency response, described in detail by Lekkas et al. (2020c) and Mavroulis et al. (2021), requires cooperation between the Civil Protection authorities as well as interaction and close contact with the earthquake-affected local population, which is incompatible with the preventive measures to limit the spread of the SARS-CoV-2 virus and its recent mutations.

Taking into account the above data and the unprecedented conditions, which have been formed not only in Greece, but also worldwide, this paper deals with the early March 2021 Thessaly earthquake and its impacts through the prism of a multi-hazard approach of disaster risk reduction and management. We initially present the effects of the seismic sequence on the building stock of the earthquake-affected area based on our post-event field surveys, which resulted in an extended mobilization of Civil Protection authorities. Moreover, we examined the trend that prevailed in the evolution of the pandemic in the earthquake-affected area during the pre- and the post- disaster phase in order to detect possible changes (increase, decrease) or stability and to identify possible factors affecting the detected trends. Emphasis is also placed on response actions during the emergency phase, adapted to the newly introduced conditions, which require the implementation of a multi-risk approach for the effective simultaneous management of geological and biological hazards. These actions can be used as a guide for managing the effects of disasters related to geological hazards amid evolving biological hazards, not only in Greece, but also in other regions and countries, characterized by respective geoenvironmental characteristics and epidemiological properties.

2. IMPACT OF THE EARLY MARCH 2021 SEISMIC SEQUENCE IN THESSALY REGION

The earthquake-induced damage on the built environment was assessed during post-event field surveys conducted by the authors in the Elassona, Tyrnavos and Larissa Municipalities of the Larissa Regional Unit, the Palamas Municipality of the Karditsa Regional Unit and the Farkadona Municipality of the Trikala Regional Unit **(**Fig. 3). Based on the post-earthquake first building inspection conducted by the General Directorate of Natural Disaster Recovery (GDAEFK in Greek), damage was also detected in a smaller scale in Kalampaka and Trikala Municipalities of the Trikala Regional Unit and in Tempi, Kileler and Ayia Municipalities of the Larissa Regional Unit (Fig. 3).

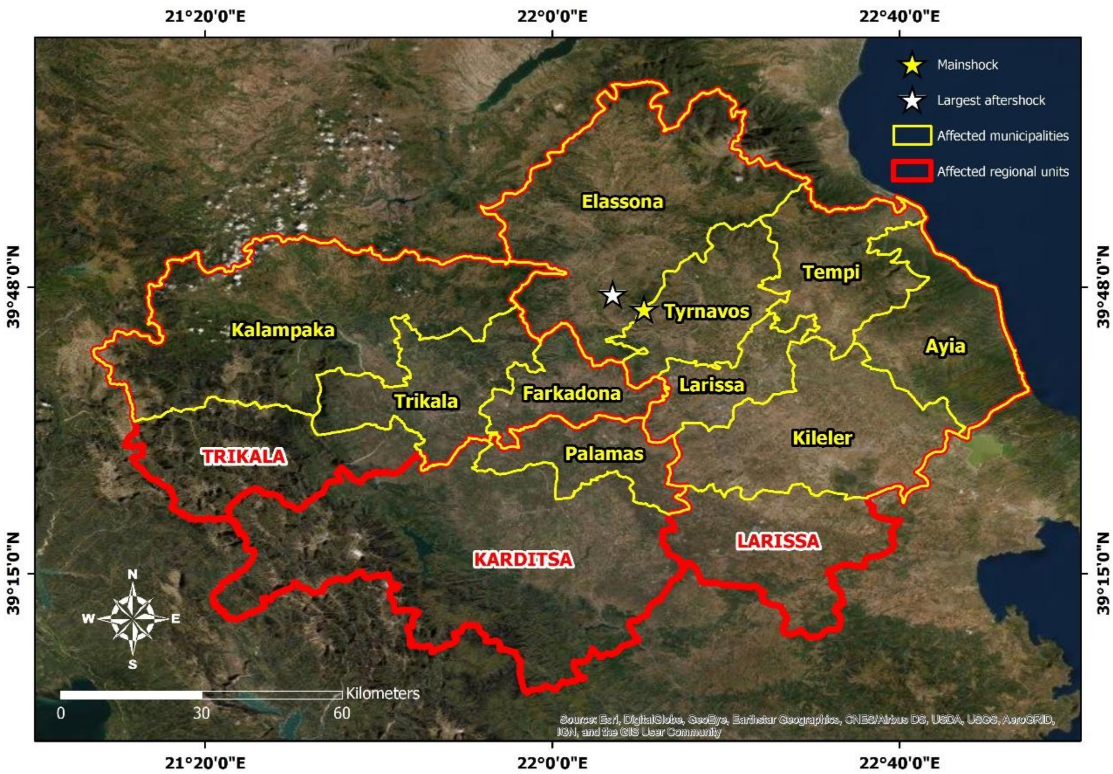

Fig. 3: The regional units (red polygons and names) and the municipalities (yellow polygons and names) of Thessaly Region affected by the early March 2021 Thessaly sequence. The earthquake epicenters of the mainshock (yellow star) and the largest aftershock (white star) are also presented.

2.1. Dominant building types in the earthquake-affected area

Based on post-event field surveys conducted by the authors in the earthquake-affected area shortly after the 3 March mainshock and according to the data provided by the

2011 Building Census of Greece (Hellenic Statistical Authority, 2011), it is concluded that the dominant building types in the affected municipalities comprise buildings with reinforced concrete frame and infill walls and buildings with load-bearing masonry walls composed of bricks and stone (Fig. 4a). Other types of buildings were also recorded comprising buildings of metal, wood and other construction material including plasterboards (Fig. 4b).

Regarding the construction period of the buildings, over two-thirds of the buildings in the affected municipalities have been constructed before 1980 (Fig. 5). This information is very important, as it highlights that the majority of the buildings in the affected area was built according to the first code for seismic-resistant design for Greece published in 1959 (Royal Decree 19-2-1959, Government Gazette 36A/26-2-1959). This code continued to be applied for about 20 years until the large destructive earthquakes that affected the largest urban centers of Greece, the 1978 Thessaloniki (Northern Greece) and the early 1981 Athens earthquakes.

Moreover, the affected area belongs to two zones of the current Greek Building Code (EAK, 2003). Its northern part belongs to **Zone I** characterized by a Peak Ground Acceleration (PGA) value of 0.16 g for a return period of 475 years, while its southern part to **Zone II** with a PGA value of 0.24 g for the same return period.

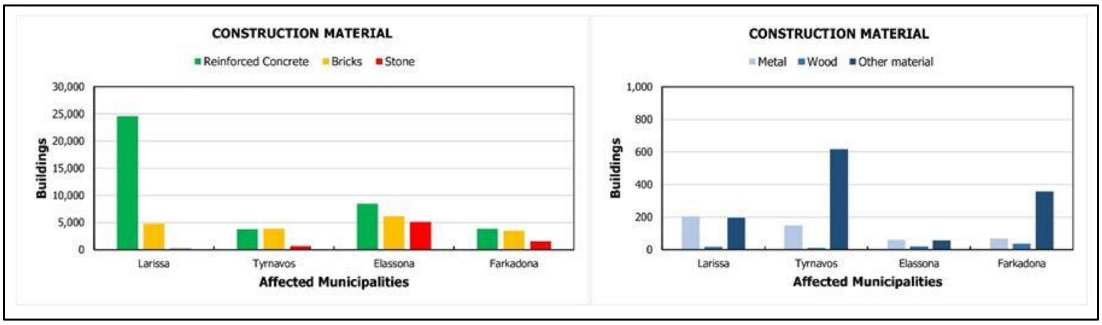

Fig. 4: (**a**) Dominant building types in the most-earthquake affected municipalities of the Thessaly Region [data from the 2011 Building Census of Greece (Hellenic Statistical Authority, 2011)]. (**b**) Buildings constructed with metal, wood and other construction materials including plasterboards were also observed.

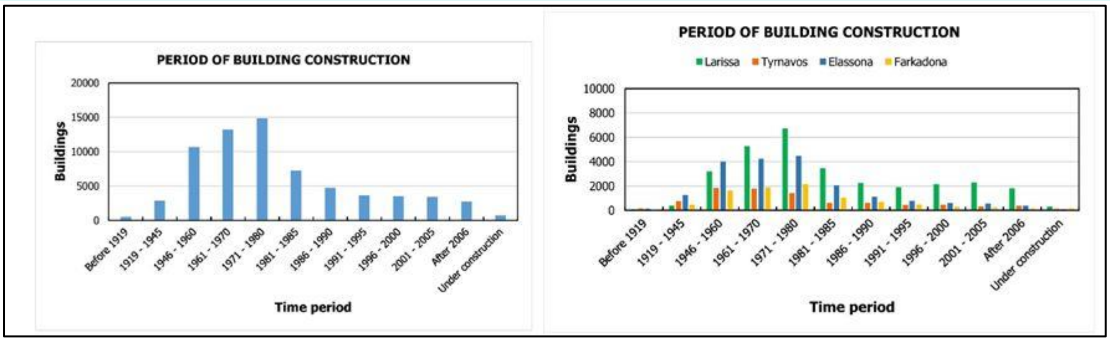

Fig. 5. (a) Over two-thirds of the buildings in the earthquake-affected municipalities have been constructed before 1980 [data from the 2011 Building Census of Greece (Hellenic Statistical Authority, 2011)].

2.2. Building damage induced by the 3 March 2021, Mw = 6.3 Thessaly earthquake

The earthquake-induced building damage was mainly observed in villages founded on recent deposits of the Titarissios and Pineios Rivers' beds (Fig. 6).

The most affected residential areas are located on the alluvial plains comprising recent deposits of Titarissios River and its main tributaries, comprising from north to south the Palaeokastro, Evangelismos, Sykia, Magoula, Domeniko, Praetorio, Amouri, Mesochori, Vlachogianni and Damassi villages (Fig. 6). Damage was also induced in villages of Pineios River plain including from west to east the Grizano, Farkadona, Zarkos and Koutsochero villages (Fig. 6). Limited damage was observed in other villages located outside the Titarissios and Pineios River alluvial plains including Verdikoussa among others (Fig. 6). The 4 March 4 2021, Mw = 6.1 earthquake aggravated damage induced by the first earthquake.

The worst affected building type is the old unreinforced buildings with load-bearing masonry walls (Figs 7, 8). These buildings suffered mainly heavy damage on their structural elements comprising vertical cracks at wall intersections due to the lack of horizontal band beams (Figs 7a-b), out-of-plane failures of the upper part of the walls attributed to the interaction between roof structure and perimeter walls and to lack of building integrity (Figs 7c-d) as well as partial or total collapse due to poor quality mortar and poor workmanship, resulting in disintegration of masonry units and loss of support to floors (Figs 7e-f).

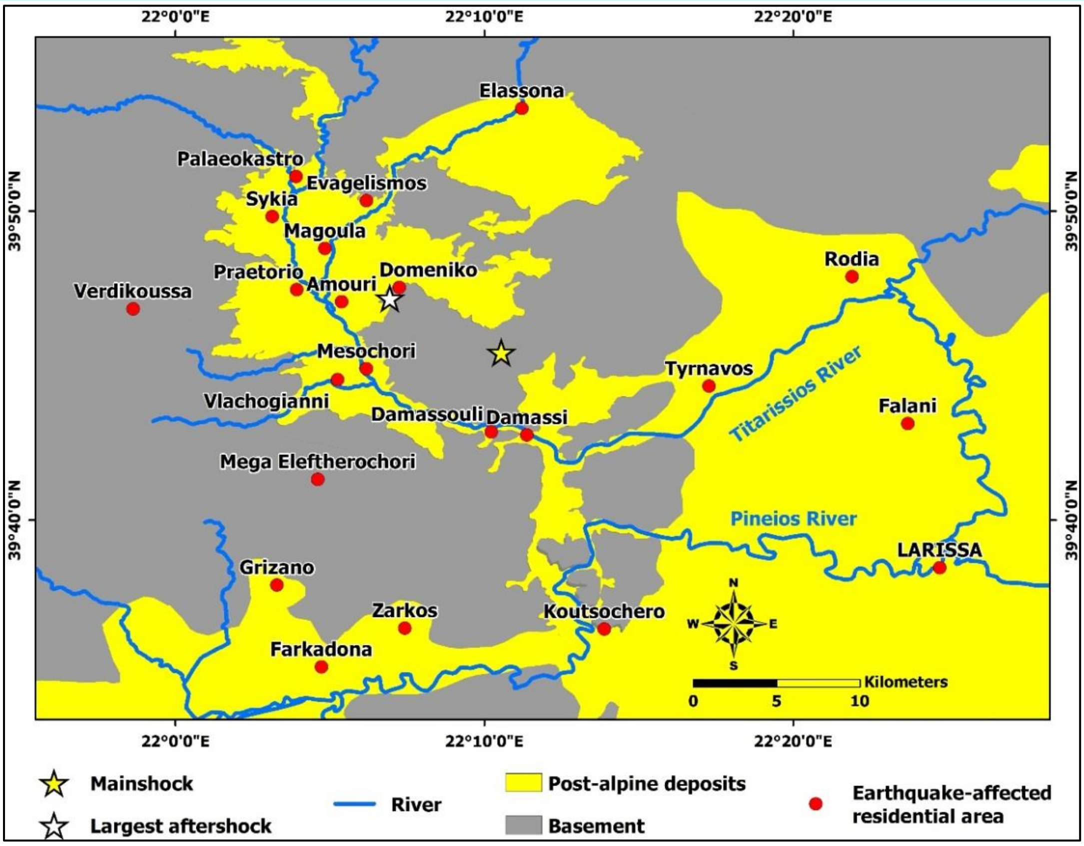

Fig. 6. Simplified geological map illustrating post-alpine deposits and their basement along with the distribution of the residential areas affected by the early March 2021 Thessaly earthquakes. The epicenters of the 3 and 4 March earthquakes (yellow and white stars respectively) in the northern part of Thessaly Basin are also presented.

Similar damage was generated in special structures, including schools, and monumental buildings, comprising churches (Fig. 8). Churches suffered damage to their load-bearing masonry walls, arches, roofs, plasters and their bell towers. Their seismic performance depended on their strengthening with longitudinal steel tie rods and on the soil foundation. A characteristic example comprises the churches in Mesochori and Vlachogianni villages located only 1.5 km away from each other. The Mesochori church founded on recent river deposits suffered partial collapse (Fig. 8a), while the Vlachogianni church founded on alpine formations and recently reinforced with steel tie rods remained intact by the earthquakes (Figs 8b-c).

Based on the results of the first building inspection conducted by GDAEFK and published on 12 March 2021, 67 school units with 142 buildings were inspected in the earthquake-affected municipalities and 47 of them needed repair before reopening. Characteristic example of a heavily affected old school building in the earthquake-affected area is the Elementary School of Damassi village, which was an over-80-year-old building with load-bearing masonry. It suffered severe structural damage by the mainshock comprising extensive cracking and partial collapse of its masonry walls (Figs 8d-f) and consequently was later demolished. It is significant to note that 63 students and 10 teachers were in the building when the earthquake struck the area. They immediately evacuated the buildings and were all safe.

Regarding the recently constructed buildings with reinforced concrete frame and infill walls, they remained intact by the earthquake in general. They suffered damage on their non-structural elements comprising detachment of plasters from infill walls, detachment of infill walls from the surrounding reinforced concrete frame and detachment of tiles from roofs and of cladding from walls (Fig. 9a-b). However, limited cases of reinforced concrete buildings that suffered structural damage including damage to columns of the ground floor were also detected (Fig. 9c).

Fig. 7: (**a**, **b**) Vertical cracks and gaps were frequently formed and propagated along the height of the bearing wall intersections. This damage is attributed to the absence of horizontal banding means, which could provide structural integrity. Examples from Mesochori village. (**c**, **d**) Failures of the upper part of the walls were also attributed to the interaction of roof structure and perimeter walls. Examples from Mesochori (**c**) and Damassi (**d**) villages. (**e**, **f**) Damage were also attributed to poor mortar and poor workmanship resulting in partial or total collapse. Views from Mesochori village.

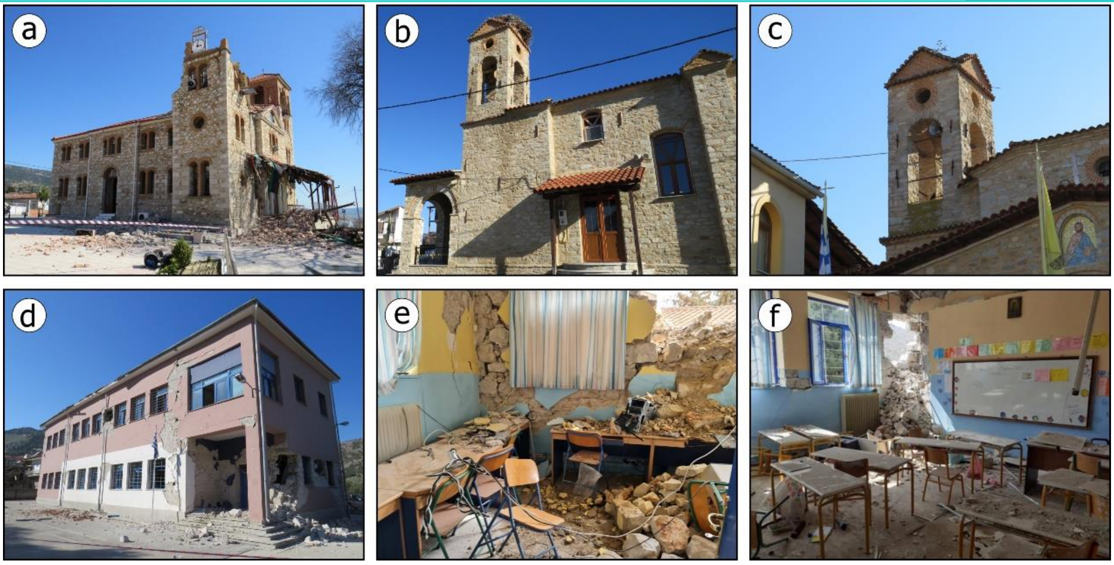

Fig. 8: (**a**) The Ayios Dimitrios church in Mesochori village, which has been founded on recent deposits, suffered damage to its walls and bell towers by the 3 March earthquake. The 4 March earthquake aggravated damage. (**b**, **c**) The Ayia Triada church in Vlachogianni village has been founded on alpine deposits and has been recently reinforced with steel ties in the bell tower and in the other parts of the construction. It remained intact by the early March earthquakes. (**d**, **e**, **f**) Damage to the old masonry elementary school of Damassi village. It suffered heavy structural damage including partial collapse of the walls.

Fig. 9. Few earthquake-affected reinforced concrete buildings suffered non-structural damage varying from slight detachment of the infill walls from the surrounding reinforced concrete frame (**a**) and cracking in the infill walls (**b**) to partial collapse of the infill walls (**c**).

2.3. Results from the first-degree inspection of buildings

Shortly after a destructive earthquake in Greece with impact on the built environment, engineers involved in disaster management in order to conduct building inspections and assess the earthquake-induced damage. The rapid visual inspections, performed immediately after the earthquake last ten up to twenty days, depending on the intensity and the damage extent and aim primarily to protect the local population, to contribute to the continuation of the basic functions of the affected community and to identify and define the earthquake-affected area.

The post-earthquake assessment procedure consists of two degrees of inspections (Lekkas et al., 2020c; Cetin et al., 2021):

(a) the first-degree inspection is a rapid visual inspection that evaluates the buildings and classifies them into two categories: usable or unusable (should not be used until re-inspection is performed) and

(b) the second-degree inspection (reinspection) that is performed only to the buildings characterized unusable during the first stage. The buildings that are reinspected, are classified in three categories regarding their usability and damage: buildings suitable for use, buildings temporarily unsuitable for use or buildings dangerous for use, depending on the observed damage. The duration of the secondary inspection is proportional to the intensity of the earthquake and the extent of the induced damage.
The results of the first-degree inspection in the earthquake-affected area in Thessaly basin were announced on 12 March 2021 by the GDAEFK (Table 1):

- A total of 5079 buildings were inspected. 4533 of them are residential. 1820 were deemed temporarily unusable and would be reinspected during the second-degree inspection.

- 148 business premises have been inspected. 49 of them were temporarily unusable and would be reinspected during the second-degree inspection.

- 66 of 132 special structures including temples and public buildings were characterized unusable. 211 of 247 warehouses were characterized temporarily unusable until the second inspection.

Based on the aforementioned, it is clear that the early March 2021 seismic sequence was destructive and had the potential for leaving thousands of residents with heavily affected properties and hundreds homeless in need of immediate temporary sheltering.

Table 1. Total buildings based on the Buildings Census of the Hellenic Statistical Authority (2011), buildings inspected by GDAEFK during the first post-earthquake building inspection and percentage of buildings inspected for the municipalities affected by the early March 2021 Thessaly sequence.

Municipality	Regional Unit	Buildings in Municipality	Inspected buildings in Municipality	Percentage of buildings inspected in Municipality (%)
Tyrnavos	Larissa	9026	1311	14.52
Farkadona	Trikala	9374	1308	13.95
Elassona	Larissa	19847	1558	7.85
Palamas	Karditsa	11085	275	2.48
Larissa	Larissa	30006	392	1.31
Tempi	Larissa	10378	62	0.60
Kalampaka	Trikala	18309	84	0.46
Kileler	Larissa	14921	46	0.31
Ayia	Larissa	10631	19	0.18
Trikala	Trikala	30135	24	0.08
Total		163712	5079	3.10

3. IMPACT OF THE COVID-19 PANDEMIC IN THE EARTHQUAKE-AFFECTED REGION OF THESSALY

The studied Thessaly earthquakes occurred within the third wave of the COVID-19 pandemic in Greece. From the third wave initiation in mid-January 2021 until the earthquake occurrence on 3 March, 49477 laboratory-confirmed COVID-19 cases and 1156 fatalities were reported throughout Greece based on the official reports of the NPHO. As regards its evolution in Thessaly Region, 2333 cases were laboratory-confirmed in the same period. Data on fatalities in Thessaly Region are not available, as they are officially announced at national level and not at regional or local level.

In early March 2021, a high viral load was detected in the community, as shown by the corresponding graph (Fig. 10). This viral load, in combination with the mutations that occurred later, had, as it turned out, the potential to cause a resurgence of the pandemic in Greece.

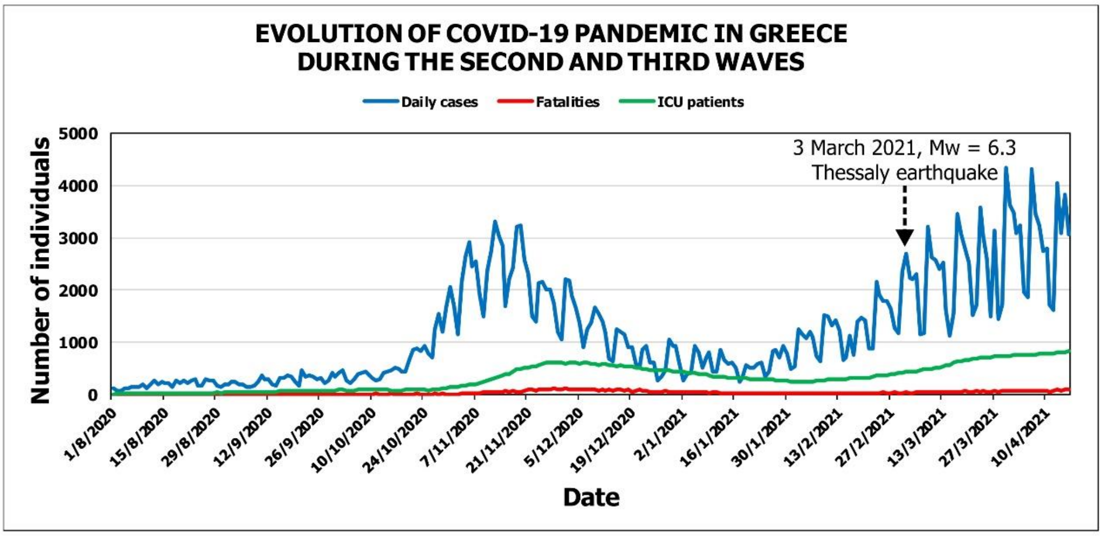

Fig. 10: The second and the third waves of the COVID-19 pandemic in Greece. The second wave lasted from the early August 2020 until mid-January 2021 and the third one started in mid-January and is evolving with the highest numbers of daily reported COVID-19 cases and related ICU patients and fatalities since the pandemic initiation (Data of daily COVID-19 cases, ICU patients and fatalities from the NPHO).

3.1. The evolution of the covid-19 pandemic in the earthquake-affected Thessaly region in the pre- and post- disaster period

We present the results of our study on the evolution of the pandemic in the earthquake-affected Thessaly Region. The analysis is based on laboratory-confirmed, daily-recorded COVID-19 cases in the earthquake-affected Karditsa, Larissa, Magnesia, and Trikala regional units of the Thessaly Region (Fig. 11) derived from the daily reports of COVID-19 epidemiological surveillance of the NPHO (2021) available on its website. These reports include the daily reported number of laboratory-confirmed COVID-19 cases, fatalities and ICU patients, their geographic and age distribution and the total number of cases, fatalities and intubations since the initiation of the COVID-19 pandemic in Greece. The number of samples, which have been tested by laboratories and Health Units of NPHO performing tests for the detection of SARS-CoV-2 virus, are also presented in these daily reports of the NPHO. All data are freely accessible to public on the respective website mentioned above.

We followed the methodology applied by Mavroulis et al. (2021) for studying the post-disaster trends and factors affecting the evolution of COVID-19 pandemic in areas affected by geological and hydrometeorological hazards in Greece. They take into account that the estimated incubation period of SARS-CoV-2, the time between exposure to the virus and emergence of symptoms ranges from 2 to 14 days (Lauer et al., 2020; WHO, 2020b) with the median incubation being 5 days (Lauer et al., 2020; WHO, 2020b) and the SARS-CoV-2 detection up to 21 days after onset of symptoms by PCR in infected patients (La Scola et al., 2020; García et al., 2020). In order to study the viral load and the infection rate in each affected regional unit before the disaster occurrence, they considered appropriate to monitor the number of daily confirmed cases in the 7 days (1 week) that preceded the disaster. In this way, any pre-existing outbreak of the novel virus in the affected areas will be perceived and the evolution of this outbreak will be possible to correlate or not with the disaster generated amid this outbreak. Taking into account all the aforementioned data, the number of daily COVID-19 cases in the present study has been tracked from 24 February to 24 March, 2021 for the Thessaly earthquake generated on 3 March 2021.

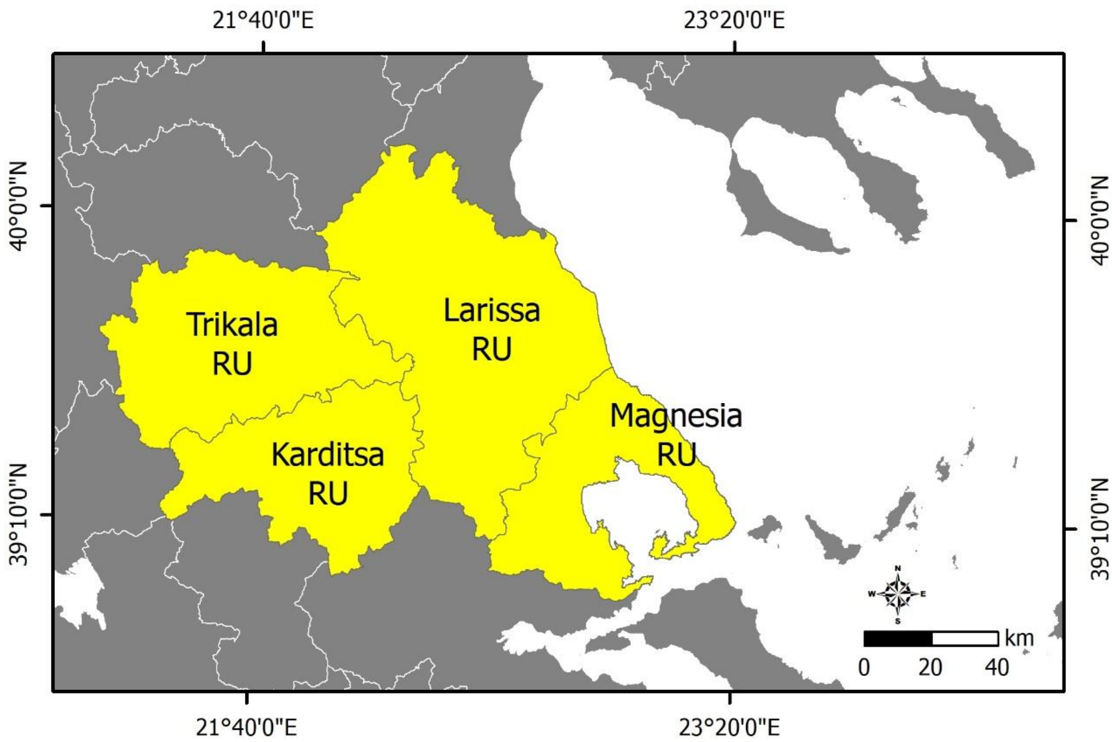

Fig. 11. The regional units (RU) of the Region of Thessaly used in our study in order to detect the evolution of the COVID-19 pandemic in the Thessaly Region.

3.1.1. Results for the affected Karditsa regional unit

In the graph for the affected Karditsa regional unit, the confirmed COVID-19 cases are presented for the week before the earthquake and for the following 3 weeks (Fig. 12). More specifically, 73 confirmed COVID-19 cases were reported during the selected pre-earthquake period. During the post-earthquake period, 338 COVID-19 cases were recorded. In particular, 79 cases were recorded during the first week after the earthquake, 114 cases during the second and 145 cases during the third. Based on this case distribution, it is concluded that the pandemic evolution in Karditsa regional unit is characterized by an increase in the daily confirmed COVID-19 cases during the studied post-disaster period. More specifically:

- the total cases of the first week following the earthquake were 6 more than those of the week before the earthquake,
- the total cases of the second week following the earthquake were 35 more than those of the first week following the earthquake,
- the total cases of the third week following the earthquake were 31 more than those of the second week following the earthquake.

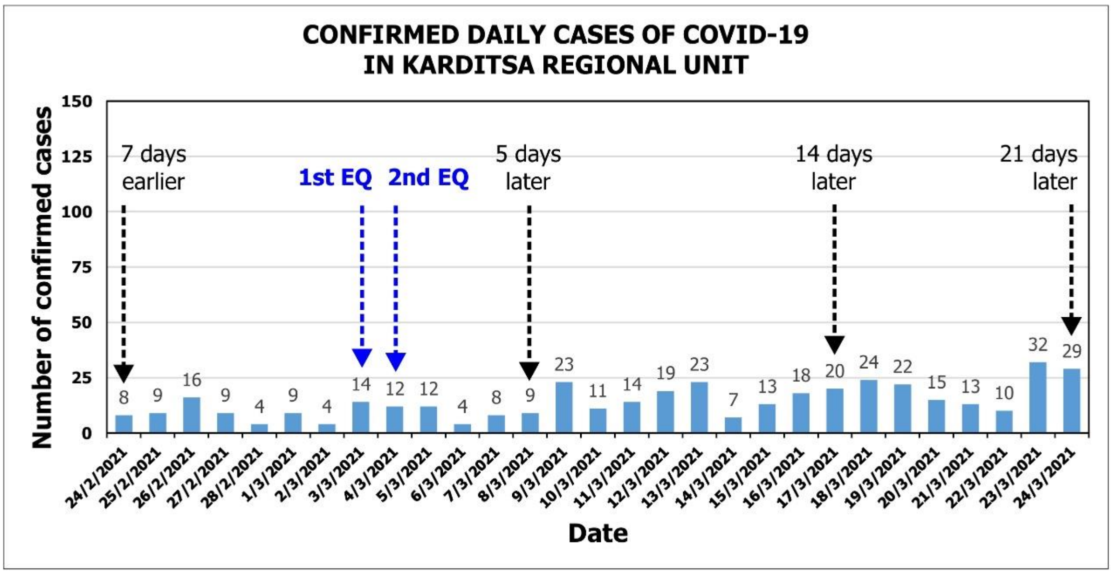

Fig. 12. Graph of the daily confirmed COVID-19 cases in the local population of Karditsa regional unit of Thessaly Region, which was affected by the destructive 3 and 4 March 2021 earthquakes. The highlighted dates refer to the 3 March 2021 earthquake.

3.1.2. Results for the affected Larissa regional unit

In the graph for the affected Larissa regional unit, the confirmed COVID-19 cases are presented for the week before the earthquake and for the following 3 weeks (Fig. 13). More specifically, 462 laboratory-confirmed COVID-19 cases was reported during the selected pre-earthquake period. During the post-earthquake period, 1592 COVID-19 cases were recorded. In particular, 477 cases were recorded during the first week after the earthquake, 514 cases during the second and 601 cases during the third. Based on this case distribution, it is concluded that the pandemic evolution in Larissa regional unit is characterized by an increase in the daily confirmed COVID-19 cases during the studied post-disaster period. More specifically:

- the total cases of the first week following the earthquake were 15 more than those of the week before the earthquake,
- the total cases of the second week following the earthquake were 37 more than those of the first week following the earthquake,
- the total cases of the third week following the earthquake were 87 more than those of the second week following the earthquake.

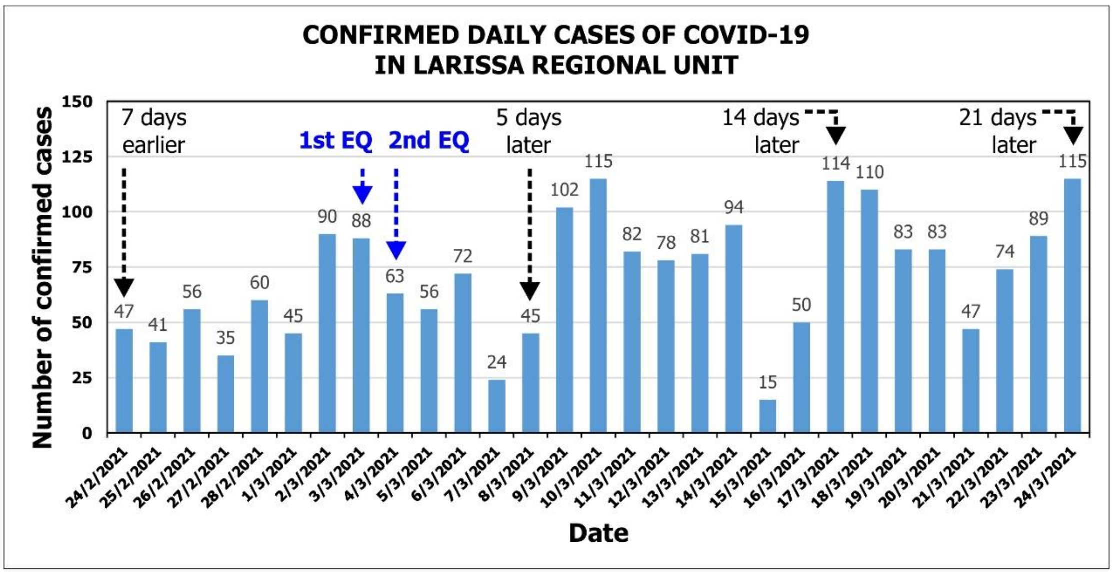

Fig. 13. Graph of the daily confirmed COVID-19 cases in the local population of Larissa regional unit of Thessaly Region, which was affected by the destructive 3 and 4 March 2021 earthquakes. The highlighted dates refer to the 3 March 2021 earthquake.

3.1.3. Results for the affected Magnesia regional unit

In the graph for the affected Magnesia regional unit, the confirmed COVID-19 cases are presented for the week before the earthquake and for the following 3 weeks (Fig. 14). More specifically, 119 confirmed COVID-19 cases were reported during the selected pre-earthquake period. During the post-earthquake period, 464 COVID-19 cases were recorded. In particular, 113 cases were recorded during the first week after the earthquake, 145 cases during the second and 206 cases during the third. Based on this case distribution, it is concluded that the pandemic evolution in Magnesia regional unit is characterized by an increase in the daily confirmed COVID-19 cases during the studied post-disaster period. More specifically:

- the total cases of the first week following the earthquake were 6 less than those of the week before the earthquake,

- the total cases of the second week following the earthquake were 32 more than those of the first week following the earthquake,
- the total cases of the third week following the earthquake were 61 more than those of the second week following the earthquake.

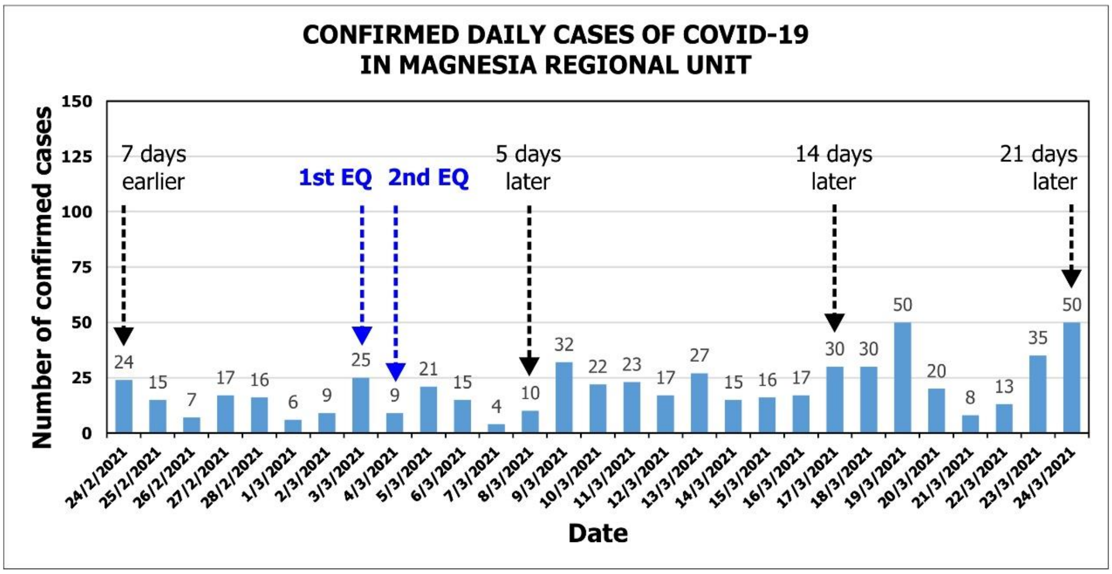

Fig. 14. Graph of the daily confirmed COVID-19 cases in the local population of Magnesia regional unit of Thessaly Region, which was affected by the destructive 3 and 4 March 2021 earthquakes. The highlighted dates refer to the 3 March 2021 earthquake.

3.1.4. Results for the affected Trikala regional unit

In the graph for the affected Trikala regional unit, the confirmed COVID-19 cases are presented for the week before the earthquake and for the following 3 weeks (Fig. 15). More specifically, 45 confirmed COVID-19 cases were reported during the selected pre-earthquake period. During the post-earthquake period, 190 COVID-19 cases were recorded. In particular, 39 cases were recorded during the first week after the earthquake, 61 cases during the second and 90 cases during the third. Based on this distribution of cases, it is concluded that the pandemic evolution in Trikala regional unit is characterized by an increase in the daily confirmed COVID-19 cases during the selected post-disaster period. More specifically:

- the total cases of the first week following the earthquake were 6 less than those of the week before the earthquake,
- the total cases of the second week following the earthquake were 22 more than those of the first week following the earthquake,
- the total cases of the third week following the earthquake were 90 more than those of the second week following the earthquake.

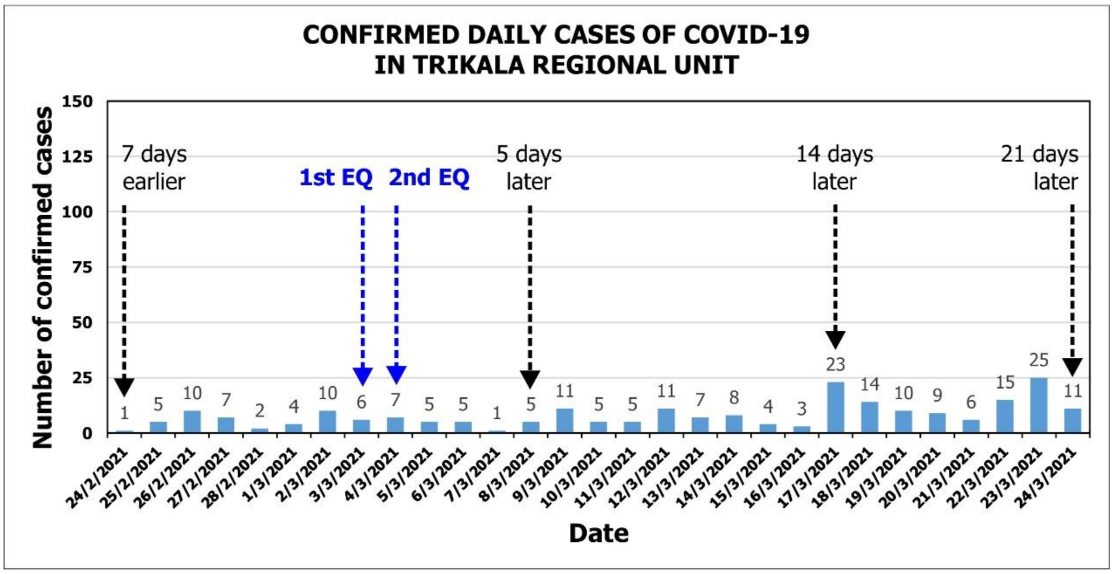

Fig. 15. Graph of the daily confirmed COVID-19 cases in the local population of Trikala regional unit of Thessaly Region, which was affected by the destructive 3 and 4 March 2021 earthquakes. The highlighted dates refer to the 3 March 2021 earthquake.

3.1.5. Results for all affected regional units

The daily cases in Karditsa, Larissa, Magnesia and Trikala regional units (Fig. 16) showed a stability from the beginning of the third wave in mid-January until 2 March. During this period, the total confirmed cases on a daily base in all studied regional units never exceeded 90. However, from 3 to 24 March, an increase is detected in the number of totally confirmed cases in the above regional units. This new trend starts with a total of 133 cases on the mainshock occurrence day, continues with a total of 153 daily cases within a week from the earthquake, with a total of 187 daily cases within two weeks from the earthquake and reaches a total of 205 daily cases within three weeks from the mainshock (Fig. 16).

This increasing trend is detected in the cases per week in all the regional units. In the week following the earthquake, the total recorded cases in all regions are 685, in the second week after the earthquake they amounted to 834 and in the third week to 1042 (Fig. 16).

Based on the above records and taking into account the median incubation period of the virus, which is 5 days (Lauer et al., 2020; WHO, 2020), the increasing trend observed in the first week after the earthquake is not attributed to the earthquake impact on the natural and built environment in the northern part of Thessaly.

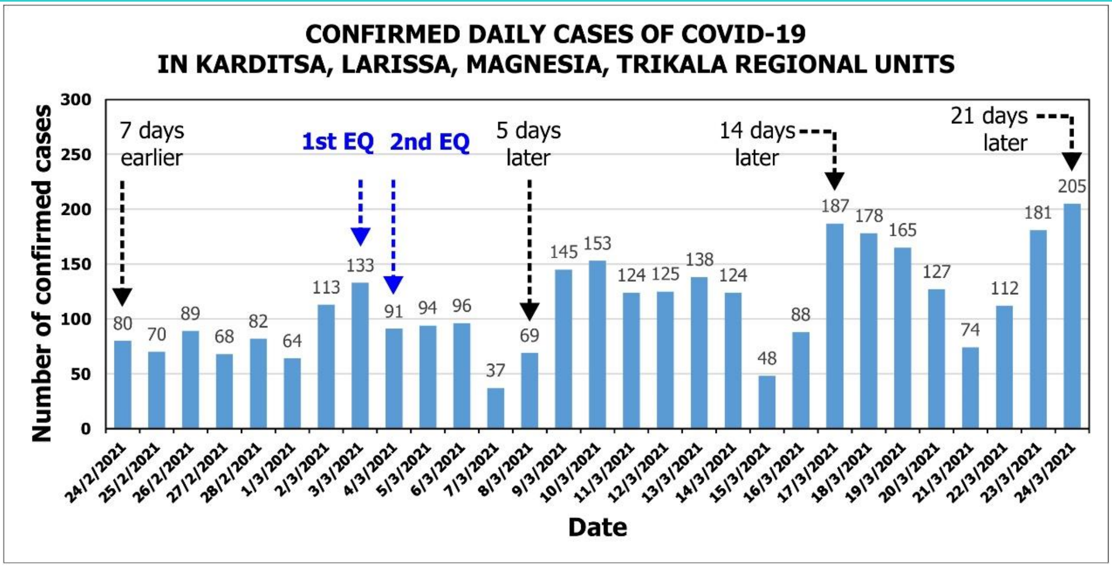

Fig. 16. Graph of the daily confirmed COVID-19 cases in the local population of the studied regional units of Thessaly Region, which were affected by the destructive 3 and 4 March 2021 earthquakes. The highlighted dates refer to the 3 March 2021 earthquake.

4. MULTI-HAZARD EMERGENCY RESPONSE AFTER THE EARLY MARCH THESSALY EARTHQUAKES

4.1. Difficulties in dealing with the compound emergency – geological hazard amid an evolving biological hazard

As it emerged from the above, the 3 March 2021 Thessaly earthquake was destructive resulting in severe structural and non-structural damage to old and unreinforced masonry buildings in the earthquake-affected villages (Fig. 9) and subsequently in dozens of homeless and more than 300 affected people, whose properties were severely damaged. This fact resulted in the mobilization of all Civil Protection authorities to deal with the emergency and the immediate management of the earthquake effects. This mobilization was the first for a compound emergency in 2021 and the first during the third wave of the COVID-19 pandemic in Greece.

The Civil Protection authorities were also mobilized and involved in the emergency operations after the 30 October 2020, Mw = 7.0 Samos earthquake generated during the second pandemic wave. Details on the emergency response actions for management of the geological hazard amid the pandemic are presented by Mavroulis et al. (2021) on the study of post-disaster factors affecting the pandemic evolution in the disaster-affected area of the North Aegean Region among others. The points that make this compound emergency unique are the following:

- Thessaly was hit by the earthquake amid the third pandemic wave, which began in mid-January and is evolving since then. The third wave in Greece is characterized by the highest numbers of daily-confirmed COVID-19 cases, ICU patients and fatalities from the initiation of the pandemic in Greece. During this phase, SARS-CoV-2 has mutated in a variety of ways since it first began spreading in humans in 2019. In the past few months, several SARS-CoV-2 variants, which were first detected in the United Kingdom, South Africa, Brazil and California, presented with mutations that have changed the virus enough to alter its impact on people, as they are more contagious than the strain commonly circulating in Europe and the United States (Liu et al., 2021; Khan et al., 2021; van Dorp et al., 2021).
- The pre-disaster viral load in the regional units of Thessaly Region was large and of high potential for resulting in an outbreak of COVID-19 cases during the post-earthquake period with adverse effects not only on the public health but also to the earthquake emergency response actions and recovery.
- The earthquake-affected mainland area of Thessaly was easily accessible and close to large urban centers with higher viral load and infectious rates.
- The population density in Thessaly is higher than those other areas affected by earthquakes so far amid the COVID-19 pandemic.
- Thessaly was hit amid the third pandemic period, but with a powerful weapon to deal with its adverse effects. Widespread testing and COVID-19 vaccines have provided an opportunity to slow the SARS-CoV-2 spread and reduce chances of developing severe infection and mortality. Trials confirm that COVID-19 vaccines drastically reduce the severity of COVID-19 infections, prevent deaths and curb the spread of the pandemic (Rutkowski et al., 2021; Levine-Tiefenbrun et al., 2021).

All these issues made the case of the earthquake-affected Thessaly more difficult in terms of selecting appropriate measures to manage the earthquake effects, which at the same time should be compatible with the applied pandemic mitigation measures.

4.2. Multi-hazard emergency response actions

The Directorate of Civil Protection of the Region of Thessaly activated the mechanism in accordance with the “Enceladus” plan published by the General Secretariat for Civil Protection for dealing with the earthquake emergency and earthquake effects. This plan was issued on February 2020 before the initiation of the pandemic in Greece and it is characterized by a single hazard approach to manage earthquake emergencies and related effects, in which hazards are treated as isolated and independent phenomena.

The Directorate of Civil Protection of the Region of Thessaly was in full cooperation and constant communication with the Ministry of Citizen Protection and the relevant Ministries during the first hours and days of the post-disaster phase in order to effectively respond to the emergency situation.

The on-site operations coordination center was established in an open space (camp) with the participation of all involved Civil Protection authorities and services, and in constant communication with the Deputy Minister for Civil Protection and Crisis Management, and the Secretary General for Civil Protection. In these spaces, the participants were not only safe from the ongoing aftershocks, but also from further transmission of the new virus. These facilities provided continuous ventilation and space for maintaining physical distancing among participants.

Moreover, specially designed places for information and coordination meetings were designated in the emergency shelter set up in an open football field of the earthquake-affected Damassi village. This shelter was set up for the accommodation of homeless and affected people with areas designated for emergency supplies distribution, medical care, health screening and monitoring, psychological support of the accommodated as well as for voluntary services (Fig. 17).

During the earthquake emergency, several actions were conducted comprising search and rescue operations, first-aid treatment and medical care, provision of emergency supplies, provision of emergency shelters, building inspections and assessment of damage extent.

Many of these actions are characterized by continuous interaction and close contact of the Civil Protection staff with the local population of the earthquake-affected area. This interaction amid the COVID-19 pandemic is incompatible with its mitigation measures. For this reason, many of the actions, which are characterized by high transmission risk among the affected population, have been adjusted to the new conditions of a multi-risk approach to disaster risk reduction and management. This adjustment comprised:

- Organization of camp sites with tents in many earthquake-affected villages including Damassi (Fig. 17), Mesochori, Amouri and Vlachogianni.
- Temporary sheltering of homeless and affected in hotels in nearby urban centers. Three hotels in Trikala and two in Larissa were leased by the Region of Thessaly in cooperation with the municipalities of the area for the residents who did not want to spend the night in their homes after the earthquake. It is important to mention

that the hotels in Trikala hosted about 300 residents during the first days of the emergency response.

- Various types of sheltering were also used shortly after the earthquake for the immediate temporary accommodation of the affected people, including semi-permanent container-type structures (Fig. 17a) and camper vans (Figs 17a-b).

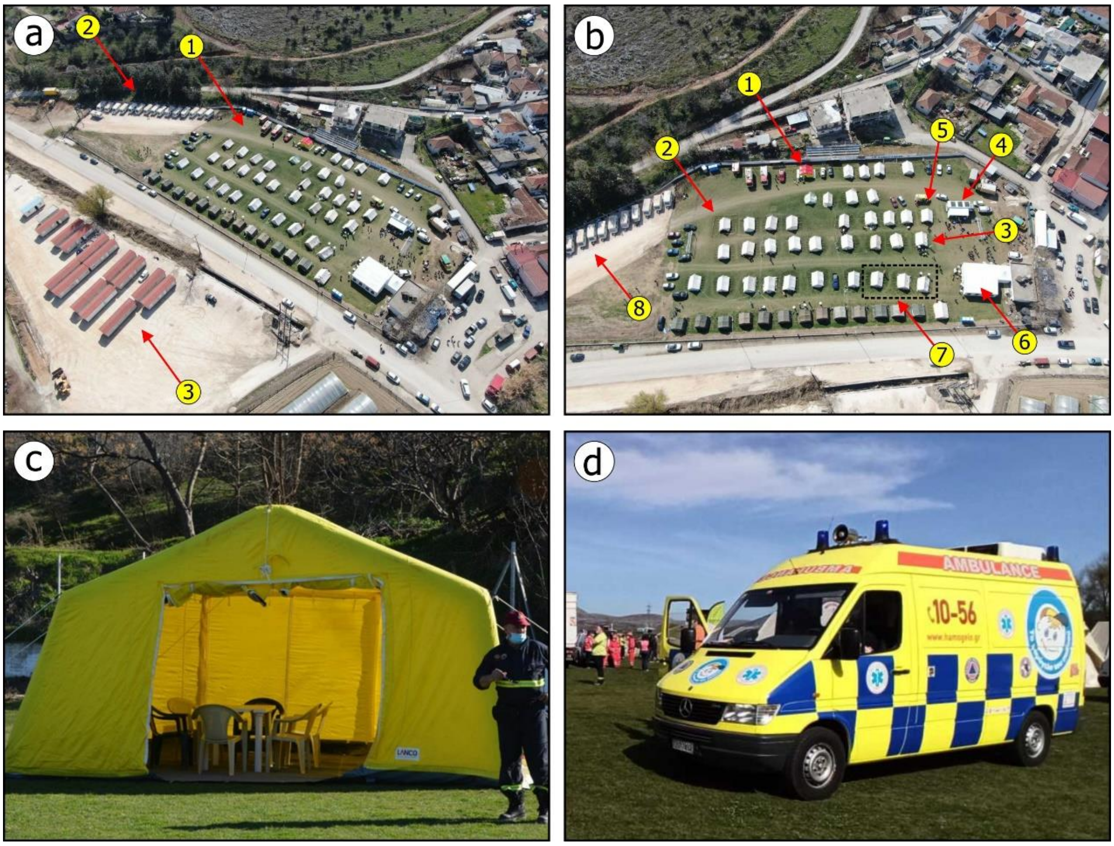

Fig. 17. (**a**) Drone view of the emergency shelter (**1**) in the earthquake-affected Damassi village. In addition to the tents, camper vans were used (**2**). They were installed in a specially designed municipal area (**2**). Few days later, container-type houses (**3**) were also set up for the temporary sheltering of the affected people who lost their properties. (**b**) Drone view of the Damassi emergency shelter with its facilities. **1**: Operations coordination center; **2**: Isolation tent intended for separating suspected COVID-19 cases and managing mild COVID-19 patients; **3**: Tent of the National Public Health Organization staff; **4**: Mobile facility staffed by specialized personnel comprising psychologist, social worker, volunteer doctor, in order to provide medical, social, psychological and material support to adults and kids; **5**: Mobile Intensive Care Unit. The mobile facility with the specialized personnel and the mobile Intensive Care Unit was provided by the volunteer organization "The Smile of the Child"; **6**: Food distribution facilities; **7**: Tents for involved voluntary teams; **8**: Camper vans area. (**c**) Close view of the Operational Coordination Center. (**d**) The aforementioned Mobile Intensive Care Unit.

The organization of many temporary shelters for the affected population, the use of hotels to accommodate homeless, and the immediate use of various means of accommodation contributed substantially to avoid overcrowding in a single emergency shelter, to maintain the physical distance between the accommodated people and to limit the transmission risk among the affected population and the staff involved in disaster management.

On late March 2021, tents were gradually removed from the Damassi emergency shelter. Most of residents were transferred to adjacent container-type structures in Damassi village and Elassona town as well as in camper vans, while others stayed in hotels in Trikala and in intact houses of their close family and friendly environment. Some of the affected people rent houses using the provided financial support comprising rent allowance.

The modification of food distribution process in the emergency shelters in Thessaly was considered mandatory amid the COVID-19 pandemic. In the pre-pandemic period, food in emergency shelters were served buffet style and self-service. Amid the COVID-19 pandemic, meals in the Damassi emergency shelter were packaged and served by staff, which wore masks and disposable gloves throughout the preparation and serving of meals (Fig. 18). Similar modifications were also applied in the provision of emergency supplies from individuals and voluntary teams.

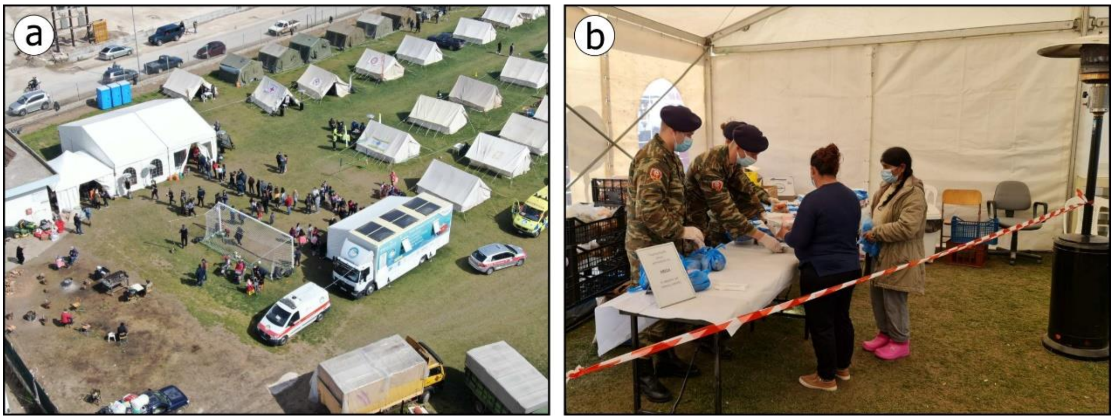

Fig. 18. (**a**) The Damassi emergency shelter had specially designed area for food and emergency supplies distribution. (**b**) Modification of the food distribution was mandatory amid the COVID-19 pandemic. Meals were served by staff wearing masks and disposable gloves throughout the preparation and the distribution process.

Temporary isolation facilities for separating suspected COVID-19 cases and managing mild COVID-19 patients, who do not require hospitalization, but ample medical support, were designated in the emergency shelters (Fig. 19a). These facilities were intended for residents (a) tested positive for COVID-19 and having mild symptoms, (b) waiting on a test or test results and having mild symptoms and (c) having no symptoms, but having been told to self-isolate. Moreover, beds, oxygen cylinders and equipment for monitoring oxygen levels were also available, while access to health assessment, medical care and counseling were available any time and kindly provided not only by the state authorities but also from specially trained volunteers (Fig. 17). This approach was essential for further prevention of transmission in case of detection of a suspected COVID-19 case.

Moreover, the involved staff of the Civil Protection authorities applied pandemic mitigation measures for their own safety and the safety of the affected community. These measures comprised mandatory use of face mask indoors and outdoors as well as regular hand washing and using of hand sanitizers according to the guidelines of the NPHO.

One of the most important actions carried out during the emergency response in the earthquake-affected area was the massive and regular screening tests in order to give the possibility to the authorities to detect virus circulation within the affected community and to further isolate the COVID-19 cases in order to prevent virus transmission among the local population of the tested earthquake-affected villages. This action took place after consultation of the Region of Thessaly with the earthquake-affected municipalities and the NPHO and was carried out by the Mobile Health Units (MHU) of the NPHO (Figs 19b-d). The action included free rapid screening tests targeted in the affected Koutsochero, Damassi, Vlachogianni, Mesochori, Amouri, Domeniko, Praetorio, Sykia, Magoula and Evagelismos villages and in Elassona and Tyrnavos towns. It began shortly after 3 March and continued during the emergency and recovery phase (4-20 March).

The screening tests showed that the majority of residents tested in the aforementioned earthquake-affected villages were negative (Table S1). This means that the viral load within the earthquake-affected villages was low at the initiation of the emergency situation and remained at the same level for many days. Due to the fact that there was no virus transmission among local population in the affected villages, the infection rate also remained very low. The results of the massive and regular screening tests showed that the earthquake-affected villages remained safe from virus transmission at least for the critical studied period (3-24 March 2021) and confirmed that the adopted response actions for dealing with the earthquake emergency amid the evolving pandemic were effective.

Fig. 19. (**a**) Isolation tent intended for separating suspected COVID-19 cases and managing mild COVID-19 patients in Damassi emergency shelter. (**b**, **c**) Mobile Health Units of the NPHO were available and properly equipped in the earthquake-affected villages for conducting mass rapid screening tests for the detection of COVID-19 cases among the affected population. (b) A unit in Mesochori village and (**c**, **d**) in Damassi emergency shelter. The Civil Protection staff was also screened for COVID-19 (**d**).

However, there are several factors that can affect the evolution of the pandemic in an area during the post-disaster period, including the demographic characteristics and the ease of access to the affected area and the epidemiological characteristics of the neighboring areas (Mavroulis et al., 2021). As regards the meizoseismal area in Thessaly, its proximity to urban centers with high population density and higher numbers of daily reported COVID-19 cases, including Larissa city, could make the earthquake-affected area more vulnerable to transmission of the new virus and its mutations, especially during the first days of the emergency. However, restrictions of non-essential movements into or out of the municipalities imposed throughout Greece in early March 2021 constituted a measure that also contributed to keep the earthquake-affected area safe from SARS-CoV-2 emergence and transmission.

5. DISCUSSION – CONCLUSIONS

Based on the aforementioned, it can be concluded that in early March 2021 an increasing trend is detected in the COVID-19 pandemic evolution in the Region of Thessaly. This trend resulted from the continuous increase of laboratory-confirmed daily-recorded COVID-19 cases in the region and coincided with the occurrence of the seismic sequence, which included the mainshock on 3 March and the aftershock the following day.

Despite the extensive impact on the built environment induced by the first earthquake and aggravated by the second, and the hundreds of homeless and in need of immediate sheltering, there was no increase in daily cases in the earthquake affected villages. This fact is demonstrated by the results of the massive screening testing targeted in the affected villages and towns by NPHO throughout the duration of the earthquake emergency and especially in the first critical phase of the post-disaster period, which we analyzed in the frame of this study. Moreover, despite the high viral load recorded in the nearby major urban centers (mainly in the adjacent Larissa city and secondarily in smaller cities), the earthquake-affected villages were characterized by different epidemiological characteristics comprising very low to negligible viral load from early to late March.

In order to prevent SARS-CoV-2 transmission in the earthquake-affected community, the involved authorities had to adapt response actions, already included in the existing disaster management plans, to the new conditions formed by the earthquake occurrence amid the pandemic. This adaptation was mandatory due to the fact that the response actions to the earthquake emergency were incompatible to the pandemic mitigation measures announced by both the NPHO and the WHO.

More specifically:

- Gathering of many affected people in a small number of emergency shelters would lead to overcrowded conditions in small spaces, which is incompatible with maintaining physical distance to limit further spread of SARS-CoV-2 virus within the community.
- The distribution of emergency supplies was done with bare hands and with participation of many people, who used and exchanged objects and equipment and often touched the same surfaces. This action is incompatible with pandemic control

measures and in particular with regular hand washing, continuous disinfection of surfaces, use of personal items and avoidance of common items and equipment use.

- In the emergency shelters, some guests may not report fever or any of the signs and symptoms of a respiratory infection, because they believe that their symptoms do not require medical attention. This is incompatible with the temporary isolation that should be followed in the case of people who have tested positive for the novel virus and have mild symptoms, are waiting for test results and have mild symptoms, and have no symptoms but have come into contact with a COVID-19 case.

The above contradicting issues, which arose from the single-hazard approach to disaster management, require the adjustment of actions in the light of a multi-hazard approach. The main goal of earthquake response actions amid an evolving biological hazard, the COVID-19 pandemic, is not only to support those affected by the earthquake and its related hazards, but also to protect those affected by the adverse effects of an uncontrolled transmission of the novel virus in the community, attributed to neglecting design and implementation of immediate response actions.

In the case of the Thessaly seismic sequence, the actions adapted to the new conditions shaped by the collided geological and biological hazards, concerned the provision of emergency shelters, the distribution of emergency supplies to the earthquake-affected population and the provision of medical care to people accommodated in emergency shelters.

The adapted measures comprised:

- Increase of the number of the emergency shelters in the earthquake-affected villages and the adjacent cities for avoiding overcrowding in limited emergency shelters.
- Inclusion of different types of emergency shelters for temporary sheltering of the affected people (hotels, intact houses of the close family and friend environment, container-type houses shortly after the earthquake, camper vans) for maintaining physical distancing between earthquake-affected families.
- Designation of isolation facilities in the emergency shelters in order to prevent further transmission in the facilities and the community in case of detection of COVID-19 cases.
- Screening tests in the earthquake-affected residential areas for detecting cases as quick as possible and preventing further transmission.

- Modification of the process followed for the distribution of emergency supplies to the earthquake-affected people for avoiding further transmission by items and surfaces.

The above-mentioned conflicting issues and the measures adopted to resolve them highlights the urgent need of a multi-hazard approach to disaster risk reduction and disaster management. This approach is widely encouraged in international frameworks and national policies for action on the disaster risk reduction. For example, the Sendai Framework for Disaster Risk Reduction 2015-2030 clearly stated that “disaster risk reduction needs to be multi-hazard”. This statement seems to be the most effective approach as interactions between hazards have been already identified (e.g., Gill and Malamud, 2014, 2016) and have high potential to generate impacts which are more severe than the sum of the single impacts.

In the case of the earthquake-affected villages, it seems that the synergy of pandemic mitigation measures and actions adapted to manage the effects of the earthquake amid the COVID-19 pandemic was effective, as the majority of the tested residents in the earthquake-affected villages were negative throughout the response phase for the earthquake emergency. The proximity of the earthquake-affected villages to large urban centers with higher viral load does not seem to affect the villages as at that time, there were restrictions of non-essential movements into or out of the municipalities.

Taking into account the above adapted measures and their positive results, it can be said that they constitute a good practice and an important lesson for disaster management and disaster risk reduction amid the evolving pandemic. This multi-hazard approach could be also adopted and applied in respective collisions of geological and biological hazards and related disasters not only in Greece, but also in other countries with respective geoenvironmental characteristics and similar epidemiological features.

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Table S1. Results of the massive rapid screening tests for COVID-19 detection in the earthquake-affected area of the Region of Thessaly. Data derived from official reports of the NPHO and announcements of the Region of Thessaly.

Massive Rapid Screening Tests for COVID-19 Detection in the earthquake-affected area of the Region of Thessaly				
Date	**Area**	**Total conducted rapid tests**	**Negative**	**Positive**
4 March 2021	Damassi	19	19	0
	Mesochori	27	27	0
	Falani	156	155	1
	Kileler	76	73	3
	Tempi	29	29	0
	Larissa	456	448	8
5 March 2021	Damassi	10	10	0
	Mesochori	8	8	0
	Amouri	11	11	0
	Ayia	96	95	1
	Stomio	84	84	0
	Larissa	690	678	12
6 March 2021	Larissa	444	434	10
7 March 2021	Damassi	23	23	0
	Mesochori	7	7	0
	Magoula	36	36	0
	Domeniko	20	20	0
	Praetorio	41	41	0
	Vlachogianni	61	61	0
8 March 2021	Koutsochero	42	42	0
	Amygdalea	5	5	0
	Mandra	51	51	0
	Amouri	9	9	0
	Damassi	10	10	0
	Tyrnavos	32	31	1
	Mesochori	7	5	2
9 March 2021	Domeniko	10	10	0
	Vlachogianni	23	23	0
	Praetorio	25	25	0
	Magoula	31	31	0
	Mesochori	11	11	0
	Amouri	7	7	0

	Damassi	10	10	0
	Elassona	81	81	0
	Farsala	209	209	0
	Larissa	660	635	25
10 March 2021	Koutsochero	3	3	0
	Mandra	19	19	0
	Damassi	14	14	0
	Mesochori	10	10	0
	Amouri	11	11	0
	Tyrnavos	38	36	2
	Larissa	453	440	13
11 March 2021	Larissa	326	319	7
	Ayios Antonios	134	133	1
	Damassi	13	13	0
	Evagelismos	59	59	0
	Kileler	114	114	0
	Mesochori	4	4	0
	Palaeokastro	22	22	0
	Tempi	25	25	0
	Sykia	10	10	0
12 March 2021	Larissa	687	674	13
	Ayia	82	82	0
	Mesochori	7	7	0
	Vlachogianni	21	21	0
	Damassi	15	15	0
	Tyrnavos	31	31	0
13 March 2021	Larissa	434	0	5
	Rachoula	17	17	0
	Elassona	146	146	0
	Magoula	11	11	0
	Mesochori	5	5	0
	Vlachogianni	5	5	0
	Amouri	8	8	0
	Praetorio	5	5	0
	Damassi	17	17	0
17 March 2021	Larissa	574	565	9
	Domeniko	2	2	0
	Mesochori	14	14	0
	Amouri	11	11	0
	Milaea	86	83	3

	Damassi	19	19	0
	Palaeokastro	17	17	0
20 March 2021	Larissa	175	171	4
	Amouri	5	5	0
	Magoula	58	57	1
	Damassi	13	13	0
	Mesochori	13	12	1