



Emergency response, intervention, and societal recovery in Greece and Turkey after the 30th October 2020, $M_w = 7.0$, Samos (Aegean Sea) earthquake

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Abstract

On 30 October 2020, an $M_w = 7.0$ earthquake struck the Eastern Aegean Sea with considerable impact on Samos Island in Greece and the area of Izmir in Turkey. It was the most lethal seismic event in 2020 worldwide, and the largest and most destructive in the Aegean Sea since the 1955 earthquake that also affected both countries. The Civil Protection authorities in Greece and Turkey were effectively mobilized responding to the earthquake emergency. The main response actions comprised initial announcements of the earthquake and first assessment of the impact, provision of civil protection guidelines through emergency communication services, search and rescue operations, medical care, set up of emergency shelters and provisions of essential supplies, psychological support, as well as education, training activities and financial support to the affected population. From the comparison of the Civil Protection framework and the implemented response actions, it is seen that actions at both sides of the eastern Aegean Sea, followed a single-hazard approach in disaster management with similar response activities coordinated by a main Civil Protection agency, which was in close cooperation with the respective authorities at a national, regional and local level. Based on the presented information, it is concluded that the post-earthquake response and emergency management were satisfactory in both countries, with valuable lessons learnt ahead of the next major earthquake. To this end, many aspects can be further addressed to enhance community resilience and introduce a multi-hazard approach in (natural and man-made) disaster management.

Keywords Disaster management · Post-earthquake response · Emergency management

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1 Introduction

The efforts focusing on Disaster Management and Disaster Risk Reduction (DRR) have become increasingly important worldwide. Scientific knowledge about the sources of earthquake ground motion as well as of the safety of the built infrastructure to seismic excitations requires in-depth study of the observations made in-situ. Among the pioneers in disaster management, Japan holds a leading position, having experienced several devastating disasters throughout its history that have resulted in accumulated experience from major disasters, ongoing Disaster Management practices, and applied DRR policies. These disasters challenged authorities and individuals to cope with important issues in managing the adverse disaster effects that had no precedent in Japanese history. The collectively acquired experience contributed to the development of an effective disaster management plan that included detailed schemes for preparedness (planning, investment, and risk education), early warning and response (emergency warning, evacuation support, and emergency rescue activities), as well as recovery and reconstruction (rehabilitation).

Another country which has experienced similarly impactful disasters in its recent history sharing an equivalent level of seismic risk with Japan is the United States of America (USA) (Hayashi 2004; Greer 2012). In Japan, the national government undertakes the mitigation of the adverse disaster effects and partially the recovery actions allowing the prefectural and municipal governments to take over the other activities (Tanaka 2008; Greer 2012). In the US on the other hand, the Federal Emergency Management Agency (FEMA) is engaged in supporting population when an emergency occurs and relies on staff from federal, state, tribal and local government partners, as well as the private sector and the non-governmental entities such as faith-based and volunteer groups along with the wider public to effectively deal with the adverse effects of disasters (FEMA 2010). Since its foundation in 1979, FEMA has constantly incorporated new missions and organizations and still transfers responsibilities gradually becoming an essential component of the Department of Homeland Security from 2003 to present (FEMA 2010).

Notably, the aforementioned DRR strategies differ in terms of the number of hazards considered. The US system adopts a multi-hazard or “all-hazard” approach, in which possible types of interactions and interdependencies between different hazards are taken into account. In contradiction, Japan follows a single-hazard approach, mainly dealing with earthquake disaster management.

Another difference from an earthquake preparedness and response perspective is the existence of a body responsible for coordinating the disaster response and supporting prefectural and local authorities. The FEMA in USA plays the aforementioned role in preparing for, responding to, recovering from, and mitigating disasters along with the contribution of several Federal departments. In Japan, the national government does not have such an agency. This sometimes leads to a lack of coordination as well as overlapping or duplication of the effort needed in time and/or in space (Britton 2007; Greer 2012).

Similar to the aforementioned countries, in Greece and Turkey, earthquake safety forms an integral part of their infrastructure management and community culture. Due to their geotectonic location in the Eastern Mediterranean region and the exposure to high seismic risk, both countries often suffer devastating earthquakes with extensive environmental impact, building damage, and heavy loss of life and property (e.g. Papazachos and Papazachos 2003; Kappos et al. 2010). In Turkey, AFAD is the responsible organization for coordinating the disaster response based on an integrated, single-hazard framework that is adaptive to various hazards (e.g. earthquakes, flood, desertification, landslides, etc.).

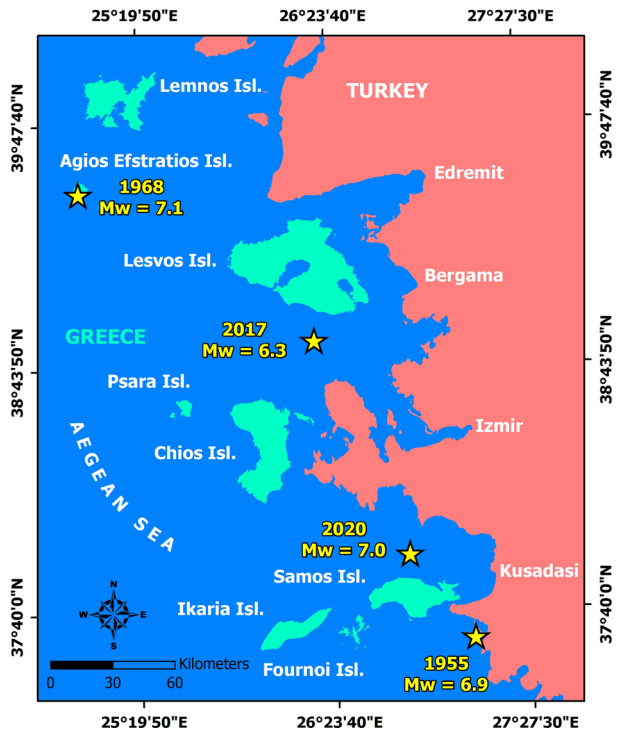
Consistent with the high levels of seismic hazard in Turkey, historically the Seismic Design Codes have been continuously revised (TBEC 1968, 1975, 1998, 2007, 2018) to reduce seismically-induced damage and losses on residential structures. Additionally, seismic design codes were also put in effect specific to critical infrastructure including ports, harbors, highways and railways (Ministry of Transportation 2007, 2008, 2020). Similarly in Greece, seismic codes have been introduced in 1959 and been revised in 1985, 1995 and 2000, notably after major earthquake events.

The response planning for the earthquake emergency, which is practiced by means of drills and exercises, is also tested under real conditions and at a large scale in both countries. Recently, the mechanisms of earthquake disaster management have been tested by the 30 October 2020, $M_w = 7.0$, Samos island (Eastern Aegean Sea) earthquake (Fig. 1).

This earthquake induced primary and secondary effects on the natural environment of the island of Samos in Greece and the metropolitan area of Izmir in Turkey. In Samos, the primary effects included permanent surface deformation (uplift and subsidence) and co-seismic surface ruptures (Lekkas et al. 2020a, b; Mavroulis et al. 2021). Primary effects of tectonic origin were not detected in Izmir (Cetin et al. 2021). The secondary earthquake environmental effects included a subsequent tsunami that caused damage mainly to coastal residential and commercial buildings of Samos and Izmir province (Triantafyllou et al. 2021; Dogan et al. 2021), slope movements, liquefaction phenomena, ground cracks, and hydrological anomalies in several sites of both affected areas (Lekkas et al. 2020a, b; Cetin et al. 2021; Mavroulis et al. 2021).

Considerable structural damage was also observed in Samos island, however, the impact was much higher on the densely populated province of Izmir including several collapses that buildings suffered despite the relatively lower peak ground accelerations locally

Fig. 1 The eastern part of the Aegean Sea with the largest earthquakes generated in the last 66 years mentioned in the introduction



recorded (Cetin et al. 2021). The 2020 Samos (Aegean Sea) earthquake was the most lethal seismic event worldwide due to the resulted fatalities. Based on official reports of the Disaster and Emergency Management Presidency (AFAD in Turkish) in Turkey and the General Secretariat of Civil Protection (GSCP) in Greece, the earthquake claimed 119 lives (117 in Turkey and 2 in Greece) mainly due to partial or total collapse of residential buildings.

Taking into account the recent seismicity, it is concluded that the 2020 earthquake is also the largest earthquake in the Eastern Aegean Sea since the $M_w=7.1$ event on 19 February 1968, located in the North Aegean region, that severely affected the Ayios Efstratios Island (North Aegean Sea, Greece) (Fig. 1). That event resulted in 175 collapsed buildings, 2348 damaged buildings, 20 fatalities, and 39 people injured. It is recalled that during the first hours of the emergency response after the 1968 Ayios Efstratios earthquake, the limited resources of the island were not enough, and hence, the authorities of the island were unable to manage the disaster effects on their own.

Another earthquake in the Eastern Aegean Sea region that caused fatalities and severe structural damage is that of the 6 July 1955, $M_w=6.9$ again in Samos (Fig. 1). It significantly affected both countries resulting in more than 500 damaged buildings and 23 fatalities (e.g. AFAD 1956; Papazachos and Papazachou 2003; KOERI 2020, KOERI 2021a).

Many decades have passed since then and as mentioned already, the progress in disaster management and DRR worldwide is noteworthy. In this context, the particular study aims to present and critically assess the disaster management measures in Turkey and Greece through the discussion on the preparedness, response, and recovery actions that were conducted by the Civil Protection authorities after the aforementioned 30 October 2020 Samos (Aegean Sea) $M_w=7.0$ earthquake. A brief overview of the Civil Protection framework in Turkey and Greece is also presented along with the authorities that were involved in disaster management and DRR in both countries in order to detect and discuss similarities and differences in the DRR strategies of both countries.

2 Civil protection framework in Greece and Turkey for earthquake emergencies

In 1995, a subdivision of the Greek Ministry of the Interior, namely, the General Secretariat for Civil Protection (GSCP) was established. It plans and organizes coordinated actions to prevent, mitigate and respond to disasters and emergencies induced by natural and man-made hazards, to observe and check the progress of the above actions, to inform the public with objective and balanced information and to supervise the Civil Protection Volunteerism System.

The resources of Civil Protection in Greece comprises specialized Civil Protection officials at multiple levels, all state services, public services of local administration, organizations, and public utilities responsible at the operational level for civil protection actions, the Civil Protection organizations including non-governmental organizations, the voluntary teams, and the specialized Civil Protection volunteers as well as citizens with special expertise (Fig. 2). The services involved in providing disaster relief in Greece comprise the Hellenic Fire Service, the Hellenic Police Force, the Hellenic Coast Guard, the Armed Forces, and the National Centre for Emergency Care (Fig. 2). The organizations and institutes assisting the GSCP comprise the Earthquake Planning and Protection Organization (EPPO/OASP in Greek), the General Directorate of Natural Disaster Recovery (GDNDR/

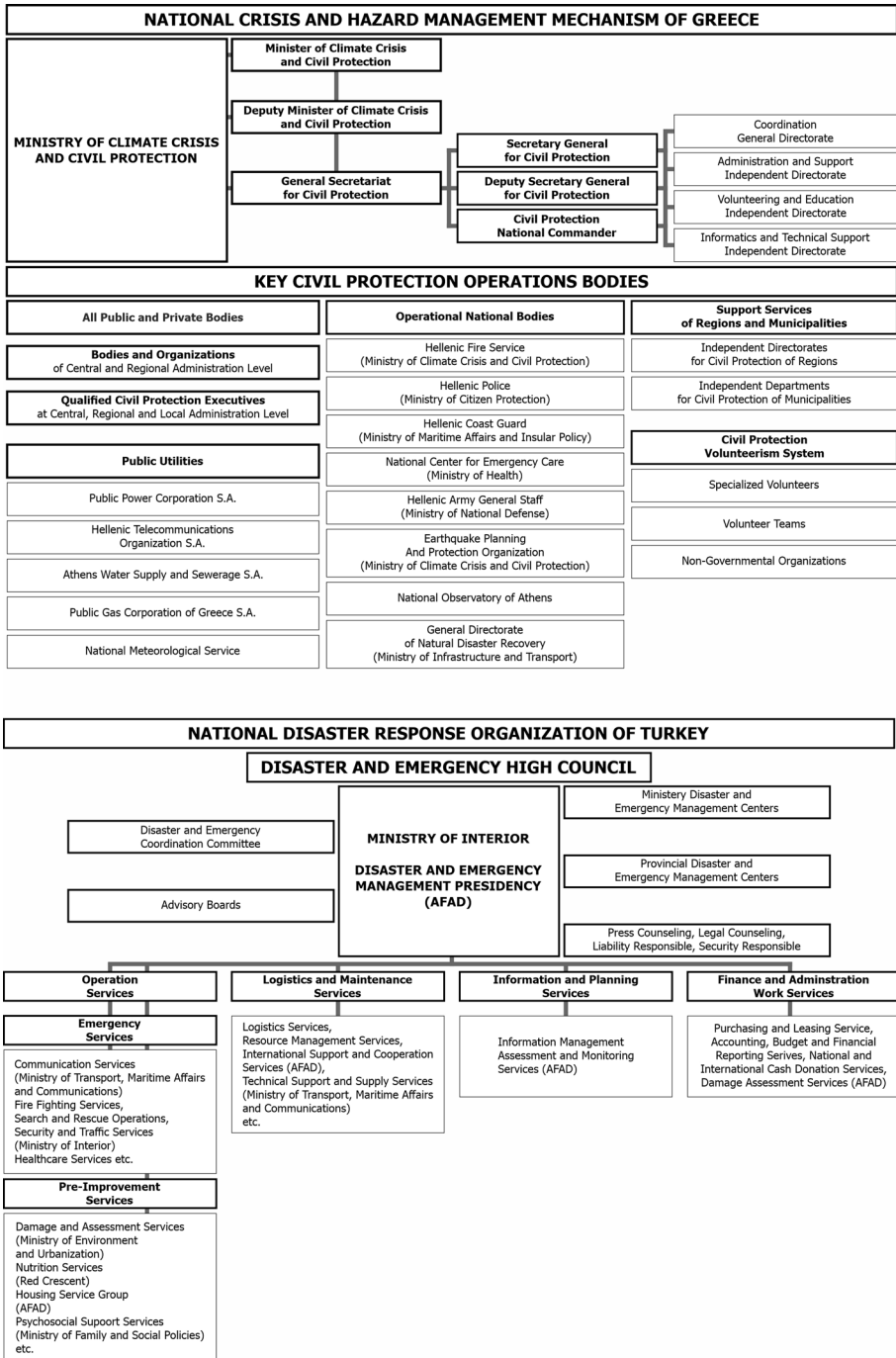


Fig. 2 The National Crisis and Hazard Management Mechanism of Greece and the National Disaster Response Organization in Turkey

DAEFK in Greek), the Engineering Seismology and Earthquake Engineering Institute (ESEEI/ITSK in Greek) and the Geodynamic Institute of the National Observatory of Athens (GINOA/EAA in Greek) (Fig. 2).

As regards the emergency response and immediate/short-term management of earthquake effects, the GSCP applies the general plan entitled “Enceladus” (named by the ancient god of earthquakes in Greek mythology) with a range of applications both the local population and the natural and built environments. This plan aims to coordinate all entities involved at local, regional, and national levels for an effective response to earthquake emergencies.

Similarly, in Turkey, the necessity of reviewing and reforming the subject of disaster management in the country was highlighted by the 1999 Izmit (Kocaeli) earthquake (AFAD 2021a; Sextos et al. 2008). The Turkish Government established the Disaster and Emergency Management Presidency (AFAD in Turkish) in 2009 AFAD is in close cooperation with local municipalities, provincial disaster and emergency directorates, disaster and emergency SAR union directorates, public institutions and organizations, universities, and local administrations. Figure 2 also presents the national disaster response organization in Turkey. The Red Crescent Association, Fire Service Departments, the Police Force, the Armed Forces, the National Medical Rescue Team, non-governmental organizations, the private sector, and international organizations also assist AFAD.

AFAD plays a significant role in DRR. It is working for reducing disaster impact, planning and coordinating the immediate response to disasters, promoting cooperation among various government agencies, and producing policies in this field (AFAD 2021b). Disaster and Emergency Advisory Board has been established by AFAD to provide recommendations on activities and determine policies and priorities for disaster management. The board is represented by members of the Ministry of Foreign Affairs, the Ministry of Interior, the Boğaziçi University Kandilli Observatory and Earthquake Research Institute, the Mining General Directorate of Research and Exploration, the Scientific and Technological Research Council of Turkey, and the Head of Department from the Turkish Red Crescent Society. A new model for crisis and risk management was recently introduced by AFAD and is well known as the Integrated Disaster Management System. So far, AFAD comprises 81 provincial branches and 11 SARS units throughout Turkey.

In addition to AFAD, the AKUT SAR Association is a non-governmental organization that serves voluntarily in search and rescue operations and provides assistance to those affected by disasters including earthquakes. AKUT supports a rapid response to variable emergencies and comprises branches in 32 Turkish cities.

More specifically, the roles and responsibilities for every involved party in disaster and emergency response situations are outlined in the Turkey National Disaster Response Plan (TAMP in Turkish), which determines the basic principles of response plan in pre-, co-, and post-disaster periods and emergencies.

There are 26 service groups under TAMP, which consist of representatives from different state ministries and the Turkish Red Crescent. All groups work in full communication with each other under the coordination of AFAD and are responsible for providing a swift response and flow of information.

3 Response and recovery in Turkey and Greece after the 2020 Samos earthquake

During the 2020 Samos island (Aegean Sea) earthquake all response actions were timely implemented according to the Enceladus plan in Greece and TAMP in Turkey. They were classified into the following categories: (a) initial earthquake notification, (b) first assessment of the impact and mobilization of authorities, (c) Civil Protection guidelines through emergency communications services, (d) search and rescue (SAR) operations, first-aid administration and medical care (mainly in Turkey), (e) set up of emergency shelters, (f) provision of emergency supplies and donations, (g) psychological support for the affected population, (h) raising awareness and education for protective measures to successfully deal with the continuous aftershock sequence, (i) post-earthquake hazard mitigation and building inspections and (j) immediate financial relief measures.

4 Initial notification of the earthquake, alerts, and announcements

In Greece, the local police and fire departments formally notified the GSCP of the earthquake occurrence. Senior administration police officials and the decentralized Civil Protection Agencies were also contacted. The staff of the local Civil Protection agency collected data from local police departments and fire agencies in accordance with pre-determined contingency plans. Since the infrastructure and services related to the information and communication technology were operational following the earthquake, the above actions were made feasible. The GINOA was in charge of making the earthquake declaration as well as notifying the GSCP and the EPPO.

In Turkey, the initial notification, alerts, and announcements were coordinated by AFAD immediately after the earthquake event. The Ministry and Provincial Disaster and Emergency Management Centers were on alert. Local provincial AFAD directorates were sent to the region, and AFAD provincial and union directorates were informed and alerted. It is important to note the key role of the mass and social media in the initial notification of the earthquake, which is an aspect worth exploring further given the increasing role of crowd sourcing in DRR. Earthquake effects on the natural environment including earthquake-triggered landslides and the subsequent tsunami, as well as building damage, were posted on social media by civilians and were broadcast live from national and local mass media.

5 First assessment of the impact: Mobilization and response of the state authorities

In both countries, social life was severely disrupted by the earthquake. In addition to casualties and injuries, damage to buildings, facilities, and infrastructure networks initial estimates of financial losses were also recorded. Response actions for saving and safeguarding life and wellbeing, as well as protecting the natural environment and private properties, were implemented in both nations shortly after the earthquake, in accordance with the aforementioned national disaster management policies. The disaster management authorities, along with the competent organizations, institutions, and voluntary teams were

mobilized to quickly assess the impact of the earthquake. The initial assessment of the impact on the local population and the natural and built environment was important for implementing actions dealing with the adverse effects of the earthquake and the subsequent tsunami.

SAR teams with their equipment and SAR dogs rushed to the earthquake-affected areas reflecting the high readiness level of the Turkish and Greek disaster management units that are the result of the equally high exposure to earthquake risk. Notably, these units offered their services not only within their borders but also in the neighboring country when and where necessary (as it was for instance the case after the Athens and Izmit (Kocaeli) earthquakes in 1999). The European Union (EU) and the North Atlantic Treaty Organization (NATO) as well as the European Council expressed their willingness and readiness to offer assistance in the earthquake-affected areas of both countries. Moreover, the European Emergency Coordination Center had close communication with the authorities of the civil protection to assist.

Shortly after the earthquake, coordination meetings were held to improve the emergency response and public announcements were made to inform the public regarding the impact of the earthquake on locals. Immediately after the event, emergency shelters were set for the accommodation of the affected people.

In Turkey, “coordination trucks” provided by AFAD were directed to the region, while airborne scanning activities were carried out by the Turkish Armed Forces. AFAD SAR teams, National Medical Rescue Team (UMKE), and 112 Emergency Aid teams were transferred to the affected area. In addition, SAR teams of Gendarmerie SAR Battalion Command (JAK) and non-governmental organizations were dispatched to the region. AKUT Izmir, Kuşadası, and Manisa teams arrived in the region of Izmir shortly after the earthquake to initiate SAR activities. Local and provincial AKUT teams were also mobilized to the region immediately after the earthquake. Similarly, the Turkish Red Crescent contributed to the response. Personnel were assigned from the Ministry of Environment and Urbanization to work in damage assessment and debris removal activities. Psycho-social support teams were transferred to the region to provide support to the people affected by the earthquake. Personnel, SAR dogs, and vehicles from AFAD, JAK, Civil Protection Organizations, and municipalities were assigned for the ongoing intervention activities in the region. Izmir metropolitan municipality participated in SAR efforts and in setting up emergency shelters. Campaigns were also launched and announced immediately after the event under the leadership of government agencies and İzmir Metropolitan Municipality (IMM) to solve the housing needs of earthquake victims. Personnel and vehicles were transported with cargo aircraft belonging to the General Staff of the Turkish Armed Forces (TSK). Coast Guard Command participates in SAR activities with guard boats, helicopters, and diving teams. The aforementioned information on the mobilization and response of the state authorities is retrieved from AFAD official reports, news, and announcements on 30 and 31 October and on 2, 4, and 6 November 2020 from AFAD official webpage (<https://www.afad.gov.tr/>).

6 Guidelines to the affected population through emergency communications services

The first and most important step taken by Civil Protection officials was to provide inhabitants with quick information about the evolving hazards and their consequences. In Greece, the GSCP sent two SMS messages to residents of the North Aegean Region’s affected islands (Ikaria, Kos, and Chios) via the unified European emergency number "112," advising them to adopt self-protection measures and keeping away from coasts to avoid the negative effects of a possible earthquake-induced tsunamis, as well as staying away from severely damaged ready-to-collapse buildings to avoid debris falling down in case of aftershocks (Fig. 3a). The second warning was issued explicitly to residents of the island of Samos, who were instructed to keep away from buildings and to seek shelter in safe outdoor areas (Fig. 3b). Unfortunately, this warning did not prevent fatalities due to a post-earthquake collapse of an old structure as discussed below.

Eastern and western Samos municipalities posted similar information and updates on their websites, including self-protection measures and emergency shelters ready to accommodate the affected population. Avoiding coastal sites and exposed electrical lines, as well as keeping away from abandoned and old masonry buildings, unstable slopes, streams and bridges were among the recommendations. Samos residents were also advised to refrain from sleeping indoors and instead seek cover in safe outdoor areas, emergency shelters, or their cars.

Residents of earthquake-affected regions in Turkey were informed to adopt self-protection measures by AFAD through the media. Brief messages were also sent to citizens’ mobile phones. They were alerted to download the mobile application “IamSafe” by AKUT to announce and notify themselves as “I am safe” (Fig. 3c, d). The purpose of this application is to enable communication between people, who are affected by the disaster and their relatives, without unnecessary usage of mobile phone lines. Information and updates were also posted on the AFAD and Izmir Municipality web pages. Furthermore, articles presenting recommendations appeared in the national and local media. Recommendations to residents comprised (a) avoiding entering into damaged buildings, (b) avoiding using

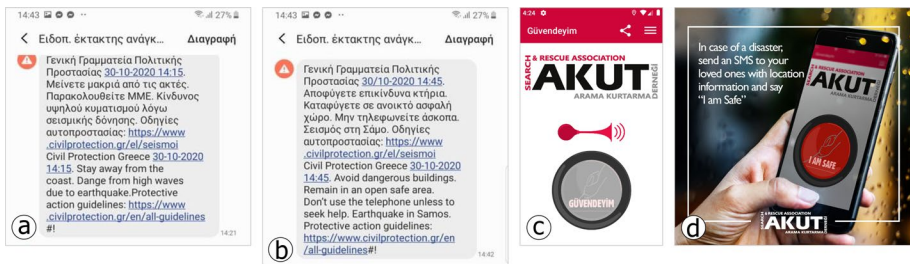


Fig. 3 **a** The first message was sent to the inhabitants of all Greek islands located within the triangle Ikaria—Kos—Chios after the 2020 Samos (Aegean Sea) earthquake. It included guidelines in Greek and English language and advice for staying away from coasts in order to avoid the adverse effects of possible tsunami generation. **b** The second message was exclusively sent to the Samos residents urging them to stay away from buildings, remain in safe outdoor sites and not to use telephone unless to seek help. Both messages contained links to sites of the General Secretariat of Civil Protection with protection measures during the aftershock period. **c, d** Residents in the earthquake-affected area of Izmir in Turkey were alerted to download the mobile application “IamSafe aka Gündeyim” (c) and notify themselves as “I am safe”. **d** The updated version of the application is also available in English

transportation lines to help SAR and UMKE teams arrive in the region rapidly, (c) remaining silent around collapsed buildings during rescue operations so that people in need to be rescued under the rubble can be heard, (d) avoiding unnecessary mobile phone usage so as not to burden the network, (e) avoiding to be close to exposed power lines and (f) availability of temporary emergency shelters.

7 SAR operations, first-aid treatment, and medical care

Because there were no collapses of inhabited residential buildings in the earthquake-affected Samos, the necessity for SAR operations led by the Hellenic Fire Service's 1st Disaster Management Special Unit (1st EMAK in Greek) was minimum. However, shortly after the earthquake, the Samos Fire Service received a call for help in Vathy town, located in the northeastern part of Samos. Two young people were fatally trapped when part of an old and abandoned building's stonework collapsed during the earthquake (Fig. 4a). Given that such loss could have been avoided, the incident clearly underlines the necessity for tighter safeguards and more frequent warnings following an earthquake. Another 19 cases of injury were also reported. Air transport from Samos to Athens was required for a severely injured 14-year-old girl and a 63-year-old woman.

AFAD SAR teams were deployed in severely affected sites shortly after the event (Fig. 4b–f). Their efforts continued uninterruptedly for 6 days, until November 4, 2020, mostly focusing on the 17 collapsed to heavily damaged buildings. It is noted that 12 of the buildings suffered an immediate collapse (Yakut et al. 2021a, b) and SAR teams successfully recovered 107 alive residents (Fig. 4b–f) as officially announced by AFAD. Rescue operations were carried out by a total of 2151 AFAD SAR personnel. UMKE, Fire Brigades from 41 cities around the country, and qualified SAR personnel from ministries and non-governmental organizations (e.g. AKUT volunteers) rushed to the city to assist AFAD teams (AFAD 2020). A total of 8712 personnel and 25 SAR dogs operated under the direction of AFAD, while AFAD staff have also reached out to 11,000 people in need of assistance. The last alive resident was recovered from the rubble after 91 h of SAR operations. Based on the official reports of AFAD shared between relevant ministries, the press, and the public, 117 fatalities and 1035 injured were recorded. Alive animals were also rescued under rubbles by the rescue teams.

As of 20 November 2020, it was reported by Yakut et al. (2021a, b), 8037 buildings suffered different levels of damage (from minor to severe) in İzmir. More precisely, 666 of them were reported to be severely damaged, collapsed, or classified as to be urgently demolished which corresponds to nearly 1.2% of the buildings in İzmir. Bayraklı district was the most heavily affected area where 166 buildings experienced severe or higher damage.

8 Psychological support for the affected population

In addition to casualties, injuries, and property loss, an earthquake-induced disaster may have a negative impact on the affected population's mental health. Feelings of grief, loss, despair, helplessness, disappointment, and sorrow might emerge days, weeks, or months following the earthquake's occurrence. As a result, the psychological support of communities and individuals affected by the 2020 Samos earthquake has been considered an



Fig. 4 **a** SAR operations in Vathy town conducted by the Disaster Management Special Units (EMAK in Greek) of the Hellenic Fire Service supported by staff of the Hellenic Fire Service, the National Center for Emergency Care, the Hellenic Police and Civil Protection volunteers (source: video captured by a resident). **b–d** SAR operations in Izmir province by AFAD and AKUT SAR units (sources: b from <https://www.karamanhabercisi.com/akut-eskisehir-ekibi-deprem-bolgesinde-gorevini-tamamladi-21883h.htm>, c from , d from), **e** A 3-year-old girl was rescued alive from the rubble days after the 2020 Samos earthquake (https://www.dailysabah.com/gallery/search-and-rescue-missions-continue-after-devastating-izmir-earthquake/images?gallery_image=24847#big). **f** SAR operations in progress in a pancake collapsed building in Izmir province by Turkish SAR units (source: <https://www.nytimes.com/2020/11/01/world/europe/turkey-earthquake-rescue.html>)

important aid to deal with the post-disaster experiences. The mental health professionals including psychologists, psychiatrists, and clinical social workers from public health services as well as volunteers with similar specialized knowledge and expertise conducted counseling sessions helping people address emotional reactions to disaster and make a plan for moving forward. Furthermore, many residents with a wide range of symptoms related to post-traumatic stress disorder (PTSD), depression, anxiety, emotional distress, and sleep disorders seek mental health professionals for effective support and advice.

In the earthquake-affected Samos island, such psychological assistance was provided by the psychological service of the Municipalities' Social Welfare Department, which anyone experiencing substantial psychological stress could contact. In collaboration with the local authorities, voluntary organizations active in Samos, such as the Regional Department of the Hellenic Red Cross and the Samos Department of the Hellenic Rescue Team, provided psychological support.

In the earthquake-affected area in Turkey, social workers and psychologists of the Ministry of Family, Labor, and Social Services (MoFLSS), the Turkish Red Crescent (TRC) Psychosocial Support Services (PSS) teams, and the IMM offered psychological assistance. 453 employees worked in the field in Izmir, according to the Turkey National Disaster Response Plan (TAMP), to psychologically support the afflicted people, lessen their anxiety, and assist them in overcoming the trauma they had endured (AFAD 2020). Also, 50 IMM experts and social professionals were sent on-site to provide psychological support. Furthermore, several non-governmental organizations in the disaster field offered psychosocial support, especially for children. Monitoring or supervision regarding these activities is mandatory in order to avoid child protection risks. It is critical to emphasize the cumulative psychological impact of a major earthquake during a pandemic, which causes increased stress in both the affected communities and the individuals.

9 Raising awareness and education for protective measures due to the continuous aftershock sequence

Raising awareness and educating targeted population groups about post-earthquake protective measures were crucial because they assisted the local community in mitigating earthquake effects, and gave people a sense of normalcy. Furthermore, these activities allowed participants to debate the lessons acquired from the management of the earthquake and the following tsunami, to become acquainted with the concept of coping with multiple disasters, and to continue to apply protocols in the face of their adverse effects.

Shortly after the earthquake, EPPO staff visited Samos Island and conducted meetings and talks with members of the Eastern and Western Samos Municipalities organized seminars for directors of primary and secondary schools in Vathy and Karlovasi towns, and a session for the employees of Eastern Samos Municipality child care institutions (Fig. 5). Additionally, they distributed educational material per targeted population group. Despite the COVID-19 pandemic implications and the associated social restriction measures, these post-earthquake raising awareness and education actions were successfully implemented.

Similar educational pre-earthquake activities took place during the planning and preparedness phases, before the October 2020 event in both countries. In Samos regional unit, EPPO staff implemented training seminars for teachers and personnel of municipal child-care centers in Samos regional unit. Teachers were taught how to follow particular documented readiness and evacuation procedures in case of an earthquake, as well as how to educate students basic safety principles, such as exercises and drills.

It is noted that table-top and field exercises had been carried out in Samos island in April 2015 and in March 2017 to prepare regional and local authorities along with the armed forces and volunteers (Panoutsopoulou et al. 2017). In the frame of these pre-earthquake exercises, several exercise episodes were implemented including building inspections and evacuation, SAR operations, triage, coordinating and decision-making meetings,



Fig. 5 Post-earthquake educational activities including workshops were conducted by the staff and the President of the Earthquake Planning and Protection Organization of Greece in Samos island. The workshops were implemented in Vathy town (a), located at northeastern Samos, and in Karlovassi town located at northwestern Samos (b–d) for providing guidelines to school teachers and child care centers’ personnel for protection during the aftershock period

dealing with communication problems, emergency shelter management, and emergency supplies’ distribution (Panoutsopoulou et al. 2017).

Pre-earthquake training programs to raise awareness and prepare citizens for earthquakes were conducted in Turkey by AFAD, AKUT, Boğaziçi Kandilli Observatory, and Izmir Municipality along with non-governmental organizations and voluntary teams. These programs comprised seminars for the education of several targeted population groups ranging from pre-school children (Fig. 6) to elderly people. In the frame of planning and preparedness, AFAD organizes on-site and online seminars to help the community be prepared for earthquakes and also offers seminars for trainers. Disaster Awareness Trainer Training by AFAD is planned to educate people and students as “Disaster Awareness Trainers” who will be involved in bringing the correct behavior before and after disasters, especially for earthquakes. AFAD also provided online education seminars from the website <https://www.hazirol.gov.tr/>, which reached out to 11.385.982 participants. Civil protection agencies and personnel were able to better detect, organize, and correct gaps in response planning as a result of the aforementioned training and exercises.

Boğaziçi University Kandilli Observatory and Earthquake Research Institute’s Disaster Preparedness Training Unit provides general information regarding earthquakes and related building damage and precautions to be taken before, during, and after an earthquake. As



Fig. 6 Raising awareness for students and educational and training activities organized by AFAD (source: Cetin et al. 2021)

part of the training, earthquake shaking simulations were provided to the general public (including children and young people) through shaking tables (KOERI 2021b).

The IMM has completed several major earthquake research and mitigation projects in the last 25 years. Between 1996 and 1999, the IMM developed the “Izmir Earthquake Master Plan” in collaboration with the Boaziçi University, the Kandilli Observatory, and the Izmir Branch of the Chamber of Civil Engineers, as part of the UN’s RADIUS (Risk Assessment Tools for Diagnosis of Urban Areas against Seismic Disasters) initiative.

10 Participation of volunteer teams

During the emergency response’s first vital hours and days, volunteers from various regions of the impacted countries supported local authorities in managing the earthquake and tsunami effects. Volunteers assisted with SAR operations, building inspection teams for damage assessment, and the planned evacuation of severely affected areas during the aftershock period, among other things. Moreover, they helped set up emergency shelters with military-style tents in safe outdoor locations, as well as daily activities such as the provision and distribution of humanitarian aid such as equipment for the homeless, long-term food supplies, meals, and personal hygiene items to the affected population. They also visited affected persons staying in hotels and tourist facilities on a regular basis to assess health needs, give pharmaceutical and medical supplies, and train employees and guests on prevention measures during the aftershock period.

11 Donations and provision of essential emergency supplies

Following the earthquake in both countries, a nationwide mobilization resulted in donations and provision of necessary emergency supplies. Those in need received relief supplies such as food, water bottles, blankets, clothing, and mattresses, for as long as required until these needs were fully met. Several locations on the earthquake-affected island of Samos were transformed into concentration, packaging, and distribution centers for relief supplies provided by the government and donated by individuals, non-governmental organizations, volunteer teams, charitable organizations, large supply chains, and shipping companies.

At the same time in the affected area in Turkey, AFAD and the TRC had also distributed equipment (thousands of blankets, beds, sleeping bags, kitchens, and heaters) to people accommodated in temporary emergency shelters and provided relief supplies. As of 6 November, food comprising 187,575 packaged food products has been served to 464,395 people, while hot and cold drinks including 161,879 water bottles have been provided to 135,034 people (AFAD 2020). The Social Services Department of Izmir Municipality distributed appliances (washing machines, refrigerators, etc.) to affected households. A warehouse with a capacity of 11,500 m² was also set up at Izmir Culture Park for the concentration and the deposition of essential emergency supplies for those in need after the disaster.

The wave of donations from organizations, companies, teams, and thousands of individuals after the 2020 Samos (Aegean Sea) earthquake and tsunami in both countries ensured a continuous flow of the emergency supplies. Due to the large number of disasters historically, induced by geological and hydrometeorological hazards, that often hit both countries this community-driven approach during emergencies is now an inherent part of the local culture comprising strong messages of humanity, solidarity, and hope to the affected population. It's also worth noting that, as was the case after another catastrophic experience in 1999, when two earthquakes struck in Izmit (Kocaeli) and Athens, solidarity and cross-border goodwill interactions overshadowed political tensions between the two nations.

12 Hazard mitigation in post-disaster recovery

During the first days of the clean-up activities following the earthquake and the subsequent disasters, the most common hazards that the local population and workers faced in the earthquake-affected areas include partially collapsed or unstable buildings, exposed electrical wiring, breaks on the water supply network, natural gas leaks, exposure to hazardous materials and airborne dust, falling debris and sharp glass objects as well as health and safety exposure risks (Lekkas et al. 2020b).

Immediate actions were designed and implemented by qualified safety professionals and response workers prior to the public approaching or moving in several response areas in the earthquake-affected Samos and Izmir. They cleared regional, municipal, and community roadways by removing debris left behind by landslides and rockfalls, as well as debris from partial and total building collapses. They also identified hazards linked with partially collapsed and unstable structures and placed warning signs and safety barriers in their vicinity (Fig. 7). After the owners' final approval, several seriously damaged structures on the verge of collapse and abandoned buildings were demolished (Fig. 7).

During the post-earthquake period, the systematic evacuation of residents from heavily affected areas of Samos and Izmir was a critical action for hazard mitigation. The evacuation was designed and carried out by a joint team of Hellenic Police and Fire Service



Fig. 7 Actions for the mitigation of hazards in the aftermath of the earthquake in Samos island: **a** supporting of buildings, **b** demolition of unstable buildings dangerous for cars and passersby, **c**, **d** placement of markings and protective barriers around severely affected buildings in order to avoid approaching

personnel, members of the Hellenic Fire Service's Disaster Management Special Units, the Municipality Departments of Civil Protection in Samos, and volunteers in Greece and by AFAD SAR personnel, UMKE, Fire Brigade, SAR personnel from ministries and non-governmental organization (e.g. AKUT) in Turkey. This decision was considered necessary to protect citizens from potential future geo-hazards, primarily slope failures and widespread building collapse during the aftershock period.

13 Provision of temporary emergency shelters

Immediately after the earthquake occurrence, citizens abandoned their residences due to fear of aftershocks or building collapse and stayed in assembly points or safe outdoor sites. During the early hours of the emergency, local authorities in Samos gathered data on the number of citizens who had evacuated their homes and remained outside. In collaboration with the Hellenic Armed Forces and voluntary teams, they participated in setting up emergency shelters in safe outdoor sites for the urgent sheltering of the temporarily homeless. Because the earthquake occurred in the middle of autumn, the afflicted people were also subjected to adverse weather conditions, such as strong winds and cold temperatures, particularly at night.

The Eastern Samos Municipality established temporary emergency shelters in Kokkari, Vathy, and Chora, while the Western Samos Municipality in Karlovasi (Fig. 8a, b).

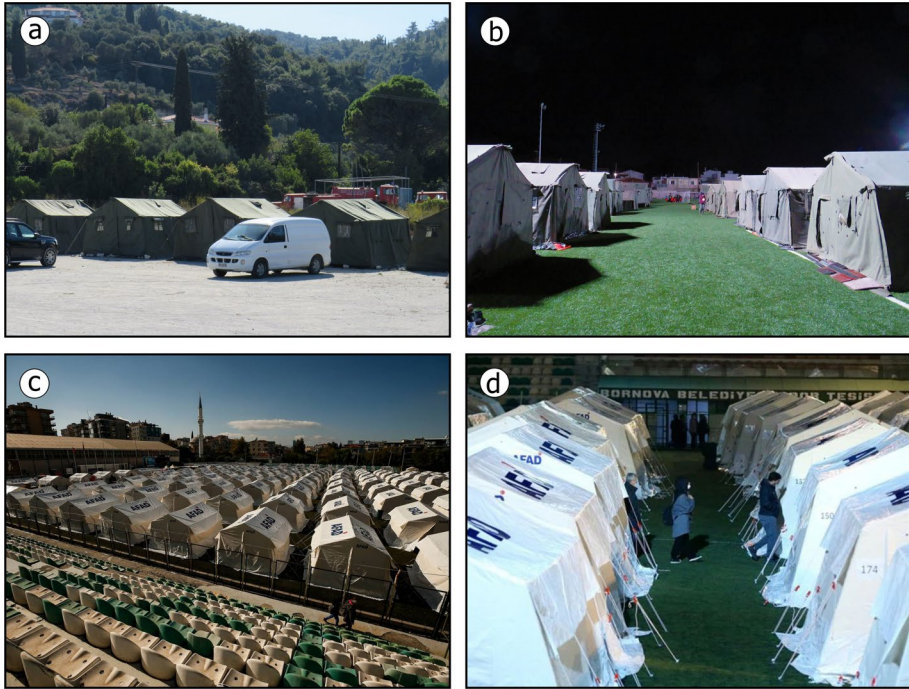


Fig. 8 Emergency shelters with military-type tents in safe outdoor sites in the earthquake-affected Samos island (a, b) and in the stadium of Bornova town (c, d)

Temporary emergency shelters comprised military, emergency rapid deployment tents as well as sanitary and hygiene facilities. Tents, sleeping bags, blankets, and beds have been provided by the Ministry of Migration and Asylum, and tents have been transported to the island by the United Nations High Commissioner for Refugees. Hotel rooms were reserved for vulnerable and homeless people. Furthermore, the affected municipalities set up semi-permanent container-type structures to be utilized as classrooms due to damage on school buildings, or as temporary housing for the homeless.

As of 4 November 2020, AFAD and IMM in Turkey established and maintained 17 large camps in safe outdoor sites for the temporary accommodation (Fig. 8c, d) of the earthquake-affected population comprising Bornova Stadium, Aşık Veysel Recreational Park, the Aegean University Campus among others as shown in Fig. 8. On these sites, as of 6 November, about 2910 tents were set up. Based on the Ministry of Interior and the reports of AFAD, the occupancy rate in the tents was 65% on 2 November and 73% on 4 November, while 19,068 blankets, 11,050 beds, 11,548 sleeping bags, 2657 kitchens, and 1023 heaters have been distributed by the AFAD and the TRC to people who are currently residing in camps (AFAD 2020).

In addition to the open-air camps, rooms in dormitories, public guest houses, and hotels were provided for the affected population. Additionally, smaller camping grounds have been consolidated with larger ones to improve the dwelling conditions.

Informal and smaller camps were also organized in several neighborhoods (Mevlana, Bayraklı, and Manavkuyu) (STL 2020a, b). The smaller camps in Bayraklı and Manavkuyu

districts were organized by IMM and the observed needs in emergency non-food and food supplies were met by AFAD, TRC, and IMM.

According to the AFAD's Izmir Turkey Earthquake Report as of November 6, 2020, 1000 container-type structures would be available soon for 7000 individuals, who were accommodating in the tent camps. The construction of new buildings was planned to begin in a month and the affected residents are planned to move to their new building in a year from the generation of the destructive earthquake (AFAD 2020).

14 Financial relief measures

Financial measures for dealing with the adverse earthquake effects referred to strengthening and reinforcement of structures, services, and systems.

In Greece, the Ministry of Finance in collaboration with the competent Ministries and the Independent Authority for Public Revenue announced interventions to help and support earthquake-affected legal entities and individuals. The financial relief measures comprised suspension of tax liabilities, insurance contributions, auctions and seizures on properties and employment contracts of part or all of their employees, compensating affected companies, providing housing assistance in the form of free state aid and interest free loan for building repair/reconstruction, exemptions from single real estate property tax for property owners in the earthquake-affected area and extensions for submitting tax declarations. Following the earthquake in Izmir, as an immediate reaction, AFAD provided 13 million Turkish Lira (TL), the MoFLSS 10 million TL, and the Ministry of Environment and Urbanization 6 million TL in assistance funds (AFAD 2020). A total of 30 thousand TL (approximately 3000 euros) was also given per household to people whose furniture and belongings were damaged or destroyed by the earthquake. Homeowners and tenants, who lost their homes by the earthquake, were also financially supported. The Izmir Municipality and Governorship also gave financial assistance to the earthquake-affected population. Moreover, the TRC and Izmir municipality have launched a nationwide campaign for donations and provision of aid and food items by individuals and companies.

15 Earthquake insurance practices

The 30 October 2020 Samos earthquake has once again highlighted the need for insurance coverage of houses against disasters induced by natural hazards. According to data from the Insurance Agencies Union, only 10–15% of residential housing stock in Greece had earthquake insurance, mostly due to mortgage requirements. The earthquake insurance covers all loss or damage caused to the building and its contents generated by the earthquake ground motion. The building damage comprises damage on structural and non-structural elements comprising the load-bearing frame, the infill and shear walls, the roof, and other installations, while the latter comprise damage on the building's equipment, machinery, and items, which have been included in the insurance contract.

In the frame of the investigation of the 2020 earthquake impact on the economy of the affected population, the Hellenic Association of Insurance Companies (HAIC) conducted the first analysis on damage and losses induced by the Samos earthquake (HAIC 2020). The study focused on the first assessment of the losses (in number and amount) of property

and car insurance, which had been announced to the Insurance Companies – members, due to Samos earthquake.

A total of 180 losses on property insurance were declared with a first assessment amount for compensation of € 3,462,790. The average declared loss (before exemptions) is estimated at €19,238. For these losses, the estimate of the compensation after the exemptions (where existed) was € 2,220,032. It is pointed out that the exemption is an international practice that reduces by a certain amount the insured risk (hence the compensation), which is offset in the long run by a corresponding relief of the insurance premiums, depending on the terms of the insurance contract.

Following the disastrous İzmit Earthquake in August 1999, Turkey's National Catastrophe Insurance Pool (DASK/TCIP) was founded in September 2000 as an official compulsory earthquake insurance entity. In Izmir, it has a penetration rate of 62.9%, whereas the national average is 59%. Almost 30,000 indemnity applications were filed in the aftermath of the 2020 earthquake. Following the inquiry phase, DASK paid out around 401 million Turkish Lira (as reported by DASK coordinator) to policyholders. Citizens submitted their claim notification after the earthquake and loss adjusters conducted loss assessment procedures for fully or partially damaged structures and the indemnity is determined for small to big losses. DASK provides online (<https://www.dask.gov.tr/tcip/>) and in-person (call center 125) resources to assist citizens in reporting damages and establishing their insurance entity.

16 Lessons learned and conclusions

The Samos island (Aegean Sea) earthquake had a significant impact on the local population and the natural and built environment of the Izmir province and Samos Island. This impact triggered the mobilization of Civil Protection authorities in both countries in order to deal with the adverse effects of the earthquake and the subsequent tsunami.

From the presentation of the Civil Protection framework and the related legislation, it is concluded that both countries followed similar approaches in the response to an earthquake emergency. They both have a national-level authority responsible for emergency management and response (the GSCP in Greece and the AFAD in Turkey).

Both countries followed a single-hazard approach in Disaster Management and Disaster Risk Reduction DRR. In Greece, GSCP has recently published general plans for emergency response and immediate/short-term management of disaster effects related to natural and man-made hazards comprising the “Enceladus” plan for earthquakes, the “Dardanos” plan for floods, the “Iolaos” plan for forest fires, the “Talos” plan for volcanic activity, the “Voreas” plan for extreme meteorological events and the “Heraclitus” plan for large-scale technological accidents. In Turkey, the National Disaster Response Plan (TAMP) has been released by AFAD in 2013 and the purpose of TAMP is to plan rules and principles before, during, and after a disaster (AFAD 2013). However, a comprehensive, multi-hazard approach for Disaster Risk Reduction has not yet been formally adopted. This is one of the emerging priorities to be addressed in a rapidly changing climate and public health environment.

Overall, both countries implemented similar response actions. The main difference in the implementation of these actions was their scale. Izmir is the third most populated city in Turkey after Istanbul and Ankara. It is also the second most populated area in the vicinity of Samos after Athens city in Greece. More specifically, the earthquake-affected Izmir

city has a population of almost 4.5 million people based on the 2019 population report of the Turkish Statistical Institute (TÜİK 2019). In contradiction, the total registered population of Samos island is 32,977 people according to the population census conducted by the Hellenic Statistical Authority in 2011.

Another major difference is that the earthquake caused heavy structural damage comprising collapse in 17 residential buildings in Izmir as being a large metropolitan, while in Samos no inhabitable residential building collapsed. Thus, the number of people affected by the earthquake was larger in Turkey. This fact resulted in a greater need for SAR operations, first-aid administration, and medical care as well as more emergency shelters and relief supplies for the housing and support of people in the earthquake-affected Izmir province during the initial critical hours and days of the earthquake emergency response.

Based on evidence related to the response to the earthquake and the triggered tsunami, it is concluded that the post-earthquake response and the emergency management in both countries were satisfactory, particularly when considering the pandemic during which recovery activities were undertaken. The time required to restore social and financial life in the affected region was reasonably small as a result of the increased awareness, preparedness, and large-scale, pre-earthquake training, particularly in the case of the Izmir Metropolitan Area. For reasons outlined by Cetin et al. (2021), damage and loss were sometimes disproportional to the intensity of earthquake ground motion. Therefore, extending existing pre-earthquake assessment programs in both countries, including smart tools for rapid visual inspection of sub-standard buildings designed to previous versions of the respective national seismic codes, risk-based prioritization to strengthen the residential building stock, and seismic upgrade of public buildings and critical infrastructure is crucial for mitigating earthquake-induced losses in the future.

Construction quality control and code enforcement must also be improved, particularly in low-income areas. The compulsory earthquake insurance system in Turkey (TCIP-Turkish Catastrophe Insurance Pool), which has a penetration rate of 62.9% in Izmir, has proven to be quite efficient in speeding up the payment of insured damages, which will help with post-disaster recovery. Greece must make similar improvements.

Despite the effective management of 2020 Samos earthquake, both countries have many to implement to enhance their preparedness and resilience to major earthquakes. They must focus on developing early warning systems similar to those applied in several earthquake-prone countries worldwide including mainly Japan and Mexico, as shown by the recent earthquakes comprising the 2011 Tohoku and the 2017 Chiapas earthquakes respectively among others. Moreover, Greece and Turkey should further incorporate into their Civil Protection policies and laws the important lessons learned and the large experience gained by recent earthquakes around the world in order to strengthen disaster risk governance to manage disaster risk. Moreover, they have to enforce policies for stricter compliance to building codes and quality control as a means to build back better during recovery and reconstruction.

Most importantly, the need for adopting wider multi-hazard approaches in DRR including crisis management under financial stresses or during an evolving biological hazard like the COVID-19 pandemic is more clear than ever. In this context, the Civil Protection authorities in Greece and Turkey need to reconsider interactions between different types of natural (i.e., earthquakes, geo-hazards, tsunamis and floods) and man-made (i.e., global health, social and financial emergencies) hazards and update their emergency plans accordingly. This requires multi-disciplinary and multi-authority consensus and training as well as cross-border collaboration strategies for the benefit of their communities.


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