An application of Systems Science in the context of Greek Environmental Education for planning interventions against volcanic hazards

Anastasios Mavrakis & Alexandra Tsigkou & Christina Papavasileiou & Georgios Sigalos & Socratis Dasaclis &Xenophon Vamvakeros & Evangelos C.Papakitsos

http://dx.doi.org/10.29009/ijres.5.3.1

An application of Systems Science in the context of Greek Environmental Education for planning interventions against volcanic hazards

Anastasios Mavrakis
West Attica Secondary Education Directorate, Greek Ministry of Education
mavrakisan@yahoo.gr

Alexandra Tsigkou
West Attica Primary Education Directorate, Greek Ministry of Education
aletsig@gmail.com

Christina Papavasileiou
Second Athens Secondary Education Directorate, Greek Ministry of Education
xripapav@gmail.com

Georgios Sigalos
ArcEnviro
sigalos@arcenviro.gr

Socratis Dasaclis
ArcEnviro
dasaklis@gmail.com

Xenophon Vamvakeros
Secondary Education Directorate of Cyclades, Greek Ministry of Education
xenofonvamvakeros@gmail.com

Evangelos C. Papakitsos
University of West Attica
papakitsev@uniwa.gr

Received January 30th, 2022 **Accepted May 10th, 2022**

http://dx.doi.org/10.29009/ijres.5.3.1

Abstract: Schools (amid in secondary and primary education) are installations vulnerable to all kinds of hazards. Because within the last 70 years, at least, there has not been any experience of volcanic activity in Greece, this kind of hazard is not extensively referred to, by official plans, local communities as well as teachers and pupils. In this paper and by using the systemic methodology of Systems Inquiry, the authors make an exploratory analysis of school-units located at the relatively short distances of 2 to 50 Km from volcanoes with registered "Volcanic Explosivity Index" (VEI) activity. Data regarding schools, adopted from the official database of the Greek government and Ministry of Education, have been utilized. The results indicate, regarding only the historically registered VEI activity and not the following consequences/phenomena (as for example, a tsunami), that vulnerable schools are located in Sousaki (East Corinth prefecture), Methana, Milos, Santorini, Nisyros and Kos Islands. The possible number of educational personnel, pupils and infrastructures is estimated. New approaches in the context of Greek environmental education are proposed for the presentation of these hazards in the educational personnel.

Keywords: environmental education; Systems Inquiry; volcanic hazards

http://dx.doi.org/10.29009/ijres.5.3.1

1. Introduction

During the last decades, the number of natural phenomena that become disasters due to natural hazards is increasing in frequency and severity, causing more vulnerable conditions for societies and infrastructures (Adger, 2006). For any state, a vital social group and infrastructure to be protected is the educational community, comprising both pupils and teachers. The population's concentration in a relatively small area increases the risk of adverse effects, as well as the human need for developing specific processes to minimize these effects. The relevant effects are drastic and occur on progressively wider scales, unprecedented to date, and affecting more and more wider areas (EM-DAT, 2020).

Dealing with emergencies is a necessity in every society (Lekkas et al., 2014; Bronfmann et al., 2019; Ebert et al., 2019). In Southern Europe, and especially in Greece, the ever-increasing number of disasters due to natural hazards, as well as the sheer number of problems that follow, endanger human lives and become a threat for vital infrastructures, causing serious disturbance or even damage, by disrupting their operation for a short or long period of time (EM-DAT, 2020). The specific situation justifies not only the need for a continuous flow of information to the general public (EM-DAT, 2020), especially when they affect vital infrastructures (Adger, 2006), but also the development of a safety culture, particularly regarding the staff of civil authorities. Among those phenomena with continuous persistence on Earth are volcanoes, which seem to have played a vital role in the evolution of today's landscape and even in the human evolution (Poulianos, 1984; 1989). Volcanoes are divided into categories, according to: their geotectonic position, their explosiveness and the shape of their volcanic cones. As active are usually characterized those volcanoes that presented any kind of activity, recorded in historical times. Volcanic damage can be caused due to products, associated with their activity. These can be in a fluid or solidified state in the following forms: lava flows, ash fallout, gases, mudflow, collapses, landslides and tsunamis. Volcanic eruptions are one of the geological phenomena that are considered predictable, since the activity of volcanoes is usually monitored and methodically recorded. The precursors of volcanic eruptions are usually

http://dx.doi.org/10.29009/ijres.5.3.1

the following: seismic activity, surface deformations in the area close to the volcano, hydrothermal phenomena and chemical changes (Vougioukalakis and Fytikas, 2005; Kassaras et al., 2020; Nomikou et al., 2021).

Regarding issues of hazards, in the prevention phase, the reduction of losses in human lives is achieved mainly through the development of detailed evacuation plans of the area around the volcano. Reduction of losses is also achieved with structural measures, like engineer solutions (Tsatsanifos et al., 2007). In addition, the reduction of economic losses is possible through the processing of geological data from previous volcanic events, topographic data, as well as possible dispersal models of volcanic products, based mainly on meteorological parameters. Consequently, several approaches have been published and announced, attempting to estimate precaution measures and preparedness procedures for populations living close to volcanoes. Those efforts include the evaluation of the regional risk of volcanic hazards, as a multi-criteria decision-making problem (Vougioukalakis et al., 2019).

The wider region of Greece is a peninsula with intense and complex seashores, consisting of intense relief that includes plains, mountains and islands (Kyriakopoulos et al., 1990; Antoniou et al., 2018). The complex geomorphology of the country allows for almost any kind of natural hazards to occur.

Since 2010, Greece has experienced a deep economic and financial crisis with high social impact (Salvati, 2018). Intense urbanism – about 40% of the country's population resides in the urban and suburban areas of the Greek capital, Athens (Attica's Administrative Region), while five major Greek cities account for 80% of the total Greek population (Cecchini et al., 2019). This renders preventive policies and planning for disasters difficult to implement. Several disasters have occurred, during recent years, in and around those heavily populated areas. Indicatively, there is/are:

Volcanic activity (Vougioukalakis and Fytikas, 2005; EM-DAT, 2020).

Earthquakes (Chouliaras, 2009), with significant examples of such geophysical disasters in dense populated areas those of the two Athens' earthquakes on

http://dx.doi.org/10.29009/ijres.5.3.1

September 7, 1999 (Mw = 5.9) with 143 fatalities (Papadimitriou et al., 2002; EM-DAT, 2020) and on July 19, 2019 (Mw = 5.2) (Kapetanidis et al., 2020).

Tsunamis (Dominey-Howes, 2002; EM-DAT, 2020).

The number of disasters due to natural hazards, registered or not, which occurred so far, seems to strongly affect the educational community's perception of hazard, especially in primary and secondary education, two sectors which undoubtedly play a significant role in society (Papavasileiou et al., 2021).

The surrounding environment and the locally recorded disasters affect the perception of an educational community, especially in primary and secondary education, regarding the significance of taking precaution measures, developing a safety culture, issuing evacuation plans and having the teaching staff properly trained for this purpose, this last concern being observed internationally (Kavan, 2021). Research on schools' preparedness regarding volcanic activity is needed for building an effective tool to overcome these issues. However, up to now, research is mainly focused merely on the volcanoes' geological, physical and chemical aspects. As an effort to minimize the negative consequences possibly exerted by future volcanic activity, there is an urgent need to enhance the public awareness of this hazard in the social sciences field. A comprehensive research that includes all scientific fields might produce more beneficial and reliable information. It should be mentioned here that the local educational authorities of Greece are liable for issuing safety plans and measures (precaution, prevention, preparation and evacuation) merely inside the educational premises. Once a school is evacuated, this liability resides in the local civil authorities.

Therefore, this study intends to enquire the level of volcanic hazards' understanding on the educational communities regarding the South Aegean active Volcanic Arc (henceforth, SAVA), with the purpose of sensitizing the local educational communities and authorities, for initiating the development of a relevant safety culture.

Results from a structured questionnaire were used for understanding the educational personnel's perception for volcanic hazard in relation with other

http://dx.doi.org/10.29009/ijres.5.3.1

geophysical hazards. By using a geographical information system application, an estimation of the possible number of educational personnel, pupils and infrastructures located in nearby regions of SAVA was carried out. Additionally, new approaches in the context of Greek education activities for mitigation regarding volcanic hazard are proposed, for the presentation of these hazards to the educational personnel in the high-risk areas of the SAVA, a totally new approach for Greek educational system and administrative authorities. Especially those volcanoes that have a particularly long repose period require a new and more reliable assessment of the volcanic risks, in vital areas of social and/or economic importance to Greece, as the Aegean Archipelago.

2. Systems Methodology

The precaution measures against all kinds of hazards is a major topic for the Greek environmental education (Palmos et al., 2021; Papakitsos and Mavrakis, 2018; Papakitsos et al., 2021), which is conducted solely as an extracurricular activity through optional programmes. For this purpose, a variety of educational tools and practices are utilized (Tilling, 1989; Mani et al., 2016; Kastolani and Mainaki, 2018). Regarding volcanic hazards, Greece exhibits the second largest concentration of active volcanoes in Europe (i.e., SAVA), after the neighboring Italy with its notorious volcanoes like Vesuvius (Naples), Etna (Sicily) or Stromboli (Aeolian Islands). Despite this concentration (SAVA), the relevant systematic approach of the Greek authorities to civil protection regarding volcanic hazards (see, https://www.civilprotection.gr/en/volcanic-eruptions), similar to the Italian one (see: Bosi, 2009; http://www.protezionecivile.gov.it/risk-activities/volcanic-risk), lacks and is not particularly known neither to the general public nor to vulnerable social groups as the primary and secondary educational population (teachers and pupils). Consequently, neither similar educational material (nor programmes) exists, as in the case of Italy (Ross, 2017; Palmos et al., 2021), for the development of a relevant safety culture. This particular lack of awareness motivated the research herein.

In order to plan interventions against volcanic hazards in a holistic manner, a systemic methodology has been selected, which had been successfully utilized before

http://dx.doi.org/10.29009/ijres.5.3.1

in environmental education (Mavrakis et al., 2019; Papakitsos et al., 2021). This methodology is a part of Systems Inquiry that is the most comprehensive conceptual framework of Systems Science (Papakitsos and Mavrakis, 2018; Papakitsos et al., 2021). In this respect, the planning of the educational intervention is perceived and modeled as a system, according to the modeling technique of OMAS-III (Papakitsos, 2013), which describes any system in terms of seven elements. These elements are presented below and simultaneously defined for the system herein:

The causality deals with the purposes of the system; in this case, the interventions' planning is motivated by the afore-mentioned lack of awareness of volcanic hazards.

The outcomes describe the results of the system; in this case, the new educational approaches that are proposed for the presentation of volcanic hazards, in the high-risk areas of the SAVA.

The means describe the input of the system; in this case, the data required regarding schools, pupils and potentially affected infrastructures, in the high-risk areas.

The rules define the legislation, regulations or natural conditions that delimit the system; in this case, the features of a volcanic eruption, the civil protection guidelines of the authorities and the manners of developing a safety culture.

The people who play a monitoring role at the system; in this case, the teachers, the educational and civil authorities.

The place describes spatial aspects of the system; in this case, the location of volcanoes and the various zones of potential effect around them.

The time defines temporal aspects of the system; in this case, the scheduling of activities that regard both the implementation of the educational intervention and the execution of safety measures during a relevant hazardous incident.

After determining the content of every element, the system is fully identified and operational.

3. Application

The afore-mentioned modeling technique (OMAS-III) has been applied herein for the planning of educational interventions against volcanic hazards in a systemic manner, as a prerequisite for the development of a relevant safety culture. The content of elements (3-7) is conveniently arranged and presented accordingly below, while the causal aspects (1) of the interventions have been clearly defined in the previous section. A separate section is devoted to the results ("outcomes") of the system (2).

3.1. Spatial aspects (6)

In terms of seismicity, Greece ranks first in the Mediterranean and Europe, as well as sixth in the world, after Japan, New Hebrides, Solomon Islands, Peru and Chile (OASP, n.d.). The geographical area of the Aegean is one of the most seismic areas on Earth, as the geological changes that occur at regular intervals are intense and continuous. The Aegean region was formed in the last 23 million years, i.e., during the most recent geological period of the Upper Cenozoic (Global Volcanism Program, 2013; Vougioukalakis et al., 2019; Kassaras et al., 2020). The active SAVA is presented in Fig. 1, consisting of eight volcanoes (/volcanic fields), along with their main features in Table 1.

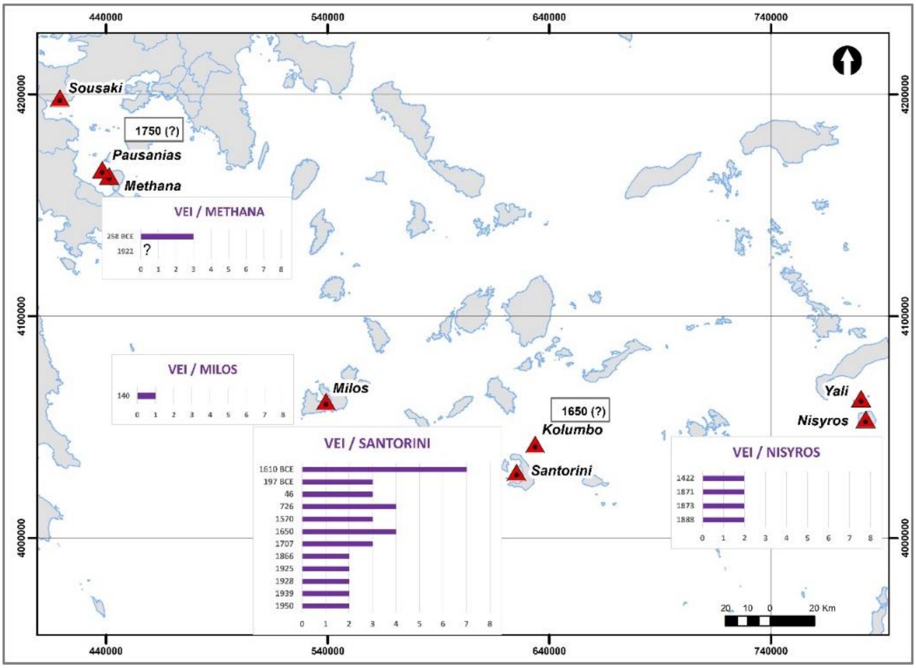


Figure 1. Locations and VEI history of South Aegean active Volcanic Arc (Source: The authors).

Numerous (selected) papers refer to their features, possible hazards and risks:

Sousaki (Kyriakopoulos et al., 1990; D'Alessandro, 2006; D'Alessandro et al., 2006; 2009; Tsatsanifos et al., 2007).

Methana and the nearby submarine volcano of Pausanias (or Pafsanias/Paphsanias) (Washington, 1924; Antoniou et al., 2018; Foutrakis and Anastasakis, 2018; Gatsios et al., 2020).

Milos Island (Traineau and Dalabakis, 1989).

Santorini Island (Dominey-Howes, 2002; Dominey-Howes and Minos-Minopoulos, 2004; Lagios et al., 2005; Foumelis et al., 2013; Vougioukalakis et al., 2016; Barberi and Carapezza, 2019).

The submarine volcano of Kolumbo (or Colombo/Columbo) is part of Santorini's volcanic field north/northeast of Santorini (Nomikou et al., 2012; Rizzo et al., 2016; Ulvrova et al., 2016).

Nisyros Island (Sachpazi et al., 2002; Sykioti et al., 2003; Lagios et al., 2005; Kinvig et al., 2010; Nomikou et al., 2021).

Table 1. Volcanoes of the South Aegean active Volcanic Arc.

Name	Primary Type	Activity Evidence	Last Known Eruption	Lat.	Lon.	Elevation (m)
Sousaki	Lava dome			37.93	23.08	180
Methana	Lava dome	Eruption Observed	258 BCE; 1922 CE?	37.615	23.336	760
Pausanias			1750 CE	37.64	23.3	-200
Milos	Stratovolcano	Eruption Dated	140 CE	36.699	24.439	751
Santorini	Shield	Eruption Observed	1950 CE	36.404	25.396	367
Koloumbo			1650 CE	36.516	25.491	-512
Nisyros	Stratovolcano	Eruption Observed	1888 CE	36.586	27.16	698
Yali	Lava dome	Evidence Credible	Unknown	36.671	27.14	180

Source (Open): Global Volcanism Program 2013.

All these volcanic centers and/or fields are located along a zone of a few tens of kilometers wide and 450 kilometers long, which starts from the Corinth canal and ends in Nisyros (Vougioukalakis et al., 2019; Kassaras et al., 2020). The most recent volcanic activity of the volcano of Santorini dates back to 1950, while that of Nisyros dates back to 1888. Various kinds of deformations are regularly observed (Sachpazi et al., 2002; Sykioti et al., 2003; Lagios et al., 2005; Foumelis et al., 2013).

3.2. Conditions of hazards and awareness (4)

The crucial issues on volcanic hazards mitigation can be briefly summarized as follows: identifying the risk; awareness and education; baseline monitoring; recognition of eruption precursors; forecasting nature of activity & hazard zonation; eruption duration and climax. For reducing volcanic risk usually, the following

http://dx.doi.org/10.29009/ijres.5.3.1

conditions should be considered: the return period analysis and risk estimation; hazard mapping; volcano monitoring; eruption forecasting; intervention; building construction.

According to Vougioukalakis and Fytikas, (2005) and Vougioukalakis et al. (2019), all volcanic centers pose a possible threat (a hazard), although this varies regarding each volcano separately. More specific hazards and risks for each volcano are:

By Sousaki due to gas release (D'Alessandro, 2006) that also cause obstacles to constructions' works such as road tunnels (Tsatsanifos et al., 2007).

Methana and Pausanias volcanic hazards exist mainly due to dangerous pyroclastic products (block and ash flows and related surges); these products are restricted nearby to the extrusive volcanic edifices, making volcanic hazard and risk in the area low.

By Milos volcano possibly due to hydrothermal activity.

Santorini is the most active volcanic field of the SAVA, one of the world's most violent caldera volcanoes.

Nisyros volcanic hazards exist mainly due to hydrothermal explosion, it is relatively high, as numerous recent hydrothermal craters are present in the volcano's caldera floor and because the area is visited by thousands of tourists during the summer time.

Because of the nature of these hazards, there are no existing opportunities to directly modify those associated with volcanoes. The same is valid as well for the collateral products of volcanic activities. The eruption types vary because of the chemical composition of lava, which is related to plate margin type (Waugh, 1996). Lava flows, ash fallout, poisonous gases, pyroclastic flows, but also the secondary effects of lahars (mudflows linked to volcanic activity), may significantly threaten the safety of local populations (Pierson et al., 2014).

http://dx.doi.org/10.29009/ijres.5.3.1

Considering the development of awareness, Education in general (Burgos-Garcia, 2007) and especially environmental education (EE) (Boca and Sinan, 2019; Hoffmann and Blecha, 2020; Hoffmann and Muttarak, 2017) in formal (theory-based) and non-formal type (including lectures, campaigns, hands-on experience, experiential learning, field trips, etc.) has proved to be an important factor for wide different contexts regarding natural hazards prevention and mitigation issues, as well as during recovery phase (Le Brocque et al., 2017). The environmental education community has become an indispensable part within contemporary societies as far as risk management and natural hazard prevention are concerned (Sorokin, 1946; Torani et al., 2019). Environmental educators use both theoretical school-based and less formalized approaches in order to raise people's awareness including all social groups (teachers, students, citizens) about the importance of disaster risk reduction, as well as provide the right information for an adequate preparedness against them (Bye et al., 2016; Kavan, 2021). Those types of education can make a significant contribution to a profound comprehension of disasters due to natural hazards, leading to the reduction of vulnerability towards the specific natural phenomena (Congcong et al., 2021; Psacharopoulos, 1994).

Among non-formal methods used in EE are field trips which are considered as an interactive teaching method with plenty of advantages like: a) give the opportunity to experience various new things at first-hand; b) helps participants to connect theoretical information with the real world; c) make learning of respective concepts more tangible and memorable; d) participants who go on field trips find learning fun and enjoy the issue since field trips are usually amusing; e) there is a significant increase in understanding conceptual information after participation in well-planned field trips; f) offer an emotional engagement concerning environmental issues and problems.

As an example of disaster education, among the features of environment and disaster mitigation course implemented in West Attica's Primary and Secondary Education Directorates, teachers visited two possible disaster-prone areas to gain more

http://dx.doi.org/10.29009/ijres.5.3.1

theoretical information and to investigate environmental problems that people living that areas faced and to develop fundamental skills of disaster mitigation.

To assess possible volcanic hazards at the local scale for school communities, the following methodology has been implemented. Multiple maps were prepared (Sigalos et al., 2016), to evaluate for each volcano of the SAVA:

The Volcanic Explosivity Index (VEI); VEI is a feature for an explosive eruption, but not an attribute of a volcano because volcanoes can erupt in a different way throughout their entire life (Newhall and Self, 1982); e.g., see the VEI of Santorini in Fig. 1 (also visible in Fig. 1 for more volcanoes).

The possible number of schools (infrastructures) and schools' population communities that may be affected from a future volcanic activity.

For this reason, the volcanic risk zones around a volcano's buffer zones were drawn. There is no way to give any specific distance (such as "from 0 to 1 Km") for the actual extent of these zones, since they vary too much for different volcanoes in different eruption situations. In accordance with the Greek Civil Protection guidelines for Santorini volcano, the following buffer zones have been chosen for all the volcanoes:

2 Km – Extreme Risk Zone (see Fig. 2, in red);

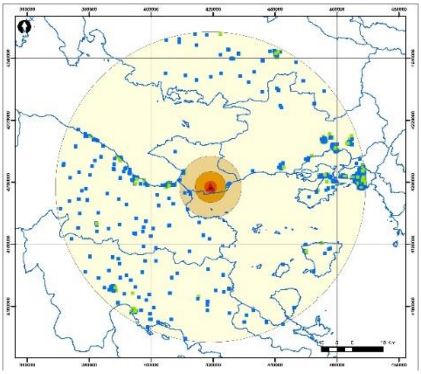
5 Km – High Risk Zone (see Fig. 2, in orange);

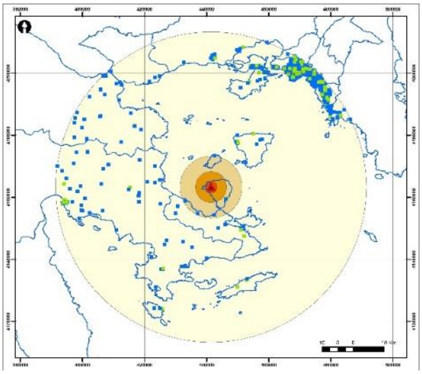
10 Km – Medium Risk Zone (see Fig. 2, in beige);

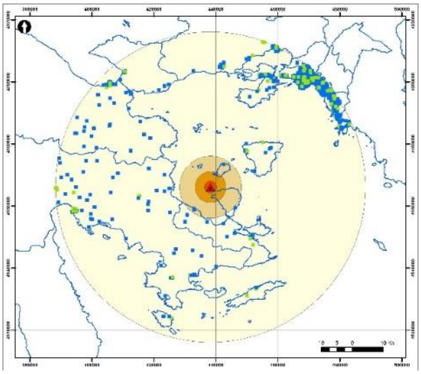
50 Km – Low Risk Zone (see Fig. 2, in pink).

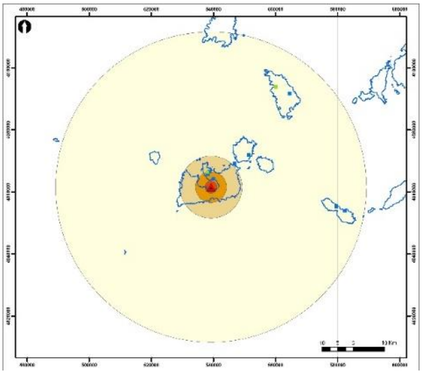
The equivalent buffer zones for volcanoes can be seen in Fig. 2 a-g, where the blue rectangular dots denote schools of primary education and the green ones denote schools of secondary education.

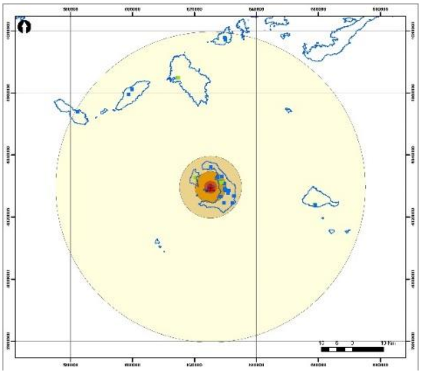
http://dx.doi.org/10.29009/ijres.5.3.1

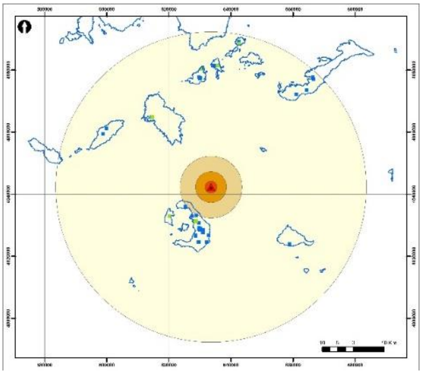

a) Sousaki


b) Methana

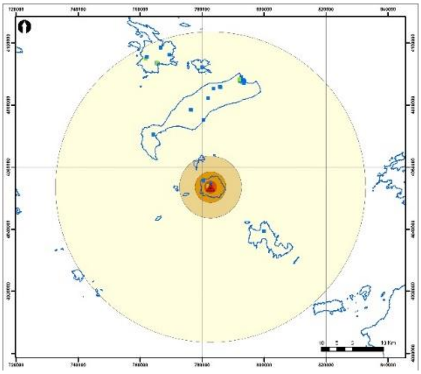

c) Pausanias


d) Milos


e) Santorini


f) Kolumbo

http://dx.doi.org/10.29009/ijres.5.3.1



g) Nisyros

Figure 2. The buffer zones for SAVA's volcanos (Source: The authors).

3.3. Temporal aspects (7)

It has been 70 years since the last eruption observed of the Santorini volcano (Table 1) (Vougioukalakis and Fytikas, 2005; EM-DAT, 2020). This long absence of volcanic activity has caused a lack of alert (and the perception of volcanic hazard) in the teaching staff, regarding volcanic hazards and, consequently, safety measures. Obviously, none of the teachers have ever experienced such a natural phenomenon in their entire life-time. Yet, it is well-known as in the case of earthquakes, that the longer an active volcano remains silent, the more violent its potential awakening can be.

According to the Greek educational regulations (4), the teaching staff (5) has the sole responsibility for applying the precaution and safety measures, legally dictated at schools against any kind of hazards, for the protection of their pupils during school-hours. Therefore, before planning an educational intervention regarding volcanic hazards, a relevant survey had to be conducted for recording the opinion and attitude of teachers.

http://dx.doi.org/10.29009/ijres.5.3.1

Table 2. The total numbers of schools, pupils and teachers' exposure to volcanic hazards per buffer zone of each volcano.

Buffer zone	2 Km	5 Km	10 Km	50 Km
Volcano	Schools Units of Primary Education			
Sousaki	-	4	8	695
Methana	-	-	2	811
Pausanias	-	-	2	873
Milos	-	3	1	7
Santorini	-	14	12	9
Kolumbo	-	-	-	44
Nisyros	1	2	-	59
Volcano	Schools Units of Secondary Education			
Sousaki	-	-	15	344
Methana	-	-	1	450
Pausanias	-	-	1	496
Milos	-	-	5	4
Santorini	-	10	1	6
Kolumbo	-	-	-	19
Nisyros	1	-	-	23
Volcano	Pupils' / Teachers' Population			
Sousaki	-	150 / 12	2100 / 220	>10000 / >1000
Methana	-	-	200 / 20	>10000 / >1000
Pausanias	-	-	200 / 20	>10000 / >1000
Milos	-	150 / 18	535 / 60	1045 / 130
Santorini	-	800 / 85	800 / 85	1655 / 190
Kolumbo	-	-	-	1870 / 210
Nisyros	50 / 15	-	5000 / 570	

Source (Open): Hellenic Statistical Service (ELSTAT).

3.4. Field survey (5)

This survey was part of a thesis (Papavasileiou, 2021; Papavasileiou et al., 2021) and carried out by submitting a structured questionnaire to a selected number of responders, between May and December 2019. Usually, structured questionnaires aim to investigate knowledge and/or behaviours of a target group of responders, regarding specific hazards (Bird, 2009). In this case, the responders were asked to answer about their perception of hazard (i.e., their feeling of safety), in a wide range of hazards according to EM-DAT classification. Responders were recruited via e-mail invitation, submitted to a representative sample of 500 teachers from the Greater Athens Area

http://dx.doi.org/10.29009/ijres.5.3.1

primary and secondary educational directorates and it was distributed via google.docs.

Items 1 to 9 include personal details of responders (gender, age, education level/degree, job position, workplace – municipality level –, educator’s specification and their opinion on the quality of life in the studied area. Items 10 to 24 investigate their general knowledge of civil protection plans and issues warnings, regarding disasters, for teachers, as well as the possible implementation to school units. Finally, items 26 to 29 evaluate the perception of teachers about vulnerable age groups, and the information/communication they receive by the civil protection general secretariat. This study was specifically focused on Item 25, which is relevant to the investigation of the educational community's perception of natural/technological hazards. Item 25 includes 27 sub-types of hazards, as they are defined in EM-DAT database, plus three questions regarding “social hazards” (illegal activities and criminal acts, inside and outside schools).

Item 25 includes the following hazards: Meteorological (Storms, Severe Storms, Lightnings, Hail, Snow, Blizzards, Long Lasting Cold, Extreme Heat Waves, Long Lasting Heat, Extreme Weather Phenomena), Geological (Earthquakes, Tsunamis, Geological Phenomena, Landslides, Volcanic Activity**)**, Hydrological (High Volume of Water, Floods), Climatological (Draughts, Wildfires), Biological (Infectious Diseases, Weather related Diseases), Extraterrestrial Hazards, Technological (Industrial Accidents, Technological Accidents, Miscellaneous Accidents, Infrastructures Failure, Natural Gas network Failure) and Social (Illegal Activities, Criminal Activities inside Schools, Criminal Activities outside Schools). The questions were formulated as follows: “How match the following natural/technological hazards affect your sense of safety?” The educators had to choose among the following responses: -2, Affected a lot; -1, Affected enough; 0, Quite affected; 1, Little affected; 2, Not affected at all.

The received responses were 210, both from primary and secondary education, being almost equally shared between males and females. A remark regarding responders is the aging population of teachers (> 50 years) in secondary education. This

http://dx.doi.org/10.29009/ijres.5.3.1

fact may limit their ability to comprehend issues concerning natural hazards. The majority of the responders have higher levels of education, with 75% being classroom teachers and 25% being principals or deputy principals, usually with many years of educational experience. Another limitation of this research was the relatively low number of responses compared to the number of teachers who received the questionnaire, thus indicating that the related (i.e., 'volcanic') safety culture is not developed/significant enough.

As far as the geological hazards concerned, there was an increased level of readiness and preparedness for earthquakes (Fig. 3), due to a long-lasting campaign which has been supervised by the Greek organization for earthquake planning and protection (OASP). This campaign includes an annual school Emergency Plan, at least three emergency drills and training sessions per year and constant information and motivation towards a culture of disaster prevention and resilience (Papavasileiou et al., 2021). The same was not true regarding the other geo-hazards.

Especially for volcanic activity and tsunamis, the majority of responders declared that their feeling of safety was not affected at all (Fig. 3). All those responses occurred in a high-risk area (Mavrakis et al., 2021; Palmos et al., 2021; Papavasileiou et al., 2021), similarly to other areas that include volcanoes with particularly long repose periods, but of vital social and/or economic importance, as the Aegean Archipelago is, in agreement with other relevant studies (Dominey-Howes and Minos-Minopoulos, 2004).

http://dx.doi.org/10.29009/ijres.5.3.1

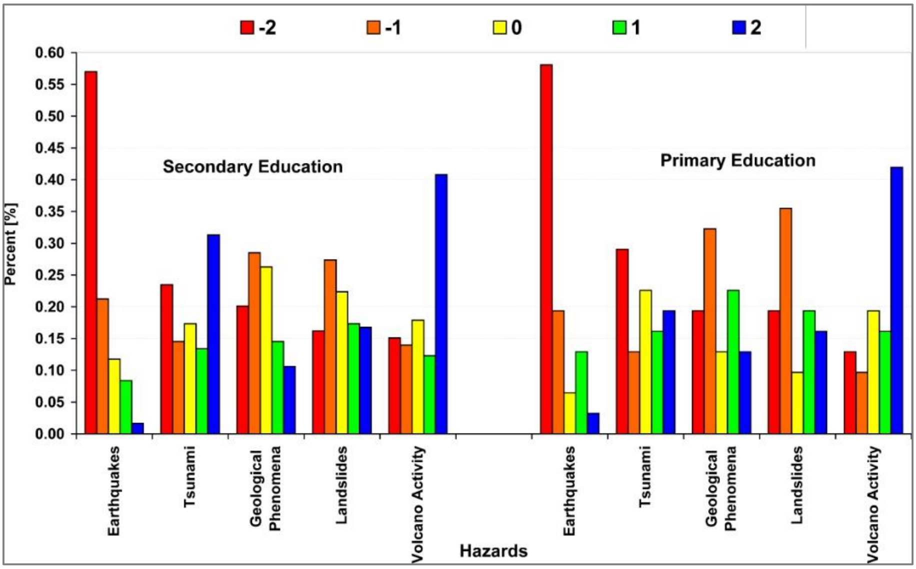


Figure 3. Diagram of responses to the field survey on geo-hazards (Source: The authors).

4. Results

As previously mentioned, the required (systemic) outcome [ii] of this educational intervention was the forming of a new training programme for teachers, aimed at initiating the development of a relevant safety culture, focused on coping with volcanic hazards in the high-risk areas of the SAVA. The planned approach included a pilot-training, for testing the technical aspects of the intervention, before proceeding to a firm training proposal.

In May 2017, the Environmental Education Co-ordinators of Western Attica’s Primary and Secondary Education Directorates organized a 12-hour training action, as part of their training duties, on the topic: ‘The volcanoes of our neighbourhood as an occasion for Environmental Education / Sustainable Development Education (SDE) Programs’ (EEO–WAPED, 2017). That action was attended by 35 teachers from Primary Schools, Gymnasiums (i.e., the Greek junior high-schools) and Lyceums (i.e., the Greek senior high-schools) of Eleusis, Aspropyrgos, Megara, Ano Liossia and Fili cities.

The educational action’s objectives aimed at:

http://dx.doi.org/10.29009/ijres.5.3.1

raising the teachers' awareness about the dangers that some areas face because of volcanic hazard due to volcanic activity;

changing teachers' perceptions of hazard towards safety from volcanic activity;

exploring ways of integrating this subject in the safety issues of the Environmental Education Programmes implemented in schools.

This training was based mainly on field experiential study of the nearby Sousaki and Methana volcanoes, as well as the SPA-town of Methana, while utilizing principles of place-based education (Tsevreni, 2009).

Field study is the most important teaching technique for Environmental Education (SDE), which, if combined with the principles of place-based education, works more effectively in terms of meaning-making, because it utilizes the direct experience of participants, who have an active role in the whole process (Papadimitriou, 2012). The pupils' field study presupposes the teachers' visit to the field, as well as the preparation of appropriate educational material. This is followed by the pupils exploring and recording their observations in appropriately designed worksheets. Finally, during the data processing in classroom, conclusions are drawn and action is taken by the pupils. Experiential education is very important for modern school, because "it emphasizes the awakening and utilization of the senses, the involvement of the learners with the issues that concern them, the experience and the emotion" (Georgopoulos, 2014), it supplies pupils with knowledge and first-hand experiences, enables them to research and discover elements of the problem useful for its global perspective, and also penetrates problem's aspects that are impossible to visualize or simulate by other means (Giannaki et al., 2019).

Place-based education is not just a study of the environment, but uses the local community and its environment as a starting point, while emphasizing on experiences from the real world, thus increasing the pupils' academic achievement, helping them to understand the world they live in, and activate citizens' action-taking (Papadimitriou, 2012). Those who have criticized the method's focus on the local environment and the

http://dx.doi.org/10.29009/ijres.5.3.1

school community, suggest organizing programmes about the “commons” of the various places, such as the “commons of natural resources” (e.g., water and air), and also how people use these “commons” for future generations, in response to contemporary challenges and opportunities, with an emphasis on building bonds and networks with “distant others”, whose fortunes are connected. This training was designed in the context of this “networking” with the distant others, as volcanoes are a common resource for many areas of Attica and Greece (the working place of the participating teachers is located in an important seismic arc).

This topic was approached with theoretical presentations, with an experiential and research approach, with the collection of data from the local community on the added value of volcanoes and thermalism in their city, as well as with exchange of views and submission of proposals for precaution measures regarding volcanic hazard and the sustainable development of tourism in these areas and in safe conditions. The teachers also had the opportunity to collect primary digital material (photos and videos), for processing the topic with their pupils, while the action’s ultimate goal was to submit the teachers’ proposals to the municipality representatives.

The training action included: A) Theoretical presentations concerning the Greek volcanic arc (SAVA), volcanic and post-volcanic phenomena, volcanic hazards in Greece, thermo-mineral waters, geo-tourism, the volcanic landscape flora; B) Hiking routes in the craters of the two volcanoes; and C) Research in the local community and World Cafe workshop in the city of Methana.

In the first part of the training action during the field study at the volcano of Sousaki, Professor K. Kyriakopoulos of the University of Athens explained the volcano’s behaviour, by using detailed surveillance material, while temperature measurements were performed with appropriate instruments, and samples were taken from the settled scientific stations. All of the teachers went up to the volcano’s crater, which is active, as it has a vaporizing effect (gas release), while some of them also collected volcanic rocks. During the group’s exploration in Sousaki, the Loutraki – Agioi Theodoroi Deputy Mayor informed the teachers about the Municipality’s efforts

http://dx.doi.org/10.29009/ijres.5.3.1

to highlight the volcano and make it accessible to pupils and other groups, while the action was recorded by the local electronic press.

In the second part of the seminar, a hiking ascent was made to the Methana volcano. Teachers were oriented in the space, based on the other volcanic arc islands (islands of Methana Volcano field), they were oriented in the time, based on the rocks of the surrounding area; they climbed into the crater, where the condition of the collapsed chamber was studied, while at the same time the flora around the volcano was introduced.

In the third part, the teachers had the pleasure to tour the city of Methana and explore precaution measures for volcanic activity (if any) and the conditions and possibilities for sustainable development. The city of Methana is a traditional SPA-town with two types of thermal springs (sulfur and radio), built at the feet of the volcano. During the tour, the teachers were given the opportunity to talk with the representatives of the municipality representatives about the city of Methana past and present. Then, with a semi-structured questionnaire, designed by the Environmental Education Coordinators, the participating teachers conducted a survey in the local community, in order to investigate the factors that contributed to the prosperity and decline of tourism locally. The questionnaire included questions about the volcanic environment of the area and precaution measures regarding volcanic hazard. Through these questionnaires, the teachers collected authentic information, which helped them to form their point of view on the area's safety culture.

After the primary research, the teachers and people from the local community participated in an open World Café workshop, which was set up at the beach-cafes' tables. World Café is a problem-solving method based on collective intelligence, as it activates participation in dialogue, views and ideas' exchange, using playful techniques and procedures (Brown and Isaacs, 2005; Camacho et al., 2020; Terry et al., 2015; Gill et al., 2016; Psaroudakis et al., 2020). The participants talk with pleasure about issues that concern them directly, and, in the flow of dialogue, contribute with ideas, proposals

http://dx.doi.org/10.29009/ijres.5.3.1

and arguments resulting in comprehensive solutions, as a result of collective intelligence (Dinou and Niarchou, 2015; Pantazidis, 2016).

The composition of the teams changed in each cycle, as well as their dynamics did. The teachers went from table to table, discussing with the new group, commenting and filling in on paper the views of the people who had passed before them. At last, they were due to vote on their favorite opinion. The registration and voting results were sent to the Municipality of Methana representatives.

The evaluation of the seminar demonstrated the teachers' positive impressions from the whole seminar, especially for their experience and their participation in all the parts of it. The need for continuous cooperation with Professor K. Kyriakopoulos and the visit in other Greece's and Europe's volcanoes for study emerged from the proposals of the teachers. Thus, the herein environmental education proposal for the presentation of volcanic hazards was formed along the guidelines of this pilot-training, ready now to be implemented on demand to a wider scale.

In accordance to other studies (Terry et al., 2015; Gill et al., 2016; Psaroudakis et al., 2020), this pilot approach showed the value of non-standard methodology (World Cafe`) in engaging/sensitizing adolescents. The integration of physical and scientific competencies was essential in the development of the volcano hazard approach. World Cafe´ is an innovative, reproducible and low-cost approach to assess perception of volcano hazard-related risks and to plan the design of dedicated health education interventions.

5. Conclusions

There are many common examples of initiating cultural change regarding safety culture against hazards, like training and education, incentive programmes, employee engagement initiatives for the perception of safety. Although quite commonly done, many organizations struggle to maintain the momentum of new programmes, which then become short-term initiatives, lovingly referred to by employees as the 'flavour-of-the-month'. Many safety programmes fail to reach their intended outcome of preventing initiatives. One of the primary reasons that many safety programs fail is

http://dx.doi.org/10.29009/ijres.5.3.1

because they are viewed as ‘programmes’, i.e., short-term initiatives that have a “shelf-life”. Often lacking is a cohesive vision and the accompanying strategies to achieve that vision.

The long-lasting effort and precaution measures regarding earthquakes, seems to be well established with educational personnel. The same is not true regarding volcano hazard, which in Greece include areas of volcanoes with long repose periods, but of vital social and/or economic importance, as the Aegean Archipelago is.

The rise of new kinds of hazards and the increased frequency of meteorological, climatological, biological and technological ones requires additional effort, new plans and extended awareness campaigns. The results of this study are particularly useful for designing future risk management plans, new policies and preparedness measures for the mitigation of consequences, thus enhancing the feeling of safety of teachers, pupils and guardians in school communities.

http://dx.doi.org/10.29009/ijres.5.3.1

References

Adger, W.N. (2006). Vulnerability. Global Environmental Change, 16(3), 268–281. https://doi.org/10.1016/j.gloenvcha.2006.02.006

Antoniou, V., Nomikou, P., Bardouli, P., Lampridou, D., Ioannou, T., Kalisperakis, I., Stentoumis, C., Whitworth, M., Krokos, M., & Ragia, L. (2018). An Interactive Story Map for the Methana Volcanic Peninsula. In Proceedings of the 4th International Conference on Geographical Information Systems Theory, Applications and Management (GISTAM 2018), pp. 68–78.

Barberi, F., & Carapezza, M. (2019). Explosive volcanoes in the Mediterranean area: hazards from future eruptions at Vesuvius (Italy) and Santorini (Greece). Annals of Geophysics, 62(1), VO01. http://dx.doi.org/10.4401/ag-7761

Bird, D.K. (2009). The use of questionnaires for acquiring information on public perception of natural hazards and risk mitigation – a review of current knowledge and practice. Natural Hazards and Earth System Sciences, 9, 1307–1325. https://doi.org/10.5194/nhess-9-1307-2009

Boca, G. D., & Sinan S. (2019). Environmental Education and Student’s Perception, for Sustainability. Sustainability, 11(6), 1553. https://doi.org/10.3390/su11061553

Bosi, V. (2009). Emergency management in volcanic crisis: Italian cases. In the Advanced Workshop on Evaluating, Monitoring and Communicating Volcanic and Seismic Hazards in East Africa. The Abdus Salam International Centre for Theoretical Physics, 17-28 August 2009, Trieste, Italy.

Bronfman, N.C., Cisternas, P.C., Repetto, P.B., & Castañeda, J.V. (2019). Natural disaster preparedness in a multi-hazard environment: Characterizing the sociodemographic profile of those better (worse) prepared. PLoS ONE, 14(4), e0214249. https://doi.org/10.1371/journal.pone.0214249

Brown, J., & Isaacs, D. (2005). The World Café: Shaping Our Futures Through Conversations That Matter. Berrett-Koehler: s.l.

Burgos-Garcia, A. (2007). Mainstreaming Occupational Safety and Health into Education: Good Practice in School and Vocational Education. The International Journal of Interdisciplinary Social Sciences: Annual Review, 2(1), 29–36. http://dx.doi.org/10.18848/1833-1882/CGP/v02i01/52022

Bye, R. J., Rosness, R., & Røyrvik, J. O. D. (2016). "Culture" as a tool and stumbling block for learning: The function of "culture" in communications from regulatory authorities in the Norwegian petroleum sector. Safety Science, 81, 68–80. http://dx.doi.org/10.1016/j.ssci.2015.02.015

Camacho, H. N., Rybels, S., Coppens, T., & Pineda, A. V. (2020). World Café as a Participatory Approach to Facilitate the Implementation Process of Problem-Based Learning. Journal of Problem Based Learning in Higher Education, 8(1), 19–40. https://doi.org/10.5278/ojs.jpblhe.v8i1.2660

Cecchini, M., Zambon, I., Pontrandolfi, A., Turco, R., Colantoni, A., Mavrakis, A., & Salvati, L. (2019). Urban Sprawl and the "Olive" Landscape: Sustainable Land Management for "Crisis" Cities. GeoJournal, 84(1), 237–255. https://doi.org/10.1007/s10708-018-9848-5

Chouliaras, G. (2009). Investigating the earthquake catalogue of the National Observatory of Athens. Natural Hazards and Earth Systems Science, 9, 905–912. https://doi.org/10.5194/nhess-9-905-2009

Congcong, P., Boshan, G., & Xinyu, C. (2021). Introduction of Environmental Protection Concept in Textile Major Education. Journal of Educational Theory and Management, 5(1), 60–63. http://dx.doi.org/10.26549/jetm.v5i1.6471

D'Alessandro, W. (2006). Gas hazard: an often neglected natural risk in volcanic areas. Geo-Environment and Landscape Evolution II, 89, 369–378. https://doi.org/10.2495/geo060371

D’Alessandro, W., Brusca, L., Kyriakopoulos, K., Michas, G., & Papadakis, G. (2009). Hydrogen sulphide as a natural air contaminant in volcanic/geothermal areas: the case of Sousaki, Corinthia (Greece). Environmental Geology, 57(8), 1723–1728.

D’Alessandro, W., Brusca, L., Kyriakopoulos, K., Rotolo, S., Michas, G., Minio, M., & Papadakis, G. (2006). Diffuse and focused carbon dioxide and methane emissions from the Sousaki geothermal system, Greece. Geophysical Research Letters, 33, L05307. https://doi.org/10.1029/2006GL025777

Dinou, I., & Niarchou, E. (2015). The Café of environmental education. Athens: eBook [in Greek].

Dominey-Howes, D. (2002). Documentary and Geological Records of Tsunamis in the Aegean Sea Region of Greece and their Potential Value to Risk Assessment and Disaster Management. Natural Hazards, 25(3), 195–224. https://doi.org/10.1023/a:1014808804611

Dominey-Howes, D., & Minos-Minopoulos, D. (2004). Perceptions of hazard and risk on Santorini. Journal of Volcanology and Geothermal Research, 137(4), 285–310. https://doi.org/10.1016/j.jvolgeores.2004.06.002

Ebert, P.A., Smith, M., & Durbach, I. (2019). Varieties of Risk. Philosophy and Phenomenological Research, 101(2), 432-455. https://doi.org/10.1111/phpr.12598

EM-DAT (2020). EM-DAT: The Emergency Events Database – Université catholique de Louvain (UCLouvain) – CRED, D. Guha-Sapir Brussels, Belgium – www.emdat.be, 2020 (last accessed on 1 December 2020).

Environmental Education Office of West Attica Primary Education Directorate (EEO – WAPED) 2017. Material from “The volcanoes of our neighbourhood as an occasion for Environmental Education / Sustainable Development Education (SDE) Programs” seminar [in Greek]. Retrieved on 5 April 2021, from https://perekp.wordpress.com/2017/05/13/%cf%84%ce%b1-

%ce%b7%cf%86%ce%b1%ce%af%cf%83%cf%84%ce%b5%ce%b9%ce%b1-%cf%84%ce%b7%cf%82-%ce%b3%ce%b5%ce%b9%cf%84%ce%bf%ce%bd%ce%b9%ce%ac%cf%82-%ce%bc%ce%b1%cf%82-%ce%b1%cf%86%ce%bf%cf%81%ce%bc%ce%ae/

Foumelis, M., Trasatti, E., Papageorgiou, E., Stramondo, S., & Parcharidis, I. (2013). Monitoring Santorini volcano (Greece) breathing from space. Geophysical Journal International, 193(1), 161–170. https://doi.org/10.1093/gji/ggs135

Foutrakis, M.P, & Anastasakis, G. (2018). Bathy-morphological setting of the Submarine Pausanias Volcanic Field, South Aegean Active Volcanic Arc. Journal of Maps, 14(2), 341-347. https://doi.org/10.1080/17445647.2018.1473816

Gatsios, T., Cigna, F., Tapete, D., Sakkas, V., Pavlou, K., & Parcharidis, I. (2020). Copernicus Sentinel-1 MT-InSAR, GNSS and Seismic Monitoring of Deformation Patterns and Trends at the Methana Volcano, Greece. Applied Sciences, 10(18), 6445. https://doi.org/10.3390/app10186445

Georgopoulos, A. (2014). Environmental Education, Identity Issues. Athens: Gutenberg [in Greek].

Giannaki, M., Babili, V., Tzokas, H., & Tsigou, A. (2019). Strengthening pupils' emotional involvement in local environmental issues: A case study, For Environmental Education. PEEKPE Magazine, 16–17 [in Greek].

Gill, L., Ramsey, P., Leberman, S., & Atkins, S. (2016). Using World Café to enhance Relationship-building for the Purpose of Developing Trust in Emotional Intelligence Training Environments. The Electronic Journal of Business Research Methods, 14(2), 98–110.

Global Volcanism Program (2013). Volcanoes of the World, v. 4.9.4. In Venzke, E. (ed.), Smithsonian Institution. https://doi.org/10.5479/si.GVP.VOTW4-2013 (last accessed on 08 May 2021).

Hoffmann, R., & Blecha, D. (2020). Education and Disaster Vulnerability in Southeast Asia: Evidence and Policy Implications. Sustainability, 12(4), 1401. https://doi.org/10.3390/su12041401

Hoffmann, R., & Muttarak, R. (2017). Learn from the Past, Prepare for the Future: Impacts of Education and Experience on Disaster Preparedness in the Philippines and Thailand. World Development, 96, 32–51. https://doi.org/10.1016/j.worlddev.2017.02.016

Kapetanidis, V., Karakonstantis, A., Papadimitriou, P., Pavlou, K., Spingos, I., Kaviris, G., & Voulgaris, N. (2020). The 19 July 2019 earthquake in Athens, Greece: a delayed major aftershock of the 1999 Mw = 6.0 event, or the activation of a different structure? Journal of Geodynamics, 101766. https://doi.org/10.1016/j.jog.2020.101766

Kassaras, I., Kapetanidis, V., Ganas, A., Tzanis, A., Kosma, C., Karakonstantis, A., Valkaniotis, S., Chailas, S., Kouskouna, V., & Papadimitriou, P. (2020). The New Seismotectonic Atlas of Greece (v1.0) and Its Implementation. Geosciences, 10(11), 447. http://dx.doi.org/10.3390/geosciences10110447

Kastolani, W., & Mainaki, R. (2018). Does Educational Disaster Mitigation Need To Be Introduced In School? SHS Web of Conferences, 42, 00063. https://doi.org/10.1051/shsconf/20184200063

Kavan, S. (2021). Evaluation of the Current Approach to Education of Security Issues at Selected Universities Preparing Future Pedagogues. Sustainability, 13, 10684. https://doi.org/10.3390/su131910684

Kinvig, H.S., Winson, A., & Gottsmann, J. (2010). Analysis of volcanic threat from Nisyros Island, Greece, with implications for aviation and population exposure. Natural Hazards Earth Systems Science, 10, 1101–1113. https://doi.org/10.5194/nhess-10-1101-2010

Kyriakopoulos, K.G., Kanaris-Sotiriou, R., & Stamatakis, M.G. (1990). The authigenic minerals formed from volcanic emanations at Soussaki, west Attica peninsula, Greece. The Canadian Mineralogist, 28(2), 363–368.

Lagios, E., Parcharidis, L.S., Foumelis, M., & Sakkas, V. (2005). Ground deformation monitoring of the Santorini volcano using satellite radar interferometry. Proceedings of 2nd International Conference on Recent Advances in Space Technologies (RAST 2005), 2005. https://doi.org/10.1109/rast.2005.1512651

Le Brocque, R., De Young, A., Montague, G., Pocock, S., March, S., Triggell, N., Rabaa, C., & Kenardy, J. (2017). Schools and Natural Disaster Recovery: The Unique and Vital Role That Teachers and Education Professionals Play in Ensuring the Mental Health of Students Following Natural Disasters. Journal of Psychologists and Counsellors in Schools, 27(1), 1-23. https://doi.org/10.1017/jgc.2016.17

Lekkas, E., Salachoris, M., Grambas, A., Plessas, P., Alexoudi, V., Valadaki, K., & Plessas, S. (2014). Disaster Data Centre–An Innovative Educational Tool for Disaster Reduction through Education in Schools. Journal of Power and Energy Engineering, 2, 35–40. http://dx.doi.org/10.4236/jpee.2014.29006

Mani, L., Cole, P.D., & Stewart, I. (2016). Using video games for volcanic hazard education and communication: an assessment of the method and preliminary results. Natural Hazards and Earth Systems Science, 16, 1673–1689. https://doi.org/10.5194/nhess-16-1673-2016

Mavrakis, A., Papakitsos, E.C., Papapanousi, C., & Papavasileiou, C. (2019). An Application of Systems Science for the Usage of Web–tools in Environmental Education: The Case of Western Attica, Greece. Journal of Research Initiatives, 4(2), Article 4. https://digitalcommons.uncfsu.edu/jri/vol4/iss2/4

Mavrakis, A., Papavasileiou, C., Alexakis, D., Papakitsos, E.C., & Salvati, L. (2021). Meteorological patterns and the evolution of West Nile virus in an environmentally stressed Mediterranean area. Environmental Monitoring and Assessment, 193(4), 227. https://doi.org/10.1007/s10661-021-09011-3

Newhall, C.G., & Self, S. (1982). The volcanic explosivity index (VEI) an estimate of explosive magnitude for historical volcanism. Journal of Geophysical Research, 87(C2), 1231–1238. https://doi.org/10.1029/JC087iC02p01231

Nomikou, P., Carey, S., Bell, K.L., Papanikolaou, C.D., Bejelou, K., Cantner, K., Sakellariou, D., & Perros, I. (2012). Tsunami hazard risk of a future volcanic eruption of Kolumbo submarine volcano, NE of Santorini Caldera, Greece. Natural Hazards, 72(3), 1375–1390. https://doi.org/10.1007/s11069-012-0405-0

Nomikou, P., Krassakis, P., Kazana, S., Papanikolaou, D., & Koukouzas, N. (2021). The Volcanic Relief within the Kos-Nisyros-Tilos Tectonic Graben at the Eastern Edge of the Aegean Volcanic Arc, Greece and Geohazard Implications. Geosciences, 11, 231. https://doi.org/10.3390/geosciences11060231

OASP (n.d.). Earthquakes and Greece. Greek Organization of Anti-seismic Planning and Protection (OASP). https://www.oasp.gr/node/207 [in Greek].

Palmos, D., Papavasileiou, C., Papakitsos, E.C., Vamvakeros, X., & Mavrakis, A. (2021). Enhancing the environmental programmes of secondary education by using web-tools concerning precaution measures in civil protection: The case of Western Attica (Greece). Safety Science, 135, 105117. https://doi.org/10.1016/j.ssci.2020.105117

Pantazidis, A. (n.d). A brief reference guide for hosting a world café. Athens: eBook [in Greek].

Papadimitriou, P., Voulgaris, N., Kassaras, I., Kaviris, G., Delibasis, N., & Makropoulos, K. (2002). The Mw = 6.0, 7 September 1999 Athens Earthquake. Natural Hazards, 27, 15–33. https://doi.org/10.1023/A:1019914915693

Papadimitriou, V. (2012). Place-Based Education. PEEKPE Magazine, 1, 46 [in Greek].

Papakitsos, E. (2013). The Systemic Modeling via Military Practice at the Service of any Operational Planning. International Journal of Academic Research in Business and Social Science, 3(9), 176–190. http://dx.doi.org/10.6007/IJARBSS/v3-i9/200

Papakitsos, E.C., & Mavrakis, A. (2018). A Systemic Model Proposed for the Management of Local Environmental Education, Awareness and Protection: A Case Study. Humanities and Social Science Research, 1(2), 1–8. https://doi.org/10.30560/hssr.v1n2p1

Papakitsos, E.C., Makrygiannis, P.S., & Mavrakis, A. (2021). A Study on Applications of Systems Engineering to Holistic Didactics. In A. Yildirim (ed.), Modern Perspectives in Language, Literature and Education, vol. 9 (pp. 36–52). Hooghly and London: B P International. https://doi.org/10.9734/bpi/mplle/v9/12711D

Papavasileiou, C. (2021). Investigating the education community's perception of physical and technological hazards: Case study the Thriassio Plain Area. Master Thesis, National and Kapodistrian University of Athens, Athens, Greece. https://pergamos.lib.uoa.gr/uoa/dl/object/2940808 [in Greek].

Papavasileiou, C., Mavrakis, A., Kourou, A., & Salvati, L. (2021). Perception of biohazards: a focus on schools in Western Attica, Greece. Euro-Mediterranean Journal for Environmental Integration, 6(27), 2–6. https://doi.org/10.1007/s41207-020-00231-6

Pierson, T.C., Wood, N.J., & Driedger, C.L. (2014). Reducing risk from lahar hazards: concepts, case studies, and roles for scientists. Journal of Applied Volcanology, 3, 16. https://doi.org/10.1186/s13617-014-0016-4

Poulianos, A.N. (1984). Once more on the age and stratigraphy of the petralonian man. Journal of Human Evolution, 13(5), 465–467. https://doi.org/10.1016/s0047-2484(84)80059-7

Poulianos, A.N. (1989). Petralona cave within Lower-Middle Pleistocene sites. Palaeogeography, Palaeoclimatology, Palaeoecology, 73(3–4), 287–294. https://doi.org/10.1016/0031-0182(89)90009-6

Psacharopoulos, G. (1994). Returns to investment in education: A global update. World Development, 22(9), 1325–1343. https://doi.org/10.1016/0305-750X(94)90007-8

Psaroudakis, I., Quattrone, F., Tavoschi, L., De Vita, E., Cervia, S., Biancheri, R., & Lopalco, P.L. (2020). Engaging adolescents in developing health education interventions: a multidisciplinary pilot project. European Journal of Public Health, 30(4), 712–714. https://doi.org/10.1093/eurpub/ckaa012

Rizzo, A.L., Caracausi, A., Chavagnac, V., Nomikou, P., Polymenakou, P.N., Mandalakis, M., Kotoulas, G., Magoulas, A., Castillo, A., & Lampridou, D. (2016). Kolumbo submarine volcano (Greece): An active window into the Aegean subduction system. Scientific Reports, 6, 28013. https://doi.org/10.1038/srep28013

Ross, S. (2017). Living in the Shadow of Italy's Volcanoes. Discover the World Education: https://www.discover-the-world.com/study-trips/living-in-the-shadow-of-italys-volcanoes/ (last accessed on 1 December 2020).

Sachpazi, M., Kontoes, C., Voulgaris, N., Laigle, M., Vougioukalakis, G., Sikioti, O., Stavrakakis, G., Baskoutas, J., Kalogeras, J., & Lepine, J.C. (2002). Seismological and SAR signature of unrest at Nisyros caldera, Greece. Journal of Volcanology and Geothermal Research, 116, 19–33.

Salvati, L. (2018). Population growth and the economic crisis: understanding latent patterns of change in Greece, 2002–2016. Letters in Spatial and Resource Sciences, 11, 105–126. https://doi.org/10.1007/s12076-018-0204-7

Sigalos, G., Loukaidi, V., Dasaklis, S., Drakopoulou, P., Salvati, L., Ruiz, P.S., & Mavrakis, A. (2016). Soil erosion and degradation in a rapidly expanding industrial area of Eastern Mediterranean basin (Thriasio plain, Greece). Natural Hazards, 82(3), 2187–2200. https://doi.org/10.1007/s11069-016-2288-y

Sorokin, P.A. (1946). Man and Society in Calamity: The Effects of War, Revolution, Famine, Pestilence Upon Human Mind, Behavior, Social Organization and Cultural Life. New Brunswick: Transaction Publishers.

Sykioti, O., Kontoes, C.C., Elias, P., Briole, P., Sachpazi, M., Paradissis, D., & Kotsis, I. (2003). Ground deformation at Nisyros volcano (Greece) detected by ERS-2 SAR differential interferometry. International Journal of Remote Sensing, 24(1), 183-188.

Terry, J., Raithby, M., Cutter, J., & Murphy, F. (2015). A menu for learning: a World Café approach for user involvement and inter-professional learning on mental health. Social Work Education, 34(4), 437–458. https://doi.org/10.1080/02615479.2015.103165

Tilling, R.I. (1989). Volcanic hazards and their mitigation: Progress and problems. Reviews of Geophysics, 27(2), 237. https://doi.org/10.1029/rg027i002p00237

Torani, S., Majd, P.M., Maroufi, S.S., Dowlati, M., & Sheikhi, R.A. (2019). The importance of education on disasters and emergencies: A review article. Journal of Education and Health Promotion, 8, 85. https://doi.org/10.4103/jehp.jehp_262_18

Traineau, H., & Dalabakis, P. (1989). Mise en evidence d'une eruption phreatique historique sur l'ile de Milos (Grece). Compte Rendus Acad. Sci. Paris, Ser II 308, 247–252 [in French].

Tsatsanifos, C., Kontogianni, V., & Stiros, S. (2007). Tunneling and other engineering works in volcanic environments: Sousaki and Thessaly. Bulletin of the Geological Society of Greece, 40(4), 1733–1740. https://doi.org/10.12681/bgsg.17102

Tsevreni, I. (2009). The need for an action-oriented environmental education, For Environmental Education. PEEKPE Magazine, 43, 10–12.

Ulvrova, M., Paris, R., Nomikou, P., Kelfoun, K., Leibrandt, S., Tappin, D.R., & McCoy, F.W. (2016). Source of the tsunami generated by the 1650 AD eruption of Kolumbo submarine volcano (Aegean Sea, Greece). Journal of Volcanology and Geothermal Research, 321, 125–139. https://doi.org/10.1016/j.jvolgeores.2016.04.034

Vougioukalakis, G., Sparks, R.S., Druitt, T., Pyle, D., Papazachos, C., & Fytikas, M. (2016). Volcanic hazard assessment at Santorini Volcano: A review and a synthesis in the light of the 2011-2012 Santorini unrest. Bulletin of the Geological Society of Greece, 50(1), 274–283. https://doi.org/10.12681/bgsg.11728

Vougioukalakis, G.E., & Fytikas, M. (2005). Volcanic hazards in the Aegean area, relative risk evaluation, monitoring and present state of the active volcanic centers. Developments in Volcanology, 7, 161–183. https://doi.org/10.1016/S1871-644X(05)80037-3

Vougioukalakis, G.E., Satow, C.G., & Druitt, T.H. (2019). Volcanism of the South Aegean Volcanic Arc. Elements, 15(3), 159–164. https://doi.org/10.2138/gselements.15.3.159

Washington, H. (1924). Notes on the Solfatara of Sousaki (Greece), a Recent Eruption at Methana (Greece), and Recent Maccalube at Vulcano. The Journal of Geology, 32(6), 460–462. http://www.jstor.org/stable/30060358

Waugh, W.L. (1996). Disaster Management in the US and Canada: The Politics, Policymaking, Administration and Analysis of Emergency Management. Springfield: Charles C. Thomas.

http://dx.doi.org/10.29009/ijres.5.3.1