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Conference Proceedings

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CONFERENCE PROGRAM

Day #1 **Wednesday 31 October**

Opening Ceremony @ Regional Council Hall
27 Dimokratias Str, Kozani

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12:00 – 13:00	Welcome Greeting and Opening Words **Theodoros Karypidis** *Regional Governor of Western Macedonia* **Antonios Tourlidakis** *University of Western Macedonia, Rector* **Stergios Ganatsios** *Western Macedonia University of Applied Sciences, Rector*
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13:30 – 14:00	**Gerasimos Papadopoulos** *UNESCO, North East Atlantic & Mediterranean Tsunami Warning System, Chairman* Early Warning Systems to Reduce Natural Hazards
14:00 – 14:15	**ILias Argyris** *Head of the Civil Protection Office, Municipality of Rhodes*
14:00 – 16:00	Lunch Break

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Conference Proceedings @ Western Macedonia University of Applied Sciences

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Day #3 | **Friday 2 November**

Conference Proceedings @ Western Macedonia University of Applied Sciences

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ABOUT

The 5th International Conference on Civil Protection & New Technology hosted in the facilities of Western Macedonia University of Applied Sciences, in Kozani, Greece took place between October 31 and November 3, 2018 and has been successfully completed.

Safe Kozani 2018 has been organized by the Region of Western Macedonia, co-organized by the University of Western Macedonia, the Western Macedonia University of Applied Sciencesand the Hellenic Fire Academy, under the auspices of the Hellenic Ministry of Foreign Affairs.

Being the 5th of the conferences series under the brand Safe Greece and aiming to a modern and efficient Civil Protection, Safe Kozani 2018 brought together all the stakeholders related to Civil Protection and the local, regional, national and international Civil Protection bodies representatives, the public and private domains, the High-End Technologies and the Academic Community with a significant participation from Greece and abroad.

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TOPICS

 Natural Disasters: causes, prevention, management, best practices, lessons learned

 Technological & Man-made Disasters: causes, prevention, management, best practices, lessons learned

 Natech (Mixed Natural & Technological) Disasters: causes, prevention, management, best practices, lessons learned

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 Civil Protection & Disability / Third Age

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 Fire Service: Work, Innovations, Challenges

 Transnational level: International, European and Mediterranean Programmes and Civil Protection synergies

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SAFE KOZANI 2018

Conference Announcements

Oral Presentations

Preparing for Earthquake at Pre-Schools: The Role of Earthquake Planning and Protection Organization

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Abstract

In recent years there were several major natural disasters in the Mediterranean region. Among these disasters, earthquakes have a lot of impacts. Greece is characterized by the occurrence of severe damaging earthquakes. It is generally accepted that earthquakes reveal the vulnerabilities of communities, workplaces, households etc. In order to build an earthquake resistant community, preventive planning is vital in mitigating impacts, protecting the population and increasing the degree of resilience of local communities.

States worldwide have highlighted the need to ensure the safety of early childhood environments in case of disaster. Taking into consideration that a great number of children are enrolled in day care facilities, building and improving the pre-schools' preparedness status becomes an important policy issue in order to prevent injuries and fatalities in case of an earthquake. It is more than evident that preparedness in early pre-school level will be increased through awareness and education of the people who work in kindergartens and provide early childhood care.

The aim of this study is to present a holistic overview of pre-schools' earthquake preparedness actions in Greece and State's relevant actions as well. More specifically, this paper focuses on two topics in the earthquake field: the assessment of awareness and preparedness of Greek pre-schools' staff concerning earthquake protection issues, and the presentation of the national policy on improving the earthquake preparedness of pre-schools in Greece.

In this framework, specific questionnaire was developed and filled in by the abovementioned target group namely the personnel of pre-schools, established in different regions of the country, during 2014 to 2017. Results and findings were analyzed to identify intervening, and facilitating factors that contribute to effective disaster management. Overall, findings supported the idea that pre-schools' Earthquake Raise Awareness Initiative, that has been undertaken by Earthquake Planning and Protection Organization (EPPO) during the recent years, provides one gateway through which pre-school environments can increase their resilience to the effects of a major hazardous event. Findings also provided an initial foundation for further research in this emerging area.

Key-words: seismic risk, earthquake emergency planning, pre-school, protection measures

1. Introduction

Vulnerability is the degree to which a population, individual or organization is unable to anticipate, cope with, resist and recover from the impacts of disasters. Children, pregnant women, elderly people, malnourished people, and people who are ill, are particularly vulnerable when a disaster strikes, and take a relatively high share of the burden associated with emergencies (WHO 2002).

A disaster occurs when an extreme event exceeds the community's ability to cope with that event. One way to reduce disaster's physical impact is to adopt emergency preparedness practices, which are pre-impact actions that provide the human and material resources needed to support active responses at the time of hazard impact (Lindell & Perry 2000). According to this approach the effects of the disasters can be mainly reduced if people are aware, well informed and motivated towards a culture of disaster prevention and resilience (UNISDR 2015). To this end, one of the priorities of the State and a key factor in effective disaster risk reduction is the implementation of strategies and specific actions to raise public awareness (EU OSHA 2012). This could be achieved through the development and dissemination of relevant information to improve knowledge about seismic risk and the acquisition of skills for the effective management of seismic events at individual, family and school level.

In all over the world a lot of children under the age of five spend their daytime hours away from their parents. Most of these children are in a pre-school. These schools are entrusted to provide a safe and healthy learning environment for millions of children. Emergencies occurring during hours of operation require pre-planning. Families and communities expect pre-schools to keep their children safe from natural disasters, so pre-schools should take steps to plan for the potential earthquake events. Lessons learned from emergencies highlight the importance of preparing school officials and first responders to implement emergency operations plans. *"By having plans in place to keep students and staff safe, schools play a key role in taking preventative and protective measures to stop an emergency from occurring or reduce the impact of an incident. Although schools are not traditional response organizations, when a school-based emergency occurs, the personnel respond immediately"* (FEMA 2013).

It is worth mentioned that preschools' disaster plans should incorporate actions that referred to the four areas of disaster management: prevention/mitigation, preparedness, response, and recovery. First of all, effective emergency planning depends on a consistent analysis and comparison of the hazards that pre-school faces in particular. This is typically performed through a hazard identification and risk assessment process in order to decide which hazards the plan should prioritize and subsequently address. In Greece that is a country with high seismicity, seismic risk reduction should be one of first priorities at family, workplace, community and national level (ELINYAE 2008, Law N.3850 2010).

The earthquake emergency plan in kindergarten is an effective tool that includes a set of actions that must be undertaken to reduce the impact of an earthquake and to ensure the protection of safety of all. This plan covers procedures for an incident occurrence during school hours and defines emergency response operations such as, evacuation procedures, communication plan, family reunification protocol, general emergency actions etc. This plan should be reviewed by all preschool staff at least annually. The primary goals of the earthquake plan are to:

- Develop effective planning that will promote the safety and welfare of children and pre-school staff, protect property, and regulate the operation of the pre-school during an earthquake event.
- Prepare children and staff to take appropriate safety actions in case of an earthquake.
- Provide parents with accessibility to guidelines and emergency procedures.

Earthquake Planning and Protection Organization (EPPO), is a State Organization and the competent authority in Greece to process and design the national policy on earthquake protection. EPPO contributes substantially to the development of earthquake consciousness and contributes to the development of seismic safety culture and resilience through public awareness projects addressed to various target groups of the population, such as: teachers, public servants, students, volunteers, people with disabilities, tourists etc (EPPO 2015). During the last decade EPPO has implemented an Earthquake Raise Awareness initiative addressed to early pre-schools' staff.

2. Methodology

This study has as a primary aim to present the results of a survey that investigates the knowledge, prevention and readiness level of kindergartens' personnel both at family and workplace level.

Since 2001, the supervision of state-owned kindergartens in Greece has passed to the Municipalities. The supervisor structures operate either as Municipality's Legal Entities or Municipality's Divisions. The participants of the present survey are personnel of municipal kindergartens, including educators and auxiliary personnel (cooks, cleaners etc.) with a permanent employment relationship or a contract work.

A closed-form questionnaire was developed for the research, which contained questions regarding the following: a) knowledge of self-protective actions in case of an earthquake b) existence of emergency planning in the responders` workplace such as hazard mitigation actions, development of emergency plan, performance of drills and the responders` perception about their level of preparedness in an event of an earthquake.

1378 questionnaires were gathered from January 2014 to December 2017 and analyzed. The questionnaires were administered to responders during seminars organized by Department of Education – Information of EPPO. The seminars entitled "Earthquake Emergency Planning at Pre-Schools Environments" are addressed to kindergartens' personnel. The research participants are employees in kindergartens from 32 Municipalities from 11 different regions of the country namely; Attica, Crete, Thessalia, Northen and Southen Aegean, Western Macedonia, Central Macedonia, Eastern Macedonia and Thrace, Ionian Islands, Peloponnesus, Thessaly and Epirus regions.

EPPO's initiative aims to develop earthquake-resilient kindergartens through awareness, self-help, cooperation and education. Recognizing the necessity of integration of the disaster safety concept at pre-primary environments, EPPO's actions are the following:

a. Implementation of seminars in municipality or prefecture level every year, in order for the early childhood schools' staff to be appropriately educated and adequately trained to face the earthquake. These seminars take place in collaboration with competent Legal Entities or Divisions of Municipalities. During these seminars, the personnel of all kindergartens of each Municipality are trained to earthquake prevention and preparedness, with the aim to remain calm and in control of the children in case of an earthquake and to follow specific documented procedures for safe exit, evacuation etc., if needed. Furthermore, teachers and caregivers are trained to teach basic safety concepts to young children, including drills and learning activities (using EPPO leaflets, educational kit) that can be incorporated into lesson plans in a fun and fear-free way (Kourou et al 2017).

b. Development of educational material (guidelines, brochures, posters, presentations etc.) specifically targeted to early childhood schools' staff, children and parents (Fig. 1). In 2017 a Guide for Developing Pre-school Earthquake Emergency Plan was prepared and published (EPPO 2017). EPPO recommends that pre-schools should use this document to guide their efforts in developing or revising their earthquake plan. The views expressed herein represent the collective expertise on earthquake planning issues. Also, the shared approach facilitates mutual understanding, coordination, and execution of the emergency management strategies.

c. Dissemination of EPPO's educational and information material concerning earthquake protection and emergency management (presentations, editions, TV social messages, website www.oasp.gr, facebook etc.).

Figure 1: EPPO's educational material

3. Results of Survey

3.1 Knowledge of Earthquake Protection Measures

According to the results, a significant majority of the responders reported that they have experienced an earthquake (Fig. 2), which is quite normal if we consider the fact that Greece ranks first in terms of seismicity in Europe and sixth worldwide.

Exploring responders` personal perception of their knowledge concerning the appropriate earthquake safety behaviors, it is worth noting that 74% of the responders answered that they are familiar with the proper actions (Fig. 3). The "knowledge of appropriate earthquake safety behaviors" question is followed by more specific ones, in an attempt to explore the seismic protection measures taken at individual level during the earthquake. At that point sufficient deviation from the correct options was observed. More specifically, 67% of the respondents consider as proper action during the earthquake to take cover under an interior door frame in a reinforced concrete building, which is not true and it only applies to masonry buildings. Furthermore, 52% of the responders stated that during the shaking they would stay still and do nothing to protect themselves. Nevertheless, it is worth mentioned that the vast majority of the participants 79% are well aware that running towards the exit is not the right action during the earthquake (Fig. 4).

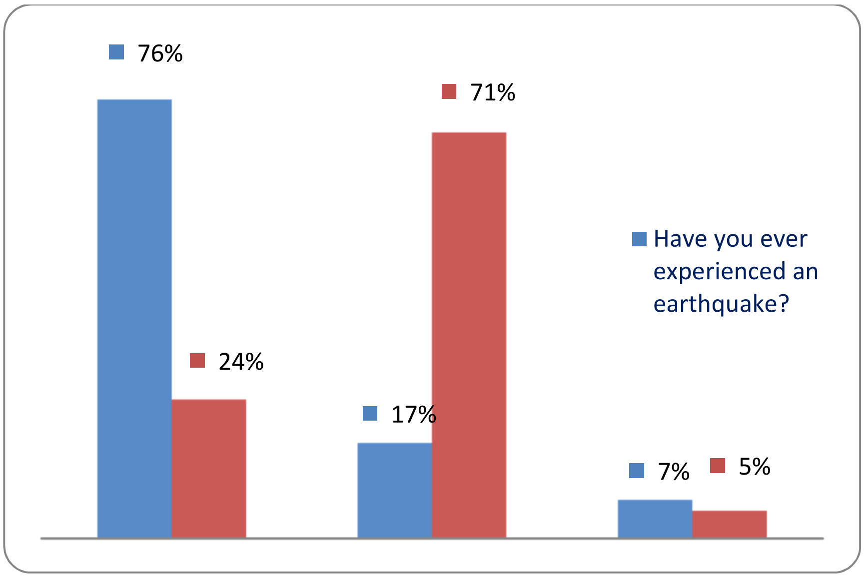

Fig. 2: Answers concerning the earthquake experience of the responders

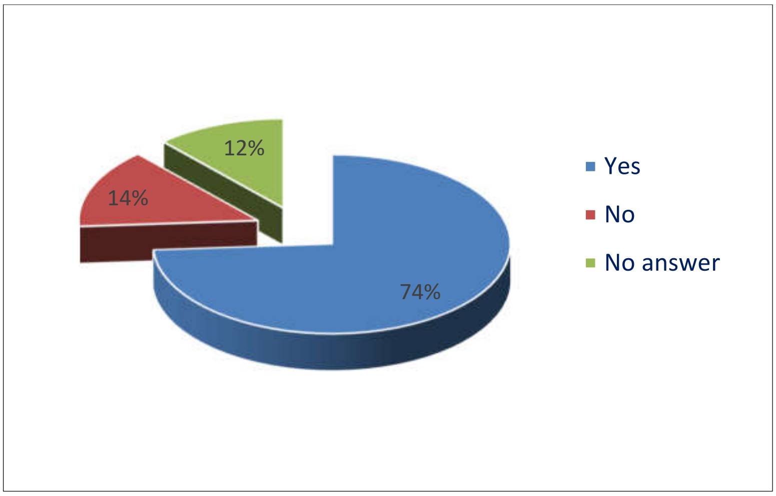

Fig. 3: Answers to the question: Are you aware of the appropriate earthquake safety behavior?

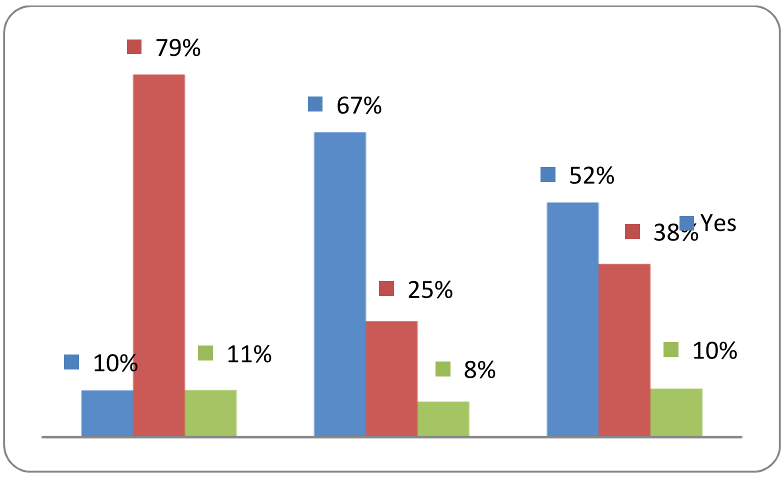

Fig. 4: Answers concerning the earthquake protection measures during the earthquake

3.2 Prevention and Preparedness Measures at Pre-School

3.2.1 Emergency Plan

Regarding the establishment of earthquake emergency planning in the responders` work environment and their level of preparedness, the results collected vary considerably.

When asked "Is there an earthquake emergency plan at your workplace?" 34% of the respondents replied affirmatively, 32% negative and a percentage of 34% was a “do not know” and “no answer” (Fig. 5).

The non-existence of emergency plan could be due to the fact that the institutional framework for emergency planning in kindergartens is not sufficiently clear as it is for schools.

For these reasons the last two years EPPO has intensified its efforts on the training of personnel in pre-school environments. More specifically, in addition to other educational actions directed to the general population (awareness campaigns, promotion of social TV spots, etc.), EPPO collaborates with the Ministry of Labor, Legal Entities of Municipalities and others agencies, develops relevant training material and organizes seminars for specific target groups.

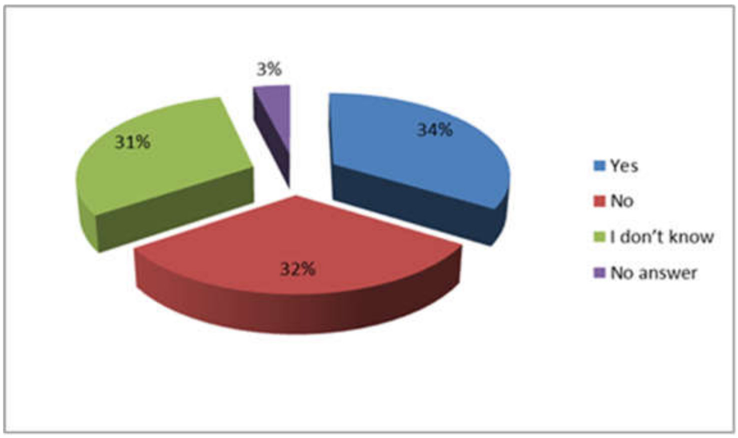

Fig. 5: Answers to the question: Is there an earthquake Emergency Plan at your Pre-school?

It is well known that most injuries and fatalities occur because the ground shaking dislodges loose objects in and out of buildings. Anything that can move, fall, or break when the ground starts to shake is an earthquake hazard. Classrooms, homes, and all the other places where young children spend time indoors contain objects that could cause injury or damage during a quake.

Regarding the questions "Have you fastened tall and heavy furniture on a wall?" and “Have you placed heavy and fragile objects to lower shelves?” a rate of 67% and 79% of the respondents respectively said yes, while 24% and 14% gave a negative answer. However, differences were emerged to the questions "Is there appropriate emergency signage in the building?", where a significant majority 58% of the responders answered negatively. Similar pattern revealed to the question "Has your building’s evacuation plan been posted in each classroom?" where the affirmative responses of employees were limited to 25%, while the rate of negative responses was 59% (Fig. 6).

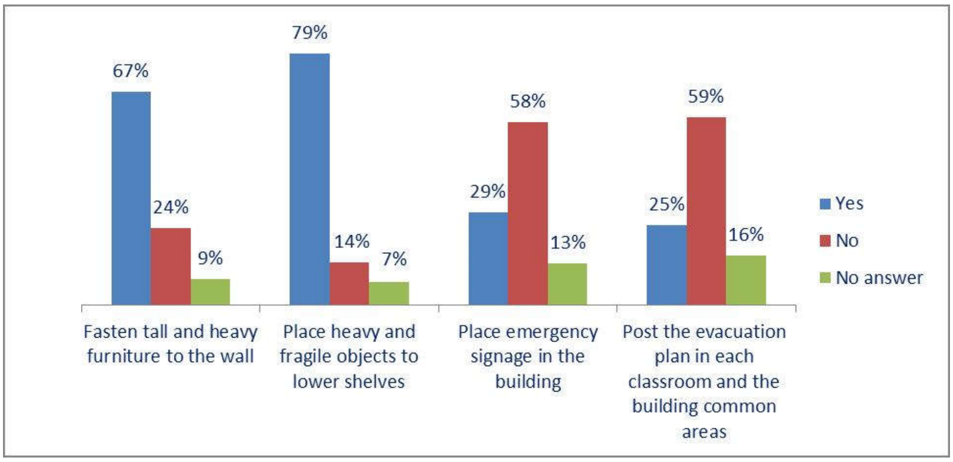

Fig. 6: Answers of participants to questions about mitigation of indoor hazards

3.2.2 Earthquake drills

Earthquake drills and exercises are an extremely important part of pre-schools' emergency plan because they: a) teach children, staff and parents how to respond to the complications of an actual earthquake, and b) help the staff to evaluate how well all parts of the emergency plan work together, and how well staff and students have been trained. They allow to see how well things operate and to correct any problems, because when an earthquake happens it is too late to discover that parts of the emergency plan may not work.

Regarding the question "Do you hold earthquake drills at your kindergarten every year?" 66% of the respondents said no, 12% had a "no answer" response while the 22% gave an affirmative answer (Fig. 7).

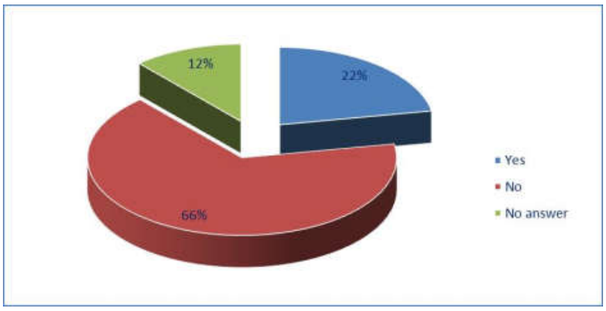

Fig. 7: Do you hold earthquake drills at your kindergarten every year?

Finally, the responders' personal attitude on earthquake preparedness status at their workplace, was explored by the question "Do you feel that you are prepared to face the consequences of a severe seismic event at your preschool?". 342 out of 1378 participants responded that they feel prepared, while on the other hand the vast majority, 1036 out of 1378, was negative responses including "No" and "No answer" (Fig. 8).

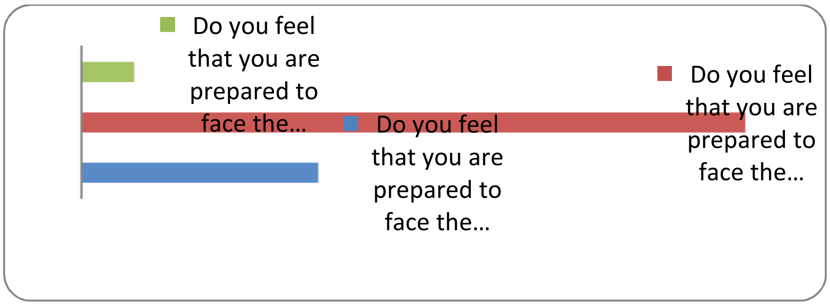

Fig. 8: Answers of participants to the question: Do you personally feel prepared to face the impacts of an earthquake in your pre-school?

4. Conclusions

Proper risk assessment, including seismic risk, is crucial to create a safe environment. It is generally accepted that earthquake emergency planning requires collective efforts on implementation, evaluation and continuous improvement.

This research is an initial approach aiming to investigate the preparedness status of preschools' employees of from 32 different Municipalities concerning earthquake protection issues at workplace level. According to the analysis of the survey results, it may be concluded that, the knowledge of participants about the self-protection actions in case of an earthquake is generally good. Regarding the prevention and preparedness measures taken at pre-schools, the results show that the employees have substantially low rates regarding the abovementioned actions in their workplaces.

It is worth mentioning that EPPO has stepped up its efforts to build awareness, increase preparedness and ensure emergency response at preschool environments, towards safety and welfare of all. However, there is still much room for improvement in the attitudes and behavior of pre-schools' personnel, particularly in the acquisition of relevant management skills and adoption of effective planning in their workplace.

Achieving improved seismic safety is not only a problem but also a challenge to promote safety, minimize impact and assist in a speedy recovery.

Nevertheless, it is extremely important that the implementation of effective programs and practices with the broad collaboration of all involved parties has been recognized as essential in order to develop a comprehensive disaster management system at pre-school environment.

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RADIO-COMMUNICATIONS AT THE HELLENIC FIRE SERVICE AND THE ROAD AHEAD TO DIGITAL ERA

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Abstract

Fire Service is a Public Safety (PS) Service that has a very important role to society by creating a stable and secure life environment. It is a common fact that the lives of firefighters and the quality of Service that they provide, depend a lot on radio communications. In mission critical services the Professional Mobile Radio (PMR) systems are used by firefighters in the field of operations to support the mobility of these first responders. In this study, aiming the improvement of the communication in the digital era we provide a review of the recent situation of analog radio-communications system that is used by the Hellenic Fire Service at the moment and highlight the limitations. Furthermore, we study the ever-changing needs of radio-communication systems on Fire Service and we also provide a brief overview of well-known PMR technologies that are used by other mission critical services in Europe. We conclude, with focus on the available digital technologies on the market highlighting their limitations and benefits for the case of Hellenic Fire Service.

Keywords: Fire Service communications, Public Safety, Private Mobile Radio, Critical Communications, Digital trunking technologies

Notes: The views and the conclusions contained in this work express only the author's and should not be interpreted as representing the official positions of the Hellenic Fire Service.

1 Introduction

Like all operations the communication between the partners is a major factor of success or failure of the commitment that is undertaken. Moreover, emergency situations need communication in order to organise the main activities as they always have great factor of heterogeneity. Emergency services around the world have different means of communication during affronting an emergency case The most popular mean is Professional Mobile Radio (PMR), also known as Private Mobile Radio or Land Mobile Radio, which are radio communication systems used by most Public Safety organizations.

In this work, firstly we will analyze the analog PMR system that is used by Hellenic Fire Service and we will highlight its limitations. Furthermore, we will emphasise on the basic prerequisites for a new digital system for Hellenic Fire Service, based on some important functional requirements due to the particularly difficult environments that should act. In the third part we analyse some of the most known technologies applied to Public Safety communications and finally, we sum up the PMR technologies used from other European countries.

2 Hellenic Fire Service's Radio-communication system

The Hellenic analog PMR radio communications system established in the early of 70's with the installation of mobile radios in vehicles that were supported by a few repeaters which were deployed on hills nearby cities. Some years later Hellenic Fire Service obtained portable radios improving the quality of service. The band used was VHF low band (30-50) MHz but later on shifted to a higher frequency band, VHF (151-174) MHz, where the systems can offer more frequency channels. Since then, the analog PMR system has been expanded all over the country offering better coverage and services. In this analog era there was one exception during the Olympics Games of Athens in 2004 when C4i project took place and the TETRA technology was used until 2014 for the communication of all mission critical services for the region of Attica.

2.1 Functional description of the recent system at Hellenic Fire Service

Currently the system that is used by Fire Service is an analog narrowband PMR with 25 KHz channel spacing which operates in VHF (151-174) MHz band and UHF (420 - 450) MHz band. The UHF band is used as link and the VHF band for radio broadcasting. Hellenic Fire Service is composed by 13 administrative regions and one of them constitutes the major which is the Attica region. In each region, a dispatch centre has been installed to control and supervise each mission of the local domain, as shown in Fig.1.

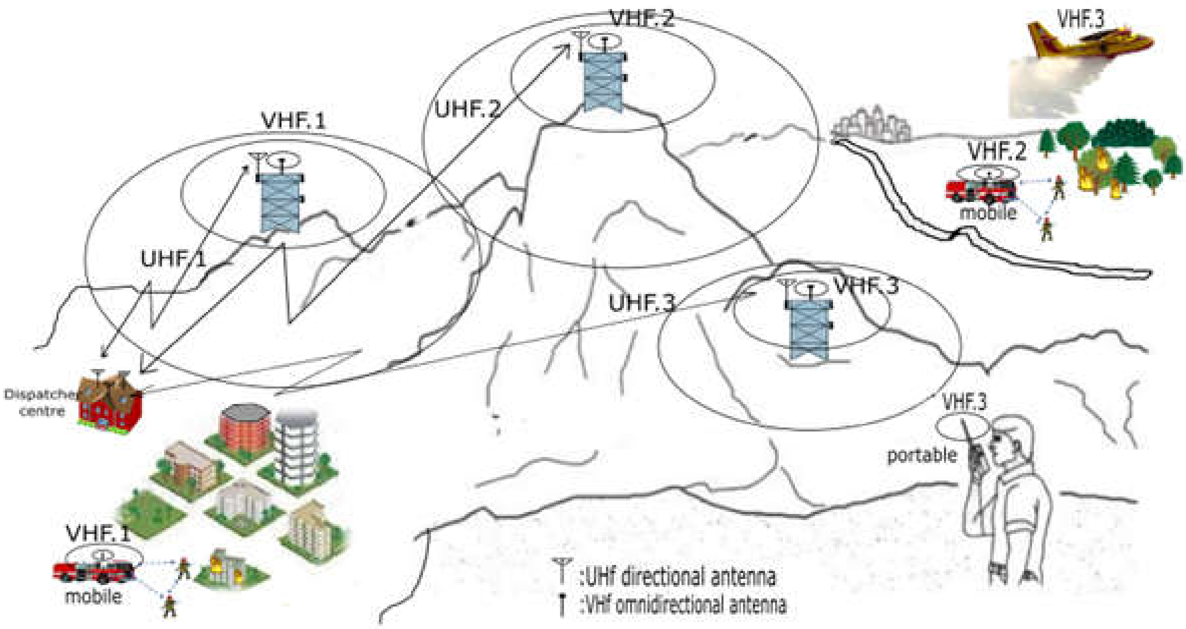

Figure 1. A schematic structure of a dispatch centre which controls three different missions at the same time.

Figure 1 presents a hypothetical scenario of three different critical missions that the dispatch centre is possible to be confronted with. These incidents, that are geographically different, but exist at the same time in the same region of responsibility need three different frequency channels with this current traditional analog system. Each channel is used for different fire mission in order to avoid any conflict in communications. The VHF frequencies are used for broadcasting voice in order to cover large regions of urban or rural areas and UHF frequencies are used for links to connect the base stations with the supervising dispatch centre.

The radio coverage at the moment is at good level across the whole country and is consisted by almost 200 VHF base stations, about 5000 portable and 3000 mobile terminals, to connect them with 130 dispatch centres.

2.2 System limits and common problems

Although the analog PMR radio communication systems are simple in use and have lower complexity than the digital ones, the analog technology has many limitations and problems. One and maybe the most important is that the analog PMR systems operate without any encryption for the radio communications thus can be easily listened to by non-authorized users. Some other basic limitations are:

- Individual analog base stations and repeaters deployed on hills nearby cities that have no network capabilities for interconnection among the system.
- Static (not easily programmable) simplex and semi-duplex frequency carriers that are not indicated for the requirements of Mission critical communications systems.

- Inefficient using of spectrum, because of each frequency carrier that has 25 KHz bandwidth offers only one physical channel
- Technically, system operation is almost unable to monitor. Common failures such as battery alerts, Tx power alerts, temperature, VSWR are complicated to diagnosed on time from far distances and for multiple sites.

Due to the influence of these limitations, manufacturers have tried to improve the system by introducing some sub-audible tones to secure analog communications and also transmitted tones for common failures but these are not efficient ways to solve such problems. As a result, the digitalization is the only way to make the system secure and reliable to the end-user and also for the dispatch control centre to have the whole control for managing of the network system.

3 The needs of the Hellenic Fire Service communication system

The basic idea of a fire Service communication system is based on the principal of the voice of a fireman needs to be heard. Assuming a premise that the personnel follows the basic principles of effective radio communication which is a major factor of success or failure of a communication system and moreover, assuming that technology is here to protect and help the good professional users of a system, the following description is a technical approach of the system that could help Hellenic Fire Service to communicate, mainly during its Service (Schottke and IAFC 2014).

3.1 The basic idea for a digital system

As the mentioned principal idea can be translated to the phrase that every fireman's voice has to be heard, under any circumstances on the right time from the right person, it automatically conducts the main strategy of constructing the system with the basic following definitions and guidelines.

Each piece of information has value, which depends on the place, the time, the person and the meaning that is communicated. The system must be smart enough in order to understand the value of information and decide its path through the number of people using the system and trying to communicate. This is an asset that old analog communication systems could not support to the extent that today's technology can provide and can only be done through multiple connections and a computer ordering the connections according to some predefined rules.

With the knowledge of older complex analog interconnected systems, this inevitably means that radio communication has to happen through a digital network in order to fulfil the functionality of being driven in more than one directions and more than one priorities.

There are lot more opportunities, functions and functionalities rising up if that network is digital in all it's extent. This means that information is digitized from the human to machine interface, on the terminal. The main advantage of such next generation communication system is that information-data can travel through networks more easily when they are digitized. As a result, not only the heart of the system needs to be digital to get the best networking result but also the terminals. This can also have disadvantages that are going to be discussed later on the paper.

The second asset for such a system is to be simple. It has to be as simple as the analog press to talk system. In situations like firefighting, users need to make simple and easy tasks to achieve communication. Moreover, it should also be simple in troubleshooting as it is vital to work the most time with the less down time.

The third asset has to be durability, both in the side of terminals and in the side of network infrastructure. The terminals are normally used in extreme environmental conditions like heat, water, dirt, explosive environments, cold, pressure and noise. The part of network infrastructure has to withstand (be scheduled to do so) elimination of grid power supply when it has to be highly available and extreme weather conditions like winds and rain. Has to be protected of fires and other major destructive events.

Moreover, it has to be highly flexible in the aspect of place, time and extent, in order to provide enough communication in every kind of situations (big or small events), lots of responders with high or low of voice traffic, data with no priority or with high priority data.

Utmost, and basically in managerial point of view, the system needs to be demonstrably tested in other occasions and from other services and not experimental in order to be manageable for the personnel of Hellenic Fire Service which will be responsible for it. It has to corporate all the previous experience and knowledge of the technical staff and co-function with other useful - successful systems already purchased in the concept of maximizing the profit of technology and minimizing the effort of the personnel to function systems as their main role is firefighting.

Finally, it has to be interoperable in order to be adaptable to cooperate with other communication systems, ad-hoc or in a more standard basis in order to provide communication with other crisis- responders.

3.2 The communication requirements for a digital Radio System

Mission critical communications are in need of instantaneous and constant connectivity to all terminal users with the extra assets of efficiency and capacity. This is leading to digital trunking radio technology. The simpler conventional systems provide communication only between users individually and in a specific geographic coverage area. Trunking systems are computer controlled radio systems which are more complex than conventional ones but they provide (SKMM 2009):

1. Plethora of radio channels for different group of users (talk groups).
2. More efficient spectrum usage because of frequency re-using.
3. Produce dynamic capacity of resources when it is required, offering flexibility to the system network.

For the operational requirements of first responders some organizations have identified common set of characteristics, some of these are presented here (ETSI 2009; ETSI 2008; ITU 2003):

- Push-to-Talk (PTT): The user pushes a radio button and the radio transmits the signal to other units, the release of that button is needed, to listen the other users' transmission.
- Group Calls: This feature provides communication between one –to –many members of a group.
- Secure communications: Voice and other applications require encryption to keep communications on PMR safe, in some cases required end-to–end encryption.
- TCP/IP Access: Voice and signalling are transported as IP packets over a network. This offers the possibility of supporting multiple voice calls over one link and allows the mobile stations to access the network through these IP protocols. .
- Emergency Alerts: This feature gives high priority to users whom lives are in threatening condition like the man down functionality.
- User ID: This gives the ability for a user to identify who is speaking.
- Grade of Services (QoS): The call blocking in mission critical communications should be very low, less than 1% for the worst case dimensioning scenarios.
- Radio coverage: Public Safety services are offered on 24h/7d thus requires complete radio coverage for normal traffic. Extra resources should be available by the use of special equipment gateway that could install on mobile terminal where the penetration through the walls is insufficient. Furthermore, the direct mode operation (DMO) should be possible to establish between radio to radio in outdoor areas without network coverage thus communications must be supported at least the terminals.
- Interoperability: Different organizations need to cooperate in an emergency situation thus interoperability is required at various levels, between communication systems or products. Additional gateways can be used to communicate with other digital standards.

3.3 The special operational domains above other Public Protection services

The safety of firefighters and the Service they provide depend on reliable and functional PMR radio communication systems that have to function in very demanding and mostly electronic hostile environments. The Hellenic Fire Service acting on these environments that have several different difficulties. Trying to organise them on large categories, we can have the following ones (ETSI 2009, Hellenic Fire Service 2017):

- Urban domains: These areas are usually identified by high density of people and buildings like cities. When a critical mission happens on such environments Fire Authorities has very limited area of operation, and also need fast reaction time from first responders.

- Rural domains and Forests: Identifies areas like countryside, mountains and hills with sparse or dense vegetation. An emergency crisis in such environments is typically large in geographical domains and has poor radio coverage as rural environments do not usually have an extensive communication infrastructure.

- Ports and airports: Ports has similar demands to the urban areas but with small scale of responsibility domain. In comparison to a generic urban environment, there is a larger presence of critical facilities (i.e. traffic control centre) which should be protected or whose services should be maintained. Critical facilities like deposit of dangerous materials like inflammable or chemical substances may also be present.

- Air communications: Air support is extremely critical and gives an advance is dealing with large scale wildfires thus it is important to have such communications especially in summer periods.

- Indoor areas: Fire Service almost always operates in indoor, areas like buildings and basements. Radio propagation on these areas is strongly affected and harmed by walls and ceilings that degrade the signal. Communication loss in that cases can highly endanger the lives of firemen's who first respond.

- Underground and motorway tunnels: Tunnels for firefighters are special artificial environments where we have high density of people who are untrained in the high risks of environment but use it in their everyday life. This is an extreme environment on the radio communications. For example, in sub-railways the radio-waves frequencies that can travel adequately are complexity defined and a network of expensive infrastructure (radiating cable) has to be deployed to keep the communication feasible with other in the tunnel and out of it.

4 Available digital technologies for public safety

The demanding of Public Safety communications are satisfied by a wide range of narrow band digital standards such as TETRA, TETRAPOL, P25, dPMR, DMR. These are all trunking technologies, offering plenty of features and services. Some of them are professional high-end systems whereas others are low-cost and low complexity systems. All of them attended for Public Safety market and have been trusted from a lot of countries. Finally, we summarize at the end of this work some of these standards that used for mission critical communications in Europe.

4.1 Digital technologies on the market

Professional mobile radio (PMR) systems are described in standards or are standardized from official organizations such as ITU, ETSI and TIA. Manufacturers produce their systems by these standards to provide mobile radio services for specific target group of users compared to commercial cellular mobile systems that apply on public. Subsequently a brief overview of PMR standards is provided where some features and limitations are highlighted and also some general technical characteristics are pinpointed.

4.1.1 TETRA

Terrestrial trunked radio (TETRA) is a professional high-end radiocommunication technology that is designed for mission critical services and developed by European Telecommunications Standards Institute (ETSI) as protocol ETSI EN 300-392 (Dunlop et al. 1999). The Tetra and Critical Communications Association (TCCA) has established this technology in 1995 and introduced it in the market three years later. Currently includes multitude of representing organizations from equipment manufacturers, operators, Service providers, as well as other interested parties. Some of the main features of the TETRA technology are (Onali et al. 2011; US Fire Administration 2016; IAFC 2005; TCCA 2010):

- High security technology that provides encryption for radio path between terminal and base station and also support end-to-end encryption.
- Trunked mode operation (TMO) and also DMO operations are supported by this standard.
- Interoperability of terminal radio equipment from multiple vendors also supports gateways to communicate with other digital standards

TETRA uses 4-time slots TDMA multiple access and is operated in UHF band (380 – 520) MHz with 25 KHz channel spacing. Also this technology typically supports data rates up to 28.8 Kbits/s. An evolution of TETRA, the TEDS, offers higher data connectivity up to 500 Kbits/s using wider radio channels (50, 100 and 150 KHz) (Camara and Nikaein 2015; ETSI 2010). Nowadays TETRA is widely used in mission critical services because of the features and security that provides, however, the base stations that are used have small range coverage that increases total cost.

4.1.2 TETRAPOL

Tetrapol was the first large scale digital PMR network that was targeted for Public Safety usage on the requirement of the French police forces in 1980 (Ferrus and Sallent 2015). Is the main competitor of TETRA in Europe, it has unique architectures and has never been applied as an ETSI standard although it was recognised by ITU (ETSI 2010). Tetrapol is also a high-end trunking technology developed by French company named Matra and nowadays the development remains in the hands of industrial group of Airbus Defence. Some major characteristics of this technology are (Ketterling 2004):

- A multilevel priority is supported with override of busy channels, as well an emergency button exists to set up high-priority call to a dispatcher site or to a predefined group of users.
- DMO operation is supported among two or more mobile stations, however does not supported between digital portable terminals.
- Limited vendors support this standard that influences on the flexibility Tetrapol supports gateways for connection with other systems i.e GSM.

Tetrapol is based on FDMA multiple access and operates in VHF (150-174) MHz, UHF (380-520) MHz and 800 MHz bands with 12.5 KHz channel spacing. Tetrapol solutions are mostly adapted in networks with few users covering a large area, which is typically the case in single agency networks. Tetrapol provides data rate channels up to 8 Kbits/s. This technology compared to TETRA needs lower minimum signal to noise ratio and signal to interference ratio limits which means that Tetrapol can operate with larger cells something that implies lower infrastructure costs (Dunlop et al. 1999).

4.1.3 Project 25

Project 25 (P25) is a digital PMR technology announced in 1989 to replace analog systems and was firstly developed by Telecommunications Industry Association (TIA) as a standard TIA-102. P25 is sponsored by the Association of Public-Safety Officials International (APCO), the National Association of State Telecommunications Directors (NASTD) and other agencies. This technology is used widely in United States public safety market whereas in Europe is used only in Latvia. The main benefits of this technology are (Baldini et al., 2013; ITU 2017):

- P25 offers high security using AES encryption and provides end to end encryption among digital terminals.
- Allows effective, efficient and reliable intra agency and inter-agency communications.
- The system is fully reconfigurable and supported DMO and TMO modes where needed, also allow analog connectivity between the P25 digital terminals with older analog FM radios.

The P25 technology operates on different frequencies bands like VHF, UHF, 700, 800, 900 MHz. The evolution of P25 was separated in two phases which cover 2 different access methods. P25 Phase I functions on FDMA with channel bandwidth 12.5 KHz and Phase II functions both on FDMA and on TDMA with channel bandwidth of 12.5 KHz (Camara and Nikaein 2015). It supports data rates up to 9.6 kbits/s for Phase I and 12.5kbits/s for Phase II respectively. The Project 25 offers high power base stations that lead to larger cells coverage whereas the cost of the P25 remains at high level.

4.1.4 Digital PMR

Digital PMR (dPMR) is a digital radio communication protocol developed by ETSI and firstly announced in 2007. This standard firstly introduced as a s a allow-cost peer to peer solution for licence free operation in 446 MHz, also called as PMR446. This first version of dPMR (mode 1) has been improved on the next version (mode 2) to attend to licensed professional market with repeater mode operation and later in mode 3 for trunked operation. Tire II was introduced in 2013 as ETSI TS 102-658 standard and some major system characteristics are (Digital PMR-mou 2010):

- dPMR mode 3 offer digital trunking technology
- IP connectivity between sites but not IP-based for end to end users, also gateways are supported for communications with other digital technologies.
- Low complexity and also infrastructure cost but for larger solutions the radio systems become more complicated.

The dPMR technology tier II operates in UHF (400 – 470 MHz) and uses FDMA access method offering low cost digital voice and data communications with 6.25 KHz channel spacing and can achieve data rates up to 4,8 kbit/s. The limitation of this technology is that sponsored by two vendors (Kenwood and Icom) in the market. Nevertheless, this technology is used and trusted by many countries and has many applications on transportations, public and private security implementations in Europe.

4.1.5 DMR

Digital Mobile Radio (DMR) is an open standard defined by ETSI as ETSI TS 102-361 in 2005. DMR has lower complexity than TETRA and is capable to satisfy the needs of many PMR users and organizations. This standard has been completed in three versions (Tiers I, II, III) with first one operating on license free band in 446MHz like dPMR. Tire II covers licensed frequency bands from 66 to 960 MHz and attended for users who need high quality voice services. Latest DMR Tier III is a licensed trunking system with a controller function that automatically regulates the communications. Some of the key features of this standard are (Ferrus and Sallent, 2015):

- Applies state of the art forward error correction.
- DMO and TMO both as conventional modes are supported (conventional is the communications between radio to radio via repeater)
- A lot of vendors are supported this standard thus DMR has wide interoperability among different manufactures terminals.
- IP data services for mission critical communications are supported.

All DMR Tiers have channel spacing of 12,5 KHz using a 2- slot TDMA multiplexing and also the data rate is up to 9,6 kbit/s. DMR Association has been created to support this technology due to influence of that, DMR found great acceptance by the manufactures and nowadays is one of the most widely supported digital business radio standard worldwide.

4.1.6 LTE

Long Term Evolution (LTE) is introduced by 3GPP in Release 8 as a standard for mobile broadband communications in 2008. Is the evolution of GSM technology with intermediate successors UMTS, HSPA and (HSPA+), although it is widely used for commercial cellular network in the Public Safety services progress has been made from Rel 12. Public Safety organizations recognized the capabilities that the LTE could offer as next generation Public safety standard thus 3GPP have been starting to support it. Some of the characteristics of LTE for PS so far included (Forge et al., 2014; Liar and Mayer, 2017):

- PTT functionality fully supported from Release 13.
- Also supported broadcast group calls, emergency group calls, emergency alerts
- Some encryption functionalities offered especially for media and control signalling.
- Smalls cells of coverage because of the limitation that current systems provide at higher frequency bands.

LTE is a wideband OFDMA technology with scalable bandwidth from 1.4MHz to 20MHz. Currently LTE uses a lot of frequency bands whereas in future for PS is being planned the UHF band (400-450) MHz to be used. This frequency band offers better propagation and the building penetration (Forge et al., 2014) that this lower bands offers. Although LTE is not fully operational technology for PS yet, it is used as supportive standard to the other technologies because of the high bit rates provided (tens of Mbits). Furthermore, it is believed that in most countries the PMR networks are starting slowly to phase out and the narrowband technologies are expected to operate another 15 years until replaced from LTE.

4.2 Mission critical communications of Fire Authorities in Europe

The upper mentioned PMR technologies are used from European Public Safety services for mission critical communications, as shown in table 2. Each one of these upper mentioned technologies has some limitations and also some benefits, however a parameter that cannot been neglected is the system total cost that includes capex and Service level agreement (SLA) costs (Forge et al., 2014).

Mission Critical communications in Europe					
Countries	**Network System**	**Technology**	**Countries**	**Network System**	**Technology**
United Kingdom	Airwave network	Mixed (TETRA/DMR)	Norway	Nodnett	TETRA
Finland	VIRVE	Hybrid (TETRA/LTE)	France	INPT	Tetrapol
Netherlands	C2000	TETRA	Spain	SIRDEE net	Tetrapol
Germany	BOS	TETRA	Croatia	CRONECT	DMR
Sweden	RAKEL	TETRA	Czech Republic	Pegas	Tetrapol
Latvia	Latvia Mol	P-25	Switzerland	Polycom	Tetrapol
Belgium	ASTRID	TETRA	Slovakia	SITNO	Tetrapol
Austria	TETRON	TETRA	Italy	SOLAS	under competition
Poland	NEXENGE	dPMR	Estonia	ESTER net	Hybrid (TETRA/LTE)

Table 2. The Radio Communications in Europe at the moment.

In Table 2, the PMR technologies are presented, that used by others Public Safety organizations in Europe. Most Fire Authorities of these countries are using TETRA and TETRAPOL as the most common and trusted digital PMR systems. Lately, there is strong interest by manufacturers to engage the LTE technology on their systems (TETRA, P-25, DMR) and apply of the benefits that this technology could offer. However, these combinations lead to hybrid solutions which are more complex in configurations than the usage of each PMR technology individually (Forge et al., 2014). As a result, LTE technology is on early stage to be used as a single solution on mission critical communications and cannot replace others at the moment.

5 Conclusion

In this paper, we analysed the system that Hellenic Fire Service uses as communication system today, and then we supplied, briefly, the requirements and the scope of them for the transmission to a new communication system. Finally, we ended up with an extensive summary of the systems supplied at the market today and their usage from European countries. The choice of the most appropriate technology is not an easy task as it should complete the requirements of the Hellenic Fire Service and should be cost efficient on the same time.

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CELL BROADCAST EMERGENCY'S ALERTS IN GREECE

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Abstract

The goal of this paper is to propose a safe and effective way to inform citizens of an emergency situation in Greece, a country where hundreds of situations such as, forest fires, earthquakes and floods happen every year.

The new technologies allow people communicate through a variety of ways such as SMS, e-mails, social networks etc. The most popular device for citizens' communication is their mobile phone. Consequently, researchers and safety stakeholders tend to use these technologies as public warning systems, in particular mobile short messages and the cell broadcasting method, which predominates in many places. However, Greece is still lagging in the area of public warning systems, wherein the mass media usually take this responsibility.

This paper proposes a new method for a public warning system in Greece, aiming to instantly inform the citizens that are in a place of disaster with a simple and informative way. The proposed methodology was evaluated by the citizens and the results were very encouraging, indicating that citizens found it easy, useful and effective for public warning (Soulopoulou, 2018).

Thematic area: Public Warning System

Keywords: cell broadcast (CB), civil protection, public warning system (PWS), cell broadcast worldwide, P.A.I. time

1. Introduction

At all stages of a crisis, communication between its managers is considered necessary. The speed and quality of crisis management depends on the quality of communication. That's why we always look for secure channels of communication, in order to avoid leaks and any false news that are intentionally diffused to cause greater panic and chaos situations.

The same happens in emergencies where safety of citizens is involved. We do not have to deal only with the intra-communication of the managers, but also with the reliable and timely information of the citizens, so that they can act if they need to be coordinated, without panic, always helping the work of the emergency managers.

This channel of geographically targeted, authoritative and timely informing of citizens is found in the application of the cell emission, where via text messages to citizens ' mobiles will be made these updates, which can be instructions.

In Greece this method still does not apply despite the attempt to create a single coordinating center for civil protection. In Europe and the rest of the world, the same method is acceptable as the best method of informing citizens in emergencies.

1.1 Worldwide methods of emergency alert today

Today's Emergency Alarm Methods they consist of a mixture of technologies such as:

- Sirens
- Radio
- TV
- Telephony

- Mobile messages
- Social networking messages
- Messages via Email

The above methods are no longer adequate to ensure public safety. The plethora of mobile phones makes them an ideal channel for a modern approach to a state of emergency, ensuring that as many people as possible can be brought to safety.

Data shows that the world citizens have access to mobile telephony. Today there are about 5 billion mobile phone subscribers worldwide and up to 2020 is expected to increase to nearly 6 billion, about two thirds of the estimated world population (chart 1) (Statista, 2018).

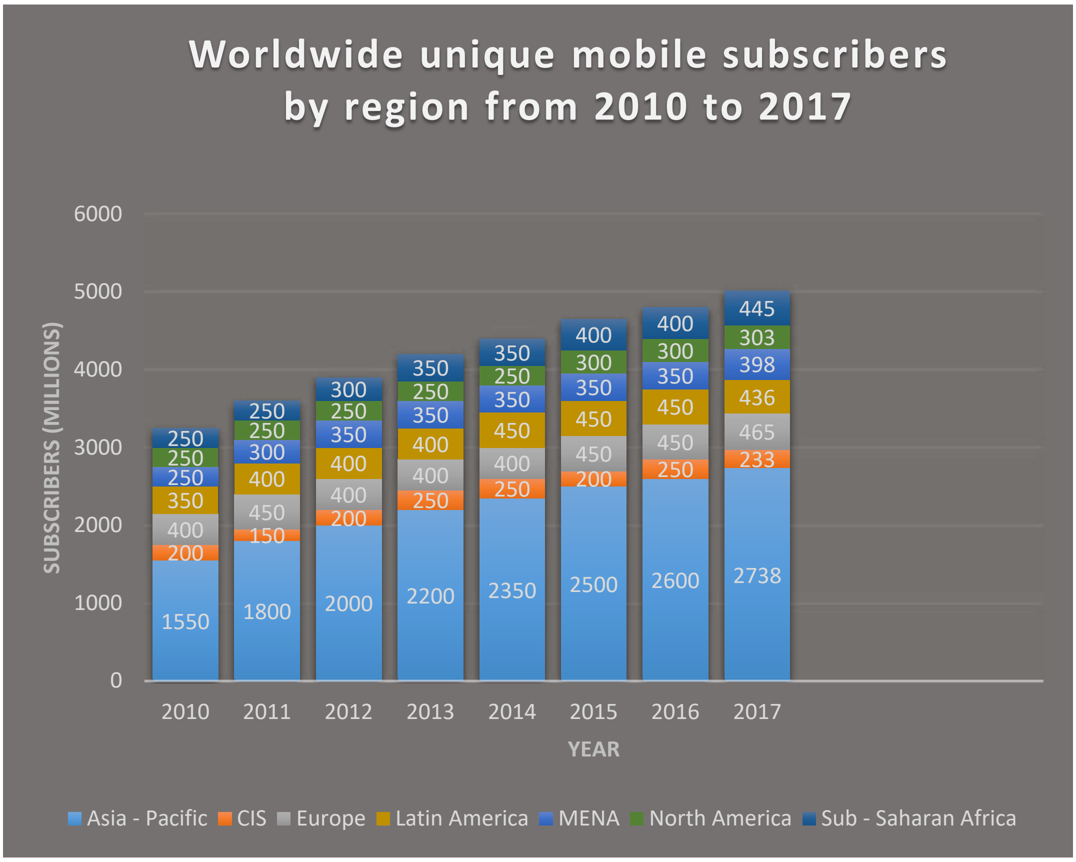

Chart 1 Worldwide mobile subscribers from 2010 to 2017
Source: for the years 2010 – 2016 Statista (Statista, 2018) August 2017
for the year 2017: GSMA Intelligence data December 2017 https://www.gsma.com/mobileeconomy/#

In 2016, 100.70% of the world's population already had a mobile phone per inhabitant worldwide. The penetration of mobile phones is predicted to continue to increase, since 2017 exceeded 104% (chart 2). Most of the growth in the mobile telephony market can be attributed to the growing popularity of Smartphones (Statista, 2018), (International Telecommunication Union, World Telecommunication/ICT Development Report and database (1), 2018).

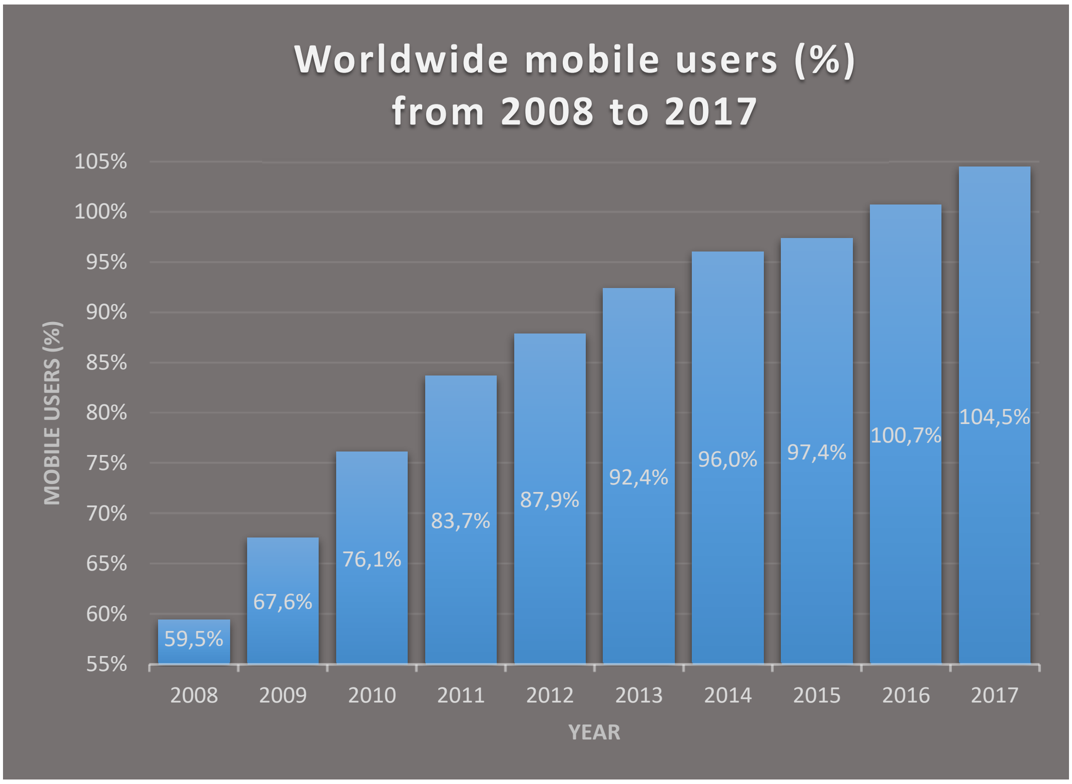

Chart 2 Worldwide mobile users (%) from 2008 to 2017
Source: (International Telecommunication Union, World Telecommunication/ICT Development Report and database (1), 2018)

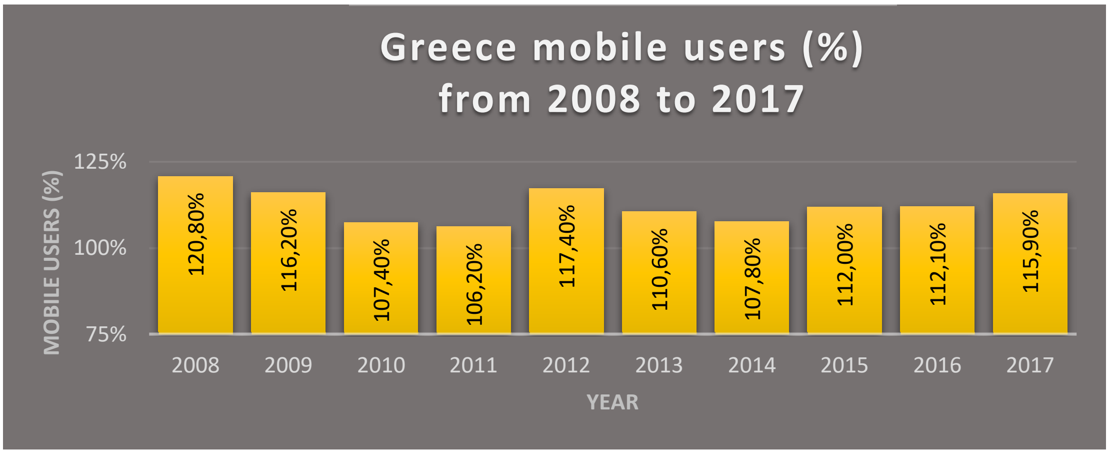

Chart 3 Greece mobile users (%) from 2000 to 2016
Source: (International Telecommunication Union, World Telecommunication/ICT Development Report and database (2)., 2018)

In Greece, we see a huge increase in mobile phones culminating in 2008, where mobile users were 120.80% compared to its population that year. (chart 3). This The number of users is falling slightly due to adverse economic circumstances in recent years, but never below 100% (2013 – 2014), while from 2015 we are seeing a slight increase at a growing rate. Therefore, the access of the Greeks to a mobile phone device today is fully covered (International Telecommunication Union, World Telecommunication/ICT Development Report and database (2)., 2018).

1.2 Alerting of emergencies in Greece

In Greece, citizens ' warning method is to use loudspeakers on vehicles. Of course, a very widespread notification system is also the use of churches' bells, perhaps the most functional today. Of course, the bell makes a certain sound and it is not possible for the citizen to understand whether the notice concerns fire, flood or anything else.

In recent years, a very large share in informing citizens in Greece, is held by the media. Until a few years ago these were the audiovisual (television and radio), while for about ten years ago the social media have emerged in everyday life.

- Today the new telephone center "112" is implemented with a modern infrastructure for the emergency Communication Management system which consists of the following sub-systems:
- Emergency Call Management System (112 ECMS) with geo-detection capability (after 1Q 2019)
- Citizens' Alert System (112 Greek PWS) with cell broadcast technology

1.3 Why Cell Broadcast and not SMS

The channel of message information on the mobile phone is done using the cell broadcast method. Many countries worldwide apply the cell broadcast from 2005 for PWS as South Korea, Japan, U.S.A., Israel, Peru, Chile, New Zealand, Netherlands, Norway, Lithuania etc.

Cell broadcast technology can be a reliable source of information at a specific location, especially for people in motion (including those visiting other countries). There are three main reasons for the use of the hive in emergency situations. (Belesioti, et al., 2009).

1. Firstly, it is that this possibility already exists in the majority of network infrastructures and mobile equipment, so there is no additional need.
2. Secondly, it does not cause a traffic charge in the telecommunication networks, which is very important during a crisis, when the load spikes tend to collapse the networks.
3. Thirdly, high scalability is possible due to the independence of the system's performance from the number of terminals and the provision of equal quality of service to all users.

The following is a comparative table between the cell broadcast (CB) message and the SMS message (table 1).

Characteristic	Short Message Service (SMS)	Cell Broadcast Service (CBS)
Service		
Transmission Type	Messages sent point-to-point.	Messages sent point-to-area
Message Dependency on Mobile Number	YES - requires the input of specific phone numbers and database maintenance	NO - does not require the input of specific phone numbers
Message Dependency on Location	NO - message received independent of location, only registered numbers notified.	YES - all mobile stations within a defined geographical area notified
Two-way Communication	Yes - users can both receive and respond directly to the sender.	Not direct response - users cannot reply directly but can respond through numbers or URLs included in message
Sensitivity to Disaster network conditions	Will often succeed in poor radio conditions, due to air occupancy for a short message of only a few tens of ms. Uses signaling radio channels, which can be subject to congestion in a disaster. Huge volumes can be subject to delays if sent during a disaster.	Broadcasts are sent on dedicated channels therefore congestion unlikely, though delays to message delivery may occur in areas of poor coverage.
Repetition	No repetition rate.	Messages can be repeatedly broadcast periodically by the GSM BSC/BTS within the range 2 s to 32 minutes. In a UMTS environment, the highest repetition rate is 1 s.
Roaming.	Visitor often reliant on home network for message routing	Message delivered to ALL mobile stations present in target cell.
Security and message integrity	Poor – no indication that a message is generated by a legitimate authority, and message can be "spoofed" from other phones.	Good - safeguards prevent an outsider from generating a cell broadcast message, therefore false or spam alerts are unlikely.
Message		
Message Size	140 160 characters. Maximum of 5 messages can be concatenated 93 characters.	Maximum of 15 Concatenated Pages
Message Type	Static messages will be sent only to all registered numbers.	Custom messages can be sent to different areas to reflect different alert status or hazards.
Message Display Notification	Display can be controlled by user	For subscribed handsets messages can be automatically pushed to the screen and a distinct alert sounded
Handset Compatible	Compatibility Compatible on all handsets.	on most handsets but may require manual configuration or software client on handset. Presentation may differ across handsets.
Reception	Message received once the mobile is switched on.	No message received if broadcast is sent whilst mobile is switched off. However, if updates to the cell broadcast are sent, they will be received when mobile is switched on.
Delivery Confirmation.	Yes - sender can request delivery confirmation	No - no confirmation of delivery.
Language selection	No. Identical to all receivers	Yes. Messages can be broadcasted in subscriber's preferred language

Table 1 Overview SMS vs Cell Broadcast
Source: GSMA: Disaster Response. Mobile Network Public Warning Systems and the Rise of Cell-Broadcast (www.gsma.com, 2013)

2. Proposal

2.1 Protective Action Initiation time

There is almost always a delay between receiving an emergency alert from the citizen and initiating protective action. This time difference is known as protective action initiation time (P.A.I.). An important area when searching for the design or improvement of an PWS message is intended to shorten this period of time.

Factors that affect a person's PAI time, are:

- Milling
- Reunification
- Prepareness

Then it is converted to how the content of the message, the context of the message and the characteristics of the message receiver can also affect the PAI time (National Academies of Sciences, Engineering, and Medicine, 2018)

Providing valid and timely communication is one of the most important tasks of a public authority towards its citizens. The responsibility of broadcasting a CB message for the purpose of informing citizens in a state of emergency is great, especially in trying to transmit the right directions and not "fake news" as much as they do, taking advantage of situations, namely the high feeling of insecurity and risk of citizens, adversely affecting PAI time.

The constant flow of messages to the event's course gives the citizen a sense of security as he sees that help and rescue services are involved in this. The messages must be simple, indicate the issuing body and not conceal the truth at all.

The information system for citizens must be and remain in their conscience solvent. Whenever it gives a tip, it should be believable and whenever it gives a command it should be executed without hesitation.

Let's not forget that all messages can be transmitted in the language that the mobile phones are opened. Therefore, the information in the targeted area can be taken by any citizen in its own language.

All these are inviolable ethical and practical rules for the implementation of the system cell broadcast. Based on these rules, I present below my suggestion for message tabs, design exclusively mine, trying to be simple and comprehensive.

2.2 Cell Broadcast Message’s Tab

Public warning messages are more likely to motivate appropriate and timely public protective actions if the warning messages contain information on five topics: guidance, time, location, risk-consequences, and source (National Academies of Sciences, Engineering, and Medicine, 2018).

The characteristics of the message receiver that affect PAI time are human factors such as age, gender, ethnicity, disability and socio-economic situations. It has also been found that those who are younger, have achieved higher levels of education, and are employees, gender (more men than women), are more likely to interpret emergency warnings better and act faster i.e. shorter PAI time (National Academies of Sciences, Engineering, and Medicine, 2018).

These features were designed and the Standard tab (fig. 1). The tab that will appear on the mobile phone should be simple and quickly understood by all citizens.

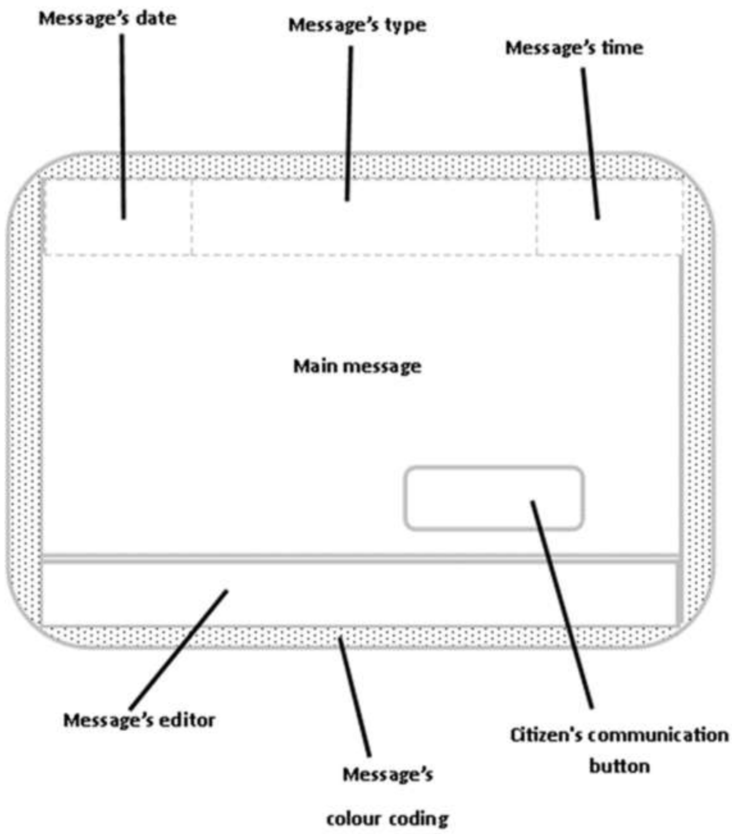

Figure 1 Cell broadcast message's standard tab

The tab consists of two frames, which create an empty space between them, which will be colored according to the type of message (color code). It is an innovative proposal of work aiming at minimizing PAI time.

By placing the five topics mentioned above, in the inner frame, we design header and footer. The header will indicate the date (left) and the time (right) of the message for the time, while in the middle the type of message with uppercase bold characters to categorize the risk. The footer will indicate the body issuing the message (source).

The source of the message issuing cell broadcast will be (The President of the Greek Democracy and the Greek Parliament, 2003):

- Local government agencies (OTA)
- The administrative regions
- The General Secretariat for Civil Protection (G.S.C.P.) through ¨ 112 ¨

In the main message area, there will be a concise message for guidance and consequences, which may contain additional information, wherein the citizen will be able to press at the end of the message "see more..." and the tab will open in a full-text page.

Warning! The length of the message should not exceed the 240 Characters because, the larger the message, the more we grow the citizen's time PAI (National Academies of Sciences, Engineering, and Medicine, 2018).

Finally, do not forget people with disabilities where a long message may make them very difficult to read but also to understand.

In special cases where the message asks for an answer or confirmation in a message – question, then there will be the communication keys within the message body. My goal is to design a simple, simple but comprehensive and comprehensible tab, where the citizen will find all the necessary information and orders.

2.3 Messages categories

As we understand, all messages will not be of the same type. The innovative proposal is to divide into three categories, and even have a color code:

- Update messages (green color)
- Warning messages (yellow color)
- Danger messages (red color)

The color code was selected according the Griffith & Leonard at «Association of colors with warning signal words» (Griffith & Leonard, 1997), where the greatest correlation with the "risk" is the red color (79%) and the greater correlation with the "warning" is the yellow color (45%). Green with (40%) and blue with (47%) They have a greater correlation with "attention". We choose the green one and the "update" does not have the gravity of "attention", leaving the blue free for future use.

2.3.1 Update messages

Green messages will be aimed at simply informing citizens.

For example, waiting for heat in the next few days, messages can be as follows (fig. 2):

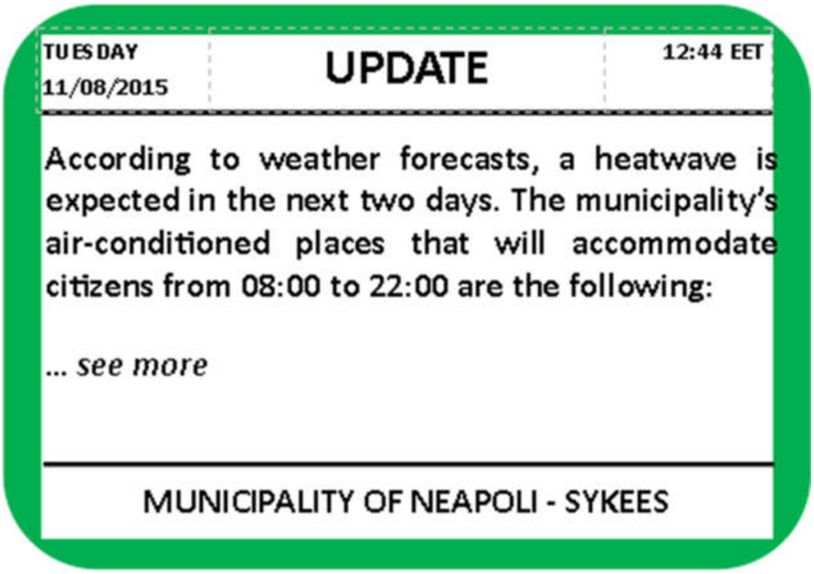

Figure 2 CB update message. Source: A local government agencies

2.3.2 Warning messages

The yellow messages will aim to draw citizens' attention to a fact. In the two warning messages (fig. 3) We also cite the areas of targeted transmissions Cell Broadcast (fig. 4).

2.3.3 Danger messages

The red messages will be aimed at bringing citizens to their vigilance for an event (fig. 5). This will be messages information that give guidance – directions to citizens in the targeted area (fig. 6) with a message cell broadcast, the way they should act. The instructions will be simple, in an imperative style, giving the severity and necessity of executing the message.

Another case is to ask citizens to state whether they are safe or need help, after a disaster or in general, after a crisis in which citizens are exposed

The proposal is the transmission of a cell broadcast message in an area, where the citizen will be asked if he is safe and the one who needs help, pressing a specific button on the screen will be tilted to the ¨ 112 ¨ with the aim of geo-detection. At the same time, it will send SMS to a specific mobile number of ¨ 112 ¨ with its coordinates, wanting to cover the event of a fall or overload of the network.

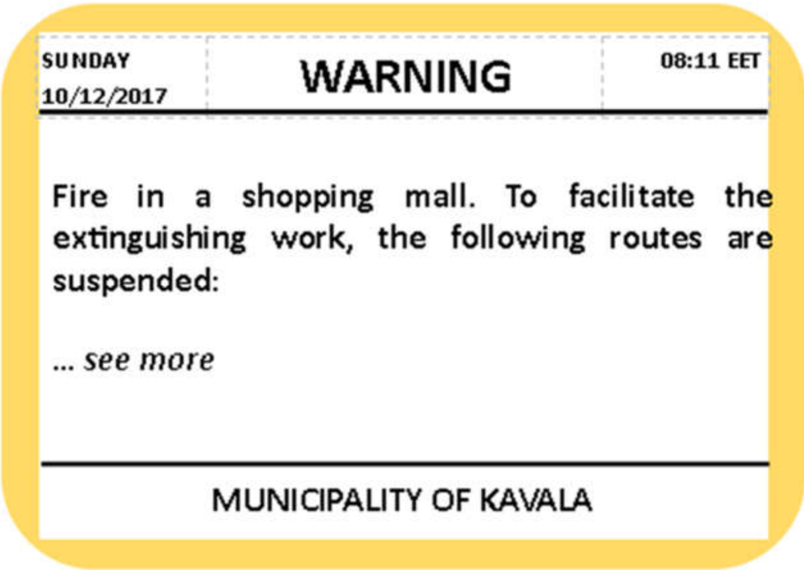

Figure 3 CB warning message. Source: An administrative region

Figure 4 Map where is designed the targeted transmission area of the figure’s 3 cell broadcast message

So, hypothetically, after an earthquake where there are found trapped or seriously injured citizens, we create a message of danger, where we inform them that the assistance and rescue services have arrived, and the rescue work has begun.

At the end of the message we will recommend them to indicate if they really need help. Then press the "SOS" button or press the "I AM O.K." key (fig. 7). The "SOS" button will send our coordinates to "112" asking for help.

With the answers that will come, we will be able to have a first image (the users of the "SOS" button need help and we focus initially on them while the users of "I AM O.K." is a crowd that is in the hot zone and must be removed) very close to real and without the aid and rescue services yet to arrive. The correct image helps us to organize and manage in a very good degree the forces of the first responders in the hot zone of the incident.

At figure 7 is presented the proposal for such cases.

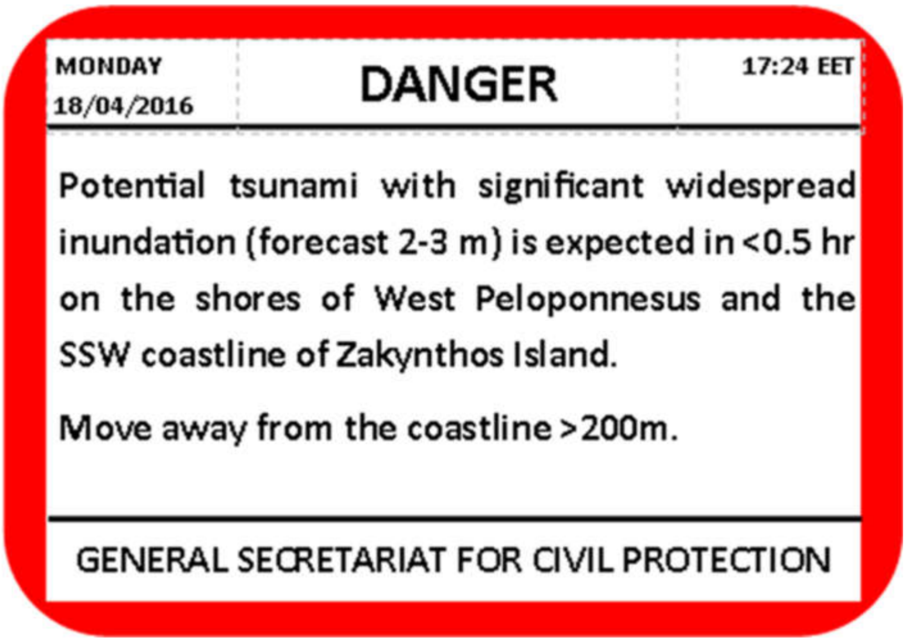

Figure 5 CB danger message. Source: G.S.C.P.

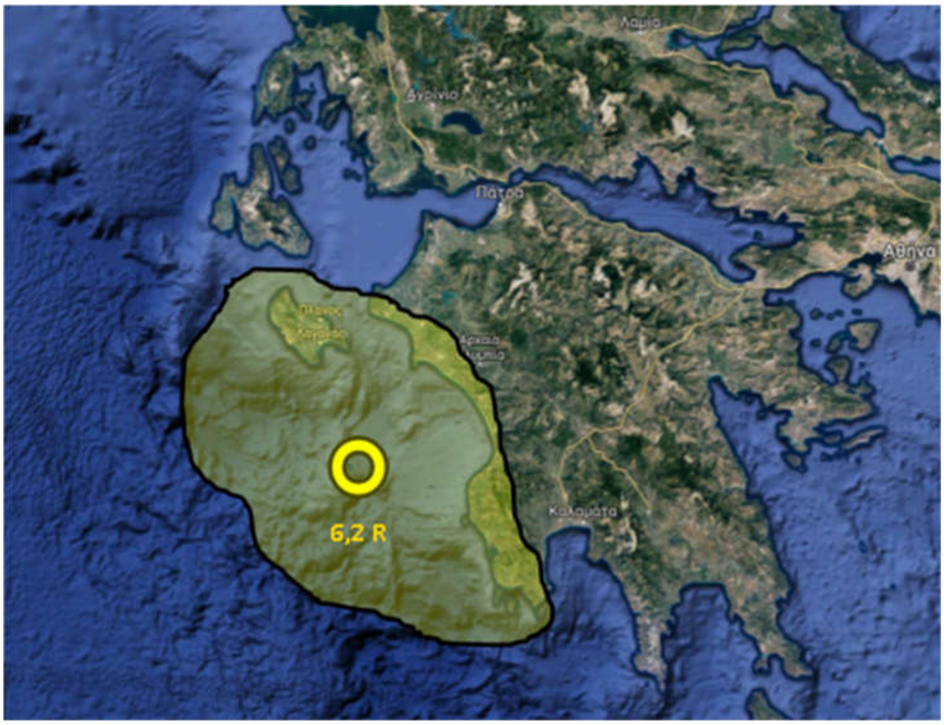

Figure 6 Map where is designed the targeted transmission area of the figure’s 5 cell broadcast message

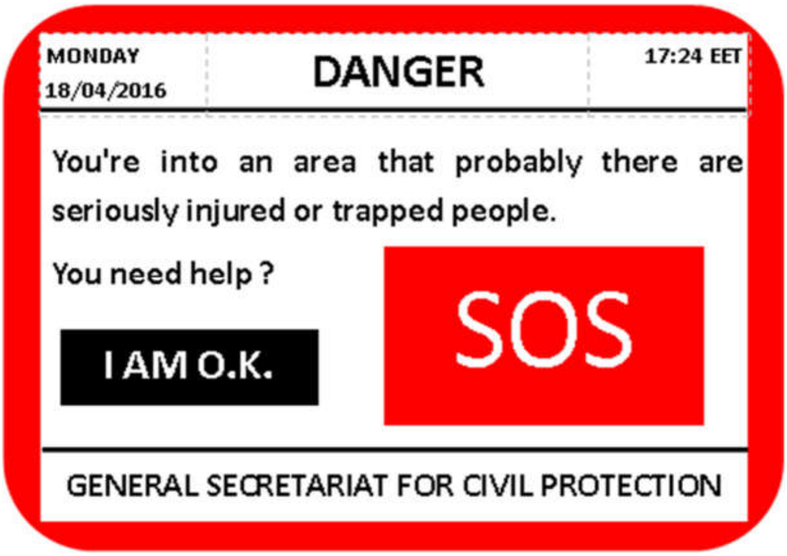

Figure 7 CB danger reply-enabled message. Source: G.S.C.P.

2.4 Legal framework

The processing of personal data should be intended to serve the person. The protection of individuals regarding the processing of personal data is a fundamental right.

Article 8 (1) of the Charter of Fundamental Rights of the European Union and article 16 (1) of the Treaty on the functioning of the European Union define that each person has right in protection of data staff character that the relating.

Rapid technological developments and globalization have created new challenges for the protection of personal data.

The above proposals are some of the recitals of the Regulation (EU) 2016/679 of the European Parliament and of the Council, with effect from 27 April 2016 (European Parliament, Council of the European Union, 2016), on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation). A regulation to be adopted by national parliaments. In Greece, the bill was submitted to a public consultation from 20/02/2018 to 05/03/2018. Not yet published the relevant law officially.

Regulation (EU) 2016/679 in recital 46 of the Official Journal of the European Union, says:

«The processing of personal data should also be regarded to be lawful where it is necessary to protect an interest which is essential for the life of the data subject or that of another natural person. Processing of personal data based on the vital interest of another natural person should in principle take place only where the processing cannot be manifestly based on another legal basis. Some types of processing may serve both important grounds of public interest and the vital interests of the data subject as for instance when processing is necessary for humanitarian purposes, including for monitoring epidemics and their spread or in situations of humanitarian emergencies, in particular in situations of natural and man-made disasters. » (European Parliament, Council of the European Union, 2016).

The application of the above regulation to Greek law will continue to give the right to use personal data without the permission of the citizen, since there will be a matter of national security such as the treatment of emergencies.

2.5 Information and education for citizens

With the operation of cell broadcast In Greece, citizens should first be informed about the new way to transmit messages in emergencies.

They need to be helped by civil protection in decoding the messages they receive on their mobile phone, that is what they see and how they should react. We will first achieve it with small informational advertisements (jingles) on the radio, on TV, on social media. Per month, test shows on the first Sunday of each month will enable the citizen to familiarize themselves with the new information system.

Very important in this period is the communication of the citizen through questionnaires with civil protection. The conclusions of the evaluation that will result from the feedback with the help of the questionnaires will provide very important information for the modification and improvement of cell broadcast. The feedback will be made through a renewed page of civil protection, which will be given other sound information about the cell broadcast as:

- When will the next check message be transmitted
- How do I know that the message I received is a control message rather than an emergency?
- When does the civil protection body issue an audit message
- I haven't set up my phone for messages cell broadcast, but I have received a verification message. How is it possible
- My mobile phone gives other sounds with the notification control message rather than regular messages. How is it possible
- I don't want to receive control messages. How do I remove the registration and other frequently asked questions (FAQ) to be formulated through the questionnaires?

The frequent emission of test messages for the first period, perhaps one or two years, will bring the citizen familiarity with the new information system. After this interval, test message emissions can be performed twice a year to control the system.

3. Related applications

3.1 Today in the Netherlands

In the Netherlands, the feedback of the latest PWS test message broadcast with the cell broadcast method (04/06/2018), 76% of citizens over the age of 12 received and responded to the message (fig. 8).

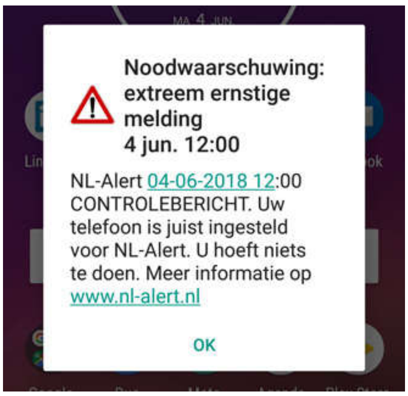

Figure 8 The message cell broadcast of the latest test show in the Netherlands (04/06/2018)

The Minister of Justice and Security in an interview at Metro (Ferdinand Grapperhaus, 2018), says that "... What is special about the NL alarm system, I think, is that national and local messages can also be transmitted. "

In another report, the same minister said that the government has access to many ways of warning citizens: NL-Alert, crisis.nl, emergency stations, social media and the own resources of the security areas. Effect of sirens removal the sirens remain active after first of January 2020 (Ferdinand Grapperhaus, 2018) (Government of the Netherlands, n.d.).

3.2 Today in the United States.

In the U.S.A. although cell broadcast is used, another problem has been encountered in informing citizens, usually receiving notifications from a patchwork of state and local agencies, using different platforms and messaging systems, often with part-time staff, said Denis Mileti[1] . "... For all practical purposes we do not really have a national warning system. " (Whitcomb, 2018).

For the above reasons, on 03/10/2018, the first test was conducted, the new nationwide system (Wireless Emergency Alert System) in the U.S. by FEMA and IPAWS. The federal government developed a system for issuing warnings, which are planned in coordination with numerous government agencies. It is cell broadcast message, as tested by local governments according to the FCC more than 40,000 times since 2012. The messages will be limited to 90 characters but will be extended to 360 in the future. The first message was sent by the President of the United States. (Zraick, 2018) (fig.9).

Figure 9 The original test message from the U.S. emergency security system on 03/10/2018

4. Building the new PWS in Greece

It is proposed to adopt the cell broadcast technology, with messages of 240 characters. As we have seen, technologically Greece is almost ready to make cell broadcast emissions (112 Greek PWS).

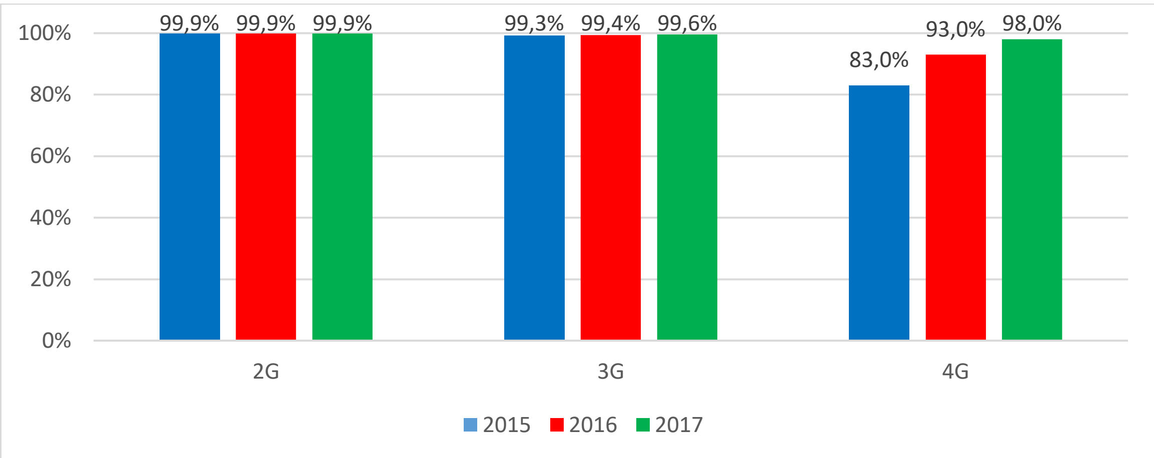

Figure 10 Evolution of the percentage of population coverage of new generation networks in Greece

Source: EETT https://techmaniacs.gr/eett-axiosimeioti-ayxisi-toy-posostoy-plithysmiakis-kalypsis-diktyon-4g-stin-ellada/

According EETT (fig. 10), Greece at the end of 2017 had a population coverage of 4G network at a rate of 98%, which allows us to count on the messages of 240 characters, we can add WEB links like "see more…" on the tab, without exist (theoretically) a problem in the network when transmitting the message, something that is applied in the Netherlands (fig. 8). This requires first research on:

- The proper functioning of the network

[1] Honorary professor at the University of Colorado in Boulder

- To determine which information should be included and
- How to better display additional information

The proposal for the implementation of the work contains a first implementation plan of the cell broadcast, with simple, intelligible and color coded (innovation) messages, giving weight to the message and the necessity of its faithful execution.

According to Paraskevi Soulopoulou (Soulopoulou, 2018), in research into the implementation of cell broadcast in Greece, the recommended update tabs have too much acceptance, are considered useful and understandable.

Another point that we will give weight is to inform and educate the citizen about its use and the necessity of feedback (as in the Netherlands) after each training, a point that is found by the above research (Soulopoulou, 2018).

Here we will make a special mention of people with disabilities who are capable to serve themselves and are familiar with the use of the mobile. According to Soulopoulou (Soulopoulou, 2018), there are many ways to perceive the message on their cell phones, but the way that understand the cell broadcast message and then they will act (time PAI), is a matter of future research.

The application of cell broadcast will not abolish the existing methods, because the citizen must first learn in this way, the transition must be done smoothly. Of course, today's information methods in Greece may use new technology and new methods of communication, such as social networks, but are lag from the proposed method because:

- The citizen is informed without any charge (free charge) to a device (mobile phone) that is proven in Greece has users of at least 110% of the population
- You don't have to look for, but it appears directly on your screen.
- It is not affected by the load on mobile networks or by any power failure and is transmittted directly to all citizens in the targeted area, without being affected by their number
- The message can be transmitted by instant compilation in the language of the mobile phone

The update is not restricted by the focused geographic area. This area may be from a building block to the whole of the Greece.

5. Conclusions

Authorities and emergency response teams must inform citizens from the initiation of an emergency until the return of society to the normality. In our country this is not usually successful, but on the contrary, an opportunity is given to too many persons to disorient the terrified citizen with fake news.

The new method proposed can immediately, constantly and with the right instructions guide the citizens who are within the area where the event takes place. This avoids misinformation and disruption of the operation carried out by civil protection forces. Of course, the risk of the use of cell broadcast technology in applications other than emergencies, is the risk of not being accepted by the citizens by creating a climate of obsolescence. It is initially proposed to be used only for emergencies.

The cell broadcast is a new method that is applied in many countries successfully. It has been used in many emergencies by giving the right orders – directions to citizens, helping them save their lives.

A method that can be used in the huge problem of migration, where people who do not speak Greek or sometimes none of the international languages (English, French and German), but who hold mobile phones, must receive instructions on where they are and what they should do.

Finally, the combination of cell broadcast with other new applications can give us even more impressive results. The creation of a new prevention ecosystem with the addition of new technologies (detection of slope displacement, river level gauges, etc.) and notification with cell broadcast technology should be the ultimate purpose of civil protection.

The technology of information imaging on the windscreen of a vehicle, which is visible from the driver (head up display), could be used to guide the driver in an emergency, depicting the messages of cell Broadcast without having to distract its attention from the road. This application could also exist in emergency vehicles.

Providing valid and timely communication is one of the most important tasks of a public authority towards its citizens. This task becomes even more important when this communication with citizens takes place in times of emergencies.

Let us make sure that we do it in the most appropriate way, with the cell broadcast technology.

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CLASSIFICATION OF WEST ATTICA SECONDARY EDUCATION SCHOOL UNITS CONCERNING NATURAL AND TECHNOLOGICAL RISKS

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Abstract

At the Secondary Education Directorate of Western Attica, there are 50 high schools, involving approximately 1000 teachers and 10000 students. Most of the above school units are within walking distance of some of about 30 SEVEZO-type facilities located in the region. In this paper we make a distance-based classification of school units concerning SEVESO-type industries. Also, we comment on some major industrial accidents (non-SEVESO type) in neighboring industries which could cause a domino effect. Additionally, we draw earthquakes (>4R) epicenters in West Attica prefecture in order to have a descriptive tool of risk assessment of school's units and digitize results of a previous technical report concerning areas vulnerable to floods with school's location.

Keywords: secondary education schools; SEVESO type industries; safety.

1. Introduction

The region of West Attica is well-known in Greece for intent social, economical and environmental problems and challenges that are faced. These problems become even more complex because of the presence of motley social groups of diverse origins and values-background, like domestic and foreign immigrants, ethnic groups, etc. At the same time, there is a large increase of population observed in the specific region, mainly because of domestic immigration, there is a downgrading of natural resources, a loss of social cohesion and an uncertainty regarding economic growth. Thriasio Plain has a long industrial tradition representing an emblematic case of urban-rural relationships made more complex under global change. The industrialization of this area and its transformation from rural into industrial land gave rise to inherent land-use changes. Thriasio Plain is characterized by spontaneous development of different activities (residence, agriculture, industry and port facilities), which co-exist within the same environment with the road network crossing the pre-existing urban poles. As an indication, there is a rubbish dump for receiving the waste of Athens metropolitan area (Greece), amounting to more than 1,570,000 tons of urban waste annually, while the local processing unit can manage about 1,200 tons daily. Moreover, there are 23,000 tons of solid industrial waste received in the dump annually, with 4,500 tons being toxic, and 8,500 tons being oil-waste. The remaining 10,000 tons of them are non-toxic (Salvati & Mavrakis, 2014; Mavrakis et al., 2015). This entire problem-nexus is transferred to the daily activities of the school societies, causing additional difficulties to the educational process (Papavasileiou & Mavrakis, 2013; Mavrakis, 2017; Mavrakis et al., 2018; Mavrakis, 2018).

At the Secondary Education Directorate of Western Attica, there are 50 high schools, involving annually about 1000 teachers and 10000 students. By category the schools are: 24 Junior High–Schools (Gymnasium –1 of Special Education and 2 with Lyceum Classes), 14 General Senior High–Schools (Lyceums), 1 Special Vocational

Education Training Center, 5 Vocational Lyceums and 3 Laboratory Centers. At the Western Attica Directorate of Primary Education, there are 59 primary schools and 61 kindergartens not included in present study.

Some of the above school units are within walking distance of some of about 26 SEVEZO-type industries (according to EU Directive) located in the region (Mavrakis et al., 2017a; 2017b).

- In this paper, using GIS applications and tools, we make a distance-based classification of school units concerning SEVESO-type industries.
- Additionally, we plot earthquakes (>4R) epicenters in West Attica prefecture in order to have a descriptive tool of risk assessment of school's units.
- We digitize results of a previous technical report concerning areas vulnerable to floods
- We comment on some major industrial accidents (non-SEVESO type) in neighboring industries which could cause a domino effect.

2. Materials and Methods

Geospatial data (SEVESO type industries, background layers, land uses) were adopted from open web and database sources such was the geodata.gov.gr, openstreetmap and the website of the Ministry of Interior Affairs (ypes). Data for the high schools' students and teachers' population were adopted from Hellenic Statistic Authority, while school locations were adopted from Secondary Education Directorate of West Attica. Maps have been created using the educational version of the ArcGIS.10.5.1 software. This version was provided for educational purposes (with license for 1 year) from the Institute of Training (INEP), department of The National Centre for Public Administration and Local Government (EKDDA). Main mission of the INEP is the improvement of the functioning and effectiveness of the public services and of the public agents through research on the documentation and through consulting support, the upgrading of the of the Human Resources of the Public Administration and Local Government, through life-long learning and training on knowledge and skills.

3. Results and Discussion

3.1 Schools and SEVESO-type industries

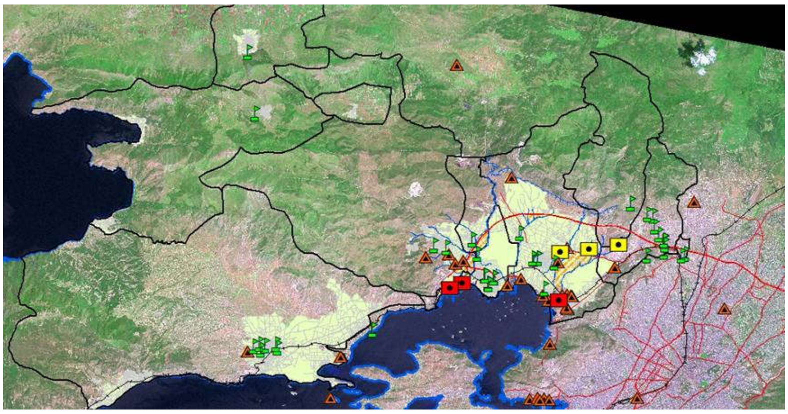


Fig. 1. Geospatial distribution of Directorate of Secondary Education of Western Attica schools' units (with green flag) and SEVESO type industries (orange – black triangles), SEVESO type accidents (red squares) and non-SEVESO major type accidents (yellow square). A Landsat satellite image (20-5-2000) was used as a background.

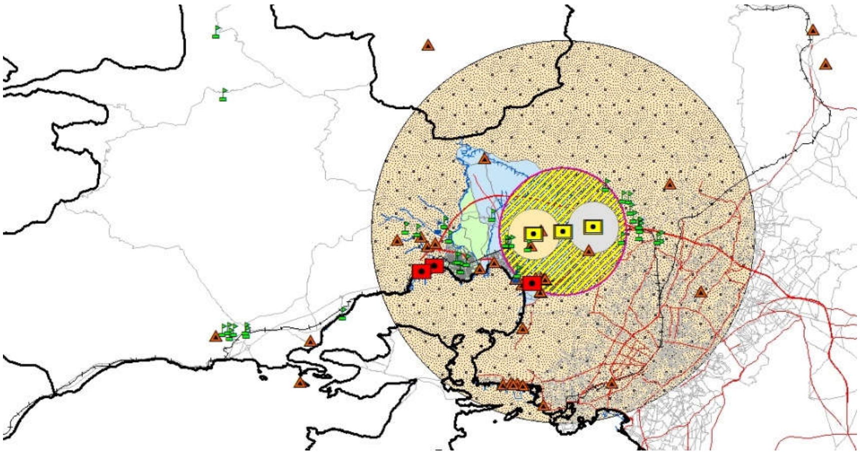


Fig. 2. Geospatial distribution of schools' units (green flag), SEVESO type industries (orange – black triangles), SEVESO type accidents (red squares) and major non-SEVESO type industrial accidents (yellow squares)

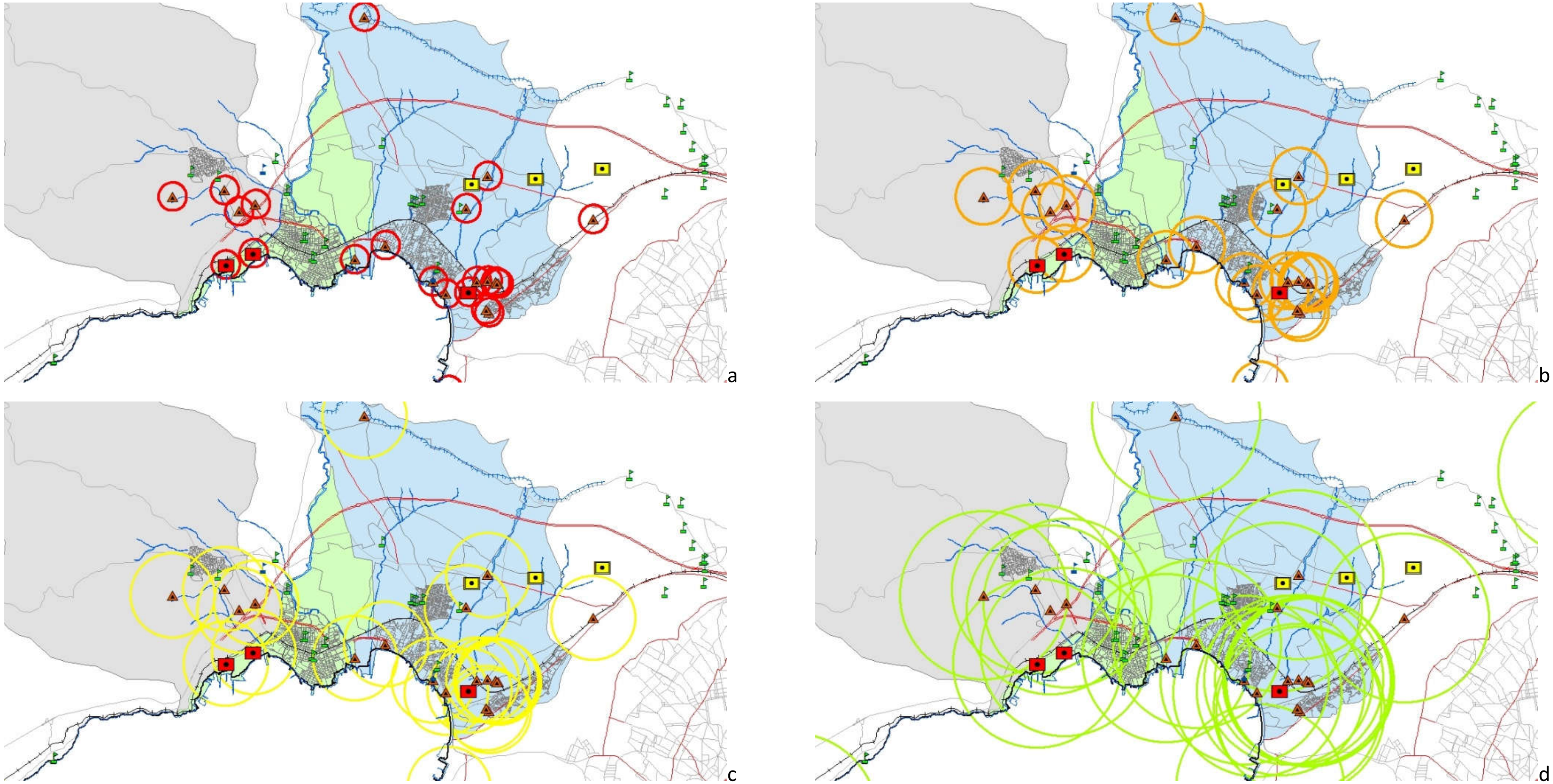


Fig. 3. For municipalities of Aspropyrgos (light blue), Elefsis (light green) & Magoula (white) and Mandra (light gray), buffer zones of 500m (a), 1000m (b), 1500m (c) and 3000m (d) for SEVESO type industries, and high schools including on them.

Using the educational software, we plot secondary education schools and SEVESO type industries. After that we create 4 buffer zones. Zones are in 500m (red zone), 1000m (orange zone), 1500m (yellow zone) and 3000m (green zone). Creation of the zones (circle radius) was made according the national norms. Then we classify schools using the function “near”.

In Fig. 1 we show the spatial distribution of high schools and SEVESO-type industries, most of them located at industrial zone of Paralia Aspropyrgou and Mandra. In Fig. 2 we show marked 3 major SEVESO type accidents (red squares) and the location of 3 major non-SEVESO type accidents (yellow squares).

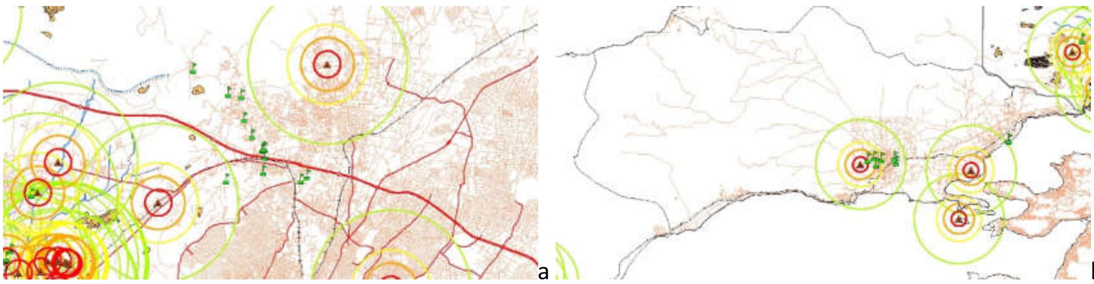
In Fig. 3, we create for municipalities of Aspropyrgos, Elefsis & Magoula and Mandra, four buffer zones at 500m (a), 1000m (b), 1500m (c) and 3000m for all SEVESO type industries located within those municipalities and high schools including on them. Figures 3a and 3b, as well as Fig. 4b, are of special interest. From the above figures we see that at the red zone there are 4 Junior High–Schools (two Gymnasium’s in Aspropyrgos –with about 500 students and 60 teachers, one in Mandra –with about 350 students and 40 teachers and 1 in Megara –with about 150 students and 20 teachers).

The second zone (orange zone) include additionally 3 Lyceums (two in Megara –with about 500 students and 50 teachers and one in Mandra –with about 200 students and 25 teachers).

The third zone (yellow zone) includes all high schools of Thriasio Plain, Megara and Nea Peramos, while the fourth zone includes the entire area.

From the municipality of Fyli – Ano Liosia, only one Gymnasium (with about 150 students and 20 teachers) seems to be in green zone, while schools located at Villia and Erythres seems to be less vulnerable to SEVESO type accidents, because there are not such industries in distance less than 3000m.

In general schools at Fyli, Villia and Erythres seem to be less vulnerable in case of a SEVESO type accident.



a b

Fig. 4. Buffer zones of 500, 1000, 1500 and 3000m for SEVESO type industries, for municipality of Fyli – Ano Liosia (a) and for Municipality of Megara – Nea Peramos (b).

3.2 Schools and Earthquake Epicenters

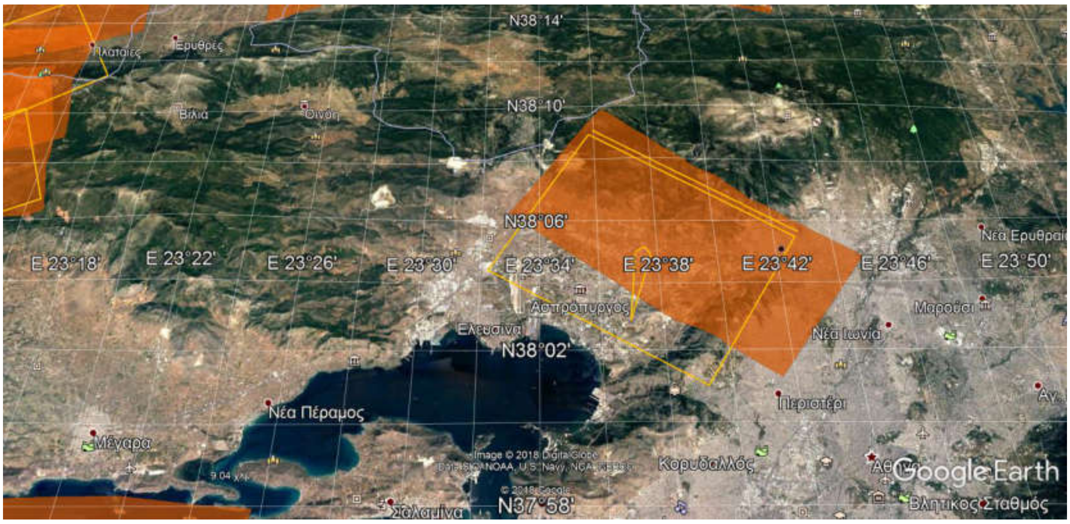


Fig. 5. Thriasio – Fyli fault. Image adopted from The Greek Database of Seismogenic Sources, a repository of geological, tectonic and active-fault data for the Greek territory. GreDaSS is web tool, continuously updatable, that can accommodate all proposals from multi-field researchers, via http://eqgeogr.weebly.com/database-of-active-faults.html

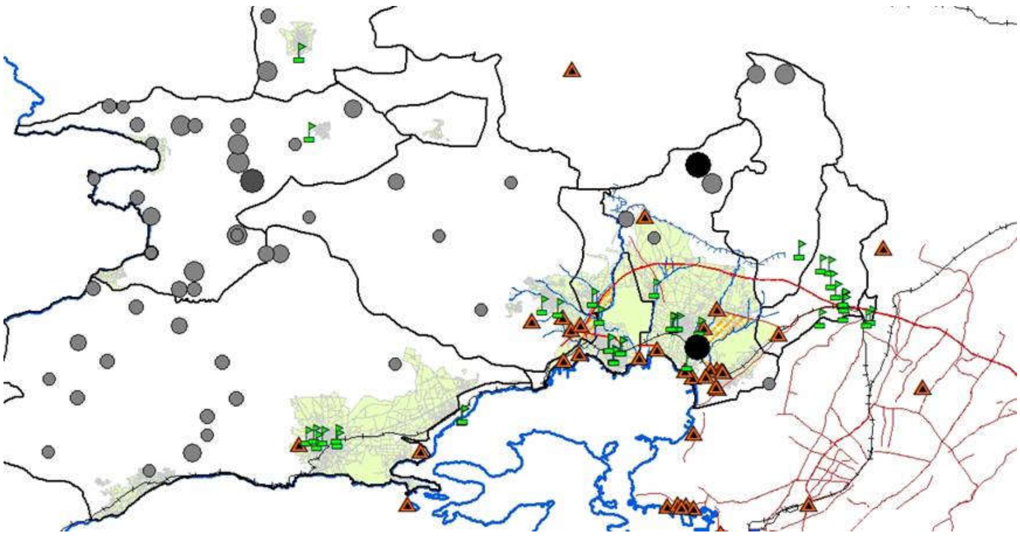


Fig. 6. Earthquakes epicenters M 4 – 5.9 R within boundaries of West Attica

In Figures 5, we show the Thriasio – Fyli fault as is represented from The Greek Database of Seismogenic Sources, a repository of geological, tectonic and active-fault data for the Greek territory. GreDaSS is web tool, continuously updatable, that can accommodate all proposals from multi-field researchers.

In Figure 6, we have plot Earthquakes epicenters M=4 – 5.9R within boundaries of West Attica Prefecture, secondary education school units and SEVESO-type industries. The plot was made only as supervisory material, maybe useful for decision / policy making administration authorities.

3.3 Schools and vulnerable areas to floods

In Figure 7, we have plot Thriasio Plain seasonal streams and we have digitized areas vulnerable to floods according to an earlier study (Stamatiadis, 2000). Those vulnerable areas include one building with two schools with students having certain disabilities. Until now, there is no school in the area which faces such risk.

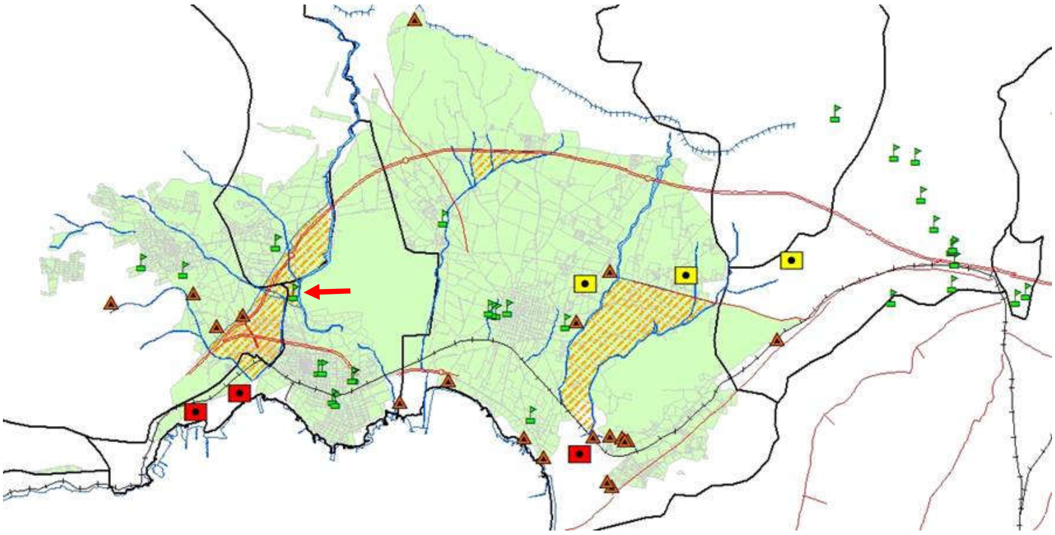


Fig. 7. Thriasio Plain: Areas vulnerable to floods according to an earlier study (Stamatiadis, 2000). Two schools with students having certain disabilities are included in vulnerable areas

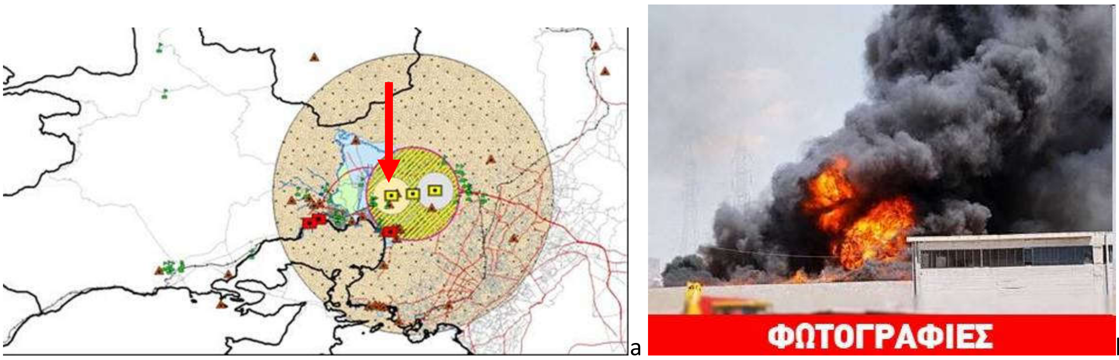
3.4 Schools and industrial accidents in non-SEVESO type industries

For three majors non-SEVESO type accidents we have drawn buffer zones using observations of the radius of smoke plume.

In the first case (July 4, 2014) fire erupted in an abandoned paper industry (Fig. 8, light orange) with the plume smoke radius at 1 Km, lasting for one week. The affected area includes one high school, one primary school and a kindergarten.

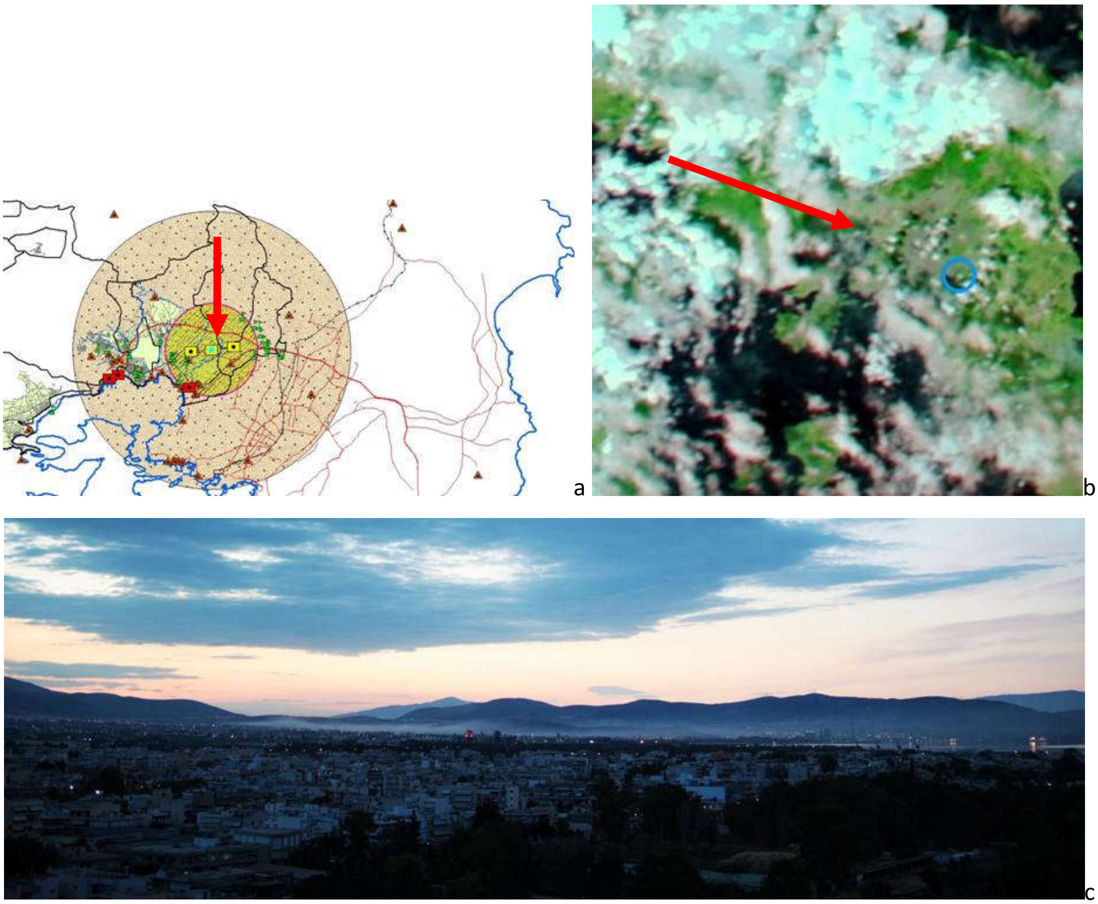
The second case was the worst industrial accident (non-SEVESO type) in the West Attica area lasting for about 35 months. In June 6, 2015, a fire erupted in an abandonment recycling factory (which account for an area of 40000 square meters) with the smoke plume during first two days in 10Km as is seen in Fig 9b from AERONET_ATHENS-NOA.2015157.aqua.721.250m plume of smoke at 3km distance. The day after (11 June 2015) the plume of smoke was visible at 3 Km covering east part of Thriasio Plain (Fig. 9c). A primary school was in less than 300m distance from the burned area.

The third case was a fire in the heart of Fyli's landfill (Fig. 10). The fire was erupted around 4:40 pm in July 17th, 2016, with the plume smoke radius at 1Km, lasting for two days. This accident confirms the enormous environmental and human health hazards of today's monstrous waste management model in Greece.



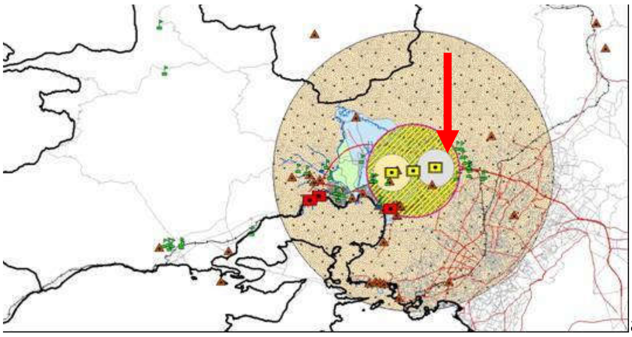
a b

Fig. 8. July 4, 2014: fire in an abandoned paper industry (light orange) with the plume smoke distance at 1 Km, lasting for one week. The affected area includes one high school, one primary school and a kindergarten



a b c

Fig. 9. In June 6, 2015, a major industrial accident (fire erupted in an abandonment recycling industry – Fig. 9a) with the plume of smoke disperse at 10km distance (image in Fig. 9b) adopted from AERONET_ATHENS-NOA.2015157.aqua.721.250m. In June 11, 2015, (Fig 9c) the plume of smoke has covered all the area at 3km distance, (Photo: DENIS GUZZO – via ecoeleusis).


a

b

Fig. 10. A fire in the heart of Fyli's landfill was erupted around 4:40 pm (17–7–2016), as was seen from Elefsis. This is another incident that confirms the enormous environmental and human health hazards of today's monstrous waste management model in Greece, via https://ecoeleusis.org/2016/07/otan-den-kegonte-ta-vouna-mas-kegonte-ta-skoupidia-mas/#prettyPhoto

4. Conclusions

In this paper using GIS applications and tools we make a distance-based classification of school units from SEVESO type industries. Also, we refer to some major industrial accidents (non-SEVESO type) in neighboring industries which could cause a domino effect.

Results indicate that there are schools within the first (red) zone of SEVESO-type industries; there is a possibility some schools to be vulnerable to a SEVESO-type incident and almost all schools of Thriasio Plain could be exposing to consequences of such type incident.

Also, non-SEVESO type accidents can cause serious problems to population living and working in the area.

We must notice that all the area of West Attica is very vulnerable to natural and technological disasters. For example, was strongly affected from 1999 earthquake, all municipalities included in the area have a prolong history of serious floods episodes with casualties and there is a time series of devastating forest fires.

All the material produced herein, can be used from administrative authorities for emergency plans, and as a decision / policy making tool for government agencies and local authorities.

Modern societies face old and new challenges regarding Natural and Technological (NaTech) Disasters. There is a need for new Educational approaches on these issues, new Culture and new Management Behaviors for this kind of hazards. Also changes in the geopolitical environment call us for our Humanism and Solidarity, but also for the need to make more efforts on Preparation, Information and Readiness of our society and especially on sensitive and vulnerable social groups as students are.

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SUPPORTING SEARCH AND RESCUE OPERATIONS WITH UAVS

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Abstract

The technology of small unmanned aerial vehicles, also known as UAVs, are currently on the up rise. This research wants to evaluate if the capabilities of UAVs could be exploited to provide valuable contributions in search and rescue efforts – and if so – what challenges would arise. The research will serve as a suggestion for what benefits the UAV platform can provide, as well as considering the challenges for implementation.

Through a thorough literature review, state-of-the-art for search and rescue, UAV platforms and sensor technology is investigated to establish a theoretical frame of reference. This framework is the foundation for evaluating how to improve the current search and rescue efforts, what capabilities current UAV and sensor technology has, and how to best apply UAVs to satisfy the needs of a rescue. The subject of UAVs in search and rescue is still in its initial stages, and the amount of research and knowledge is therefore limited.

The main challenges identified and discussed in this research is under the categories of adverse meteorological conditions and technological challenges. There were also identified some challenges regarding compliance to regulations and in relation to human and organization, however these were less precarious for the implementation. Furthermore, it was established that UAVs are not yet capable of replacing manned aircrafts, but could still be a unique and valuable asset to a rescue operation. There were identified some hazards due to implementation of UAVs, none of which were believed to pose and excessive risk, especially when considering the expected benefit for the rescuers.

1. Introduction

The main purpose of this paper is to study and define the emerging technology of Unmanned Aerial Vehicles (UAV) in Search and Rescue (SAR) missions.

This is an issue with additional extensions to the complexity dimension, having to face a number of challenges.

The methodology is approached through two dimensions: By taking into account the difficulties of traditional SAR techniques (uncertainty and criticality of the time required for the inspection of the search areas, the number and position of victims etc), and by exploring the interdependence of the parameters and the limitations of the UAV technology itself, in order to be efficient for the purpose it serves each time.

2. Research and Rescue - Methodologies

The term "Search and Rescue" describes a complete set of actions to reliably locate and help people who have either been lost in remote environments, or trapped in disaster areas, with the aim of maximizing the probability of their survival (Hoyos et al, 2015). The SAR philosophy is based on four key actions to be taken: Locate (the missing person) - Access (the site where he/she is located) - Stabilize (his / her health situation) - Transport (to a safe place).

Typically, different types of SAR operations are distinguished, depending on the environment in which they occur. These include: urban (Urban-USAR) - which take place within cities - and non-urban or remote (Wilderness-WISAR), maritime (Maritime -MSAR), underwater or mountain rescue, etc. SAR operations in non-urban areas are looking for people who have been lost or injured in deserts, mountains, rivers, lakes or any other sparsely populated or remote environments (Tomotani, 2015). Urban search and rescue refers to people trapped in confined spaces. Structural collapse is usually the cause of trapping people, but people can also get trapped in traffic accidents, mines, etc. It can also be caused by a variety of natural and man-made disasters and emergencies such as earthquakes, hurricanes, floods, technological accidents, terrorist attacks, etc. Although most bibliographic reports on SAR operations are targeting missing persons in non-urban areas, there are additional challenges in urban areas (e.g debris, area emergency evacuation, etc) (Chen & Miller-Hooks, 2012).

A SAR mission is a highly uncertain and complex process. A difficult and time-consuming project due to the long distances and / or inaccessible areas being investigated. It requires people with specialized training, consumption of thousands of man-hours, a great financial burden. Very often it depends on the completeness of the available information that can be used in the initial search phase as well as on the past experience, the subjective judgment and the individual perceptions of the rescue teams (Goodrich et al., 2008; Koester, 2008; Ferguson, 2008; Lin & Goodrich, 2010; Doherty et al., 2014).

The probability of a missing person to be in the search area, especially in non-urban SAR, is often described by calculating the Probability of Area (POA), that is, the probability of being in a particular part of the investigated area. The search is a process of removing the uncertainty about the possible location of a missing person. Creating a probability distribution map is particularly critical because it guides rescue teams, resource allocation, coordination of efforts and search time in the field, reducing the risk to overlook an area of high probability. Areas with a high probability are first searched in the hope of finding the missing person quickly (Koester, 2008) .

Case studies show that both the missing person's profile, ie that is, the characteristics and personal functions of an individual (e.g. activity in which a person is involved when he / she is lost, age, health status), the environmental conditions and geographical factors (e.g. soil, weather conditions, vegetation, number of roads, inaccessible area, rain, fog) have a strong impact on the missing person, as they can influence his behavior. Also, as time passes, the probability map changes dynamically, especially when the SAR lasts for a long time. Many SAR researchers have worked: (a) to analyze historical search and rescue cases; and (b) to explain the behaviors of missing persons. (Setnicka & Andrasko, 1980; Syrotuck, 2000; Soylemez & Usul, 2006; Ferguson, 2008)

The conclusions from these publications are good resources for building effective models of probability maps.

As for snow avalanches, there are two ways to rescue the victim. The rescue can begin immediately after the avalanche, assuming that there are members of the group who are not affected or are unable to otherwise. This category also includes the first responders who are close to the avalanche accident and have the necessary equipment and skills. Secondly, there is organized rescue where specially trained and equipped personnel arrive at the accident site when notified.

Snow avalanches take more than 200 lives a year worldwide (Ranke, 2015). Most (over 80%) of deadly avalanches are caused by the victim or by someone close to the victim (McClung & Schaerer, 1993). Moreover, due to the inherent risk of self-activating secondary avalanches in an avalanche area, rescuers are likely to be exposed to something that can be considered as an undesirably high risk. The majority (61.6%) of rescue missions are conducted under conditions of dangerous avalanches (Hohlrieder et al., 2008; Silvagni et al., 2016).

The existing process of locating and rescuing an avalanche victim is considered to be inadequate with regard to the techniques used (Wolfe, 2015). SAR has remained largely unchanged for many years after the invention of the first victims of avalanche detector in 1968 by John Lawton (Dawson, 2013).

It is a transceiver (Avalanche Transceivers / AT) emits a limited range. The first rule of its function is that both rescuers and victims have to carry such transceivers. The transceiver emits a pulse signal, which is in the form of flow lines that are identified and detected. When a signal is detected, a secondary search starts in order to minimize the distance from the victim ...

Electronically assisted SAR when it is feasible is faster and more preferable than other detection solutions, given the time constraints. However, even if modern avalanche transceivers are valid and reliable, their operating range is currently about 60 meters, which affects the rescue time. Under actual operating conditions, this range is reduced by several factors like ambient noise, interference with other electronic devices or other beacons (Meister & Dammert, 2014).

The Recco rescue system is also widely used, consisting of: a) The passive part, consisting of a reflector and located on the victim, embedded in clothes, boots, helmet. It does not require electricity or user activation. b) The active part consists of a small handheld radar based detector and can easily be transported by a rescuer. Theoretically, it has a range of 200m in the air and 30m in the snow. This system is not a substitute but is complementary to avalanche rescue transceivers.

Other technical solutions are designed to limit the effect of the victim's full burial with airbags (Haegeli, 2014), but their disadvantages are size, weight and cost. (A "full burial" is defined when the snow covers the victim's head and chest, otherwise the term "partial burial" applies) (Brugger, 2007).

2.1 The Time Parameter

When a small airplane crashes in a remote area or a fishing boat is lost in the sea or a hurricane destroys an area or just a person gets lost while walking, the SAR teams must scan vast areas in the search for victims as soon as possible. Researchers underline the importance of speed and flexibility in such operations.

Time is the key element that affects the likelihood of a successful rescue scenario (that is, a disappeared person being found alive), and it is important that SAR resources are put in the right position as quickly as possible. Recent statistical studies show that the survival rate, for example, of trapped victims in collapsing buildings, falls within 72 hours of the disaster (Tomotani, 2015). In non-urban SAR operations, if a person is not found within 51 hours of being lost, his chances of survival are significantly reduced (Adams et al., 2007). This time period is even shorter (24 hours) for patients with Alzheimer's disease (Koester & Stooksbury, 1995). Note that at the same time the actual search radius is increased by approximately 3 km per hour (Setnicka & Andrasko, 1980; Syrotuck, 2000). A faster response from search and rescue teams leads to a higher survival rate of 91% in the first 30 min and drops to only 19% on the fourth day (Qi et al., 2015).

Time is a crucial factor in the survival of victims at risk of exhaustion or hypothermia and in SAR maritime missions. The survival of people sinking into the sea is very much dependent on the time he/she passes in the water and varies greatly with the temperature of the sea, which makes the rapid recovery of the victim imperative (Ebrahimi-Oskoei, 2014). With regard to SAR operations in avalanches, the chance of survival of the victims depends on the degree of burial, the presence of a clear airway and the severity of bodily harm. In addition, the duration of burial is also a factor in the survival of the victims. According to statistics, 93% of the victims survive if rescued within fifteen minutes of full burial. The chance of survival falls rapidly after the first fifteen minutes of full burial. Given that only one out of ten avalanche victims survives after an organized rescue operation in a remote area, there is still room for improvement.

3. The application of UAVs to SAR missions

The use of small UAVs is a promising platform for carrying out SAR missions and can play an important role in their successful outcome.

UAVs can easily and quickly access inaccessible environments. They are agile, can be easily transported, and show autonomous behaviors, providing airborne support with precision and reliability. With built-in sensors that can adapt to UAVs, rescue personnel are allowed to accurately investigate and map large areas that can be difficult to access in real time (inaccessible areas, roads blocked by debris or traffic overload), guiding rescue teams to target locations and thus broaden the search capabilities to identify people in need (Nordberg et al., 2002; Green et al., 2005; Cooper & Goodrich, 2008; Qi et al., 2015)

UAV technologies are also particularly beneficial when SAR reaches the priority at search phase. Probability distribution maps can be used by the UAVs to design the flight path. To support the priority search, a UAV flies over areas of higher probability and provides visual support with the built-in sensor. Conversely, the data collected by the UAVs can feed the rescue teams with these data that are necessary to update the probability distribution maps.

After an earthquake or other disaster, the UAVs can provide information on the area of destruction, the location and severity of building damage, the identification of victims under the ruins, providing support for the development of appropriate strategies. The earthquake in Haiti in 2010 was the starting point for exploiting

UAVs and assessing the structural integrity of buildings, roads and other infrastructures, which is carried out more quickly and with greater precision (Máthé & Buşoniu, 2015). The chance of survival of people trapped in buildings that have collapsed depends mainly on the types of damage to affected buildings. Therefore, with the rapid mapping of the affected area, buildings can be characterized and ranked according to the damage they have suffered at a specific scale appropriate for the assessment of the rescue teams in order to optimize their work according to the gaps of the survivors in the ruins. (Murphy et al., 2008; Pratt et al, 2009; Chou et al., 2010; Molina et al., 2012; Restas, 2015). Small and flexible UAVs are guided in complex three-dimensional environments (small and difficult-to-access spaces, inside damaged buildings without touching the unstable structure with the risk of further collapse, etc.) to see if there are survivors or victims. At the same time, they are valuable tools for collecting data and creating three-dimensional maps that provide information on the extent of damage inside the building. Special software and 3D imaging allow engineers to locate and evaluate even the smallest cracks that may seem insignificant but in fact they are not. In this way they can arrive at accurate conclusions and objective safety decisions in order to avoid accidents and additional losses (Michael, 2012; Restas, 2015).

The technological developments in the UAV field have made significant advances in avalanches SAR, where the time consuming traditional techniques required for the development of rescue teams are a major obstacle to increase the victim's chance of survival (Zeggada, 2018).

The use of UAVs in SAR operations also protects the members of rescue teams who encounter dangerous conditions and increased likelihood of further accidents or injuries in their effort to reach difficult and inaccessible areas in order to locate and rescue the victims (e.g., secondary avalanches, aftershocks, landslides or floods, destroyed buildings or structures unstable and dangerous) (Máthé & Buşoniu, 2015; Qi et al., 2015).

Continuous communication between SAR teams and the operation center, as well as the use of real-time information to inform them, is clearly necessary in all SAR operations (Huang et al., 2013). The capabilities of using UAVs as an aerial transponder to develop an information and communications exchange network make them valuable tools to enhance the operational effectiveness of SAR teams (OCHA, 2014; Meier, 2015).

UAVs can also be used in the first aid phase by members of a rescue team. For example, in the technological advances that are being developed, we will see the UAV, having traced and approached the victim, releasing this life-saving instrument, giving it more lifetime until it is approached by rescue personnel (Kelion, 2013). The flying ambulance - defibrillator arrives quickly at the scene of the accident. It is manned by a network camera and a loudspeaker that allows communication with specialist doctors so that they can, with proper guidance, provide first aid to the victim.

UAVs are cheaper to manufacture, operate and maintain. Even if a small UAV crashes due to severe weather conditions or difficult ground characteristics, financial damage is limited. They can also be used by rescuers with minimal training, and are a valuable resource or a safe alternative to aerial support when there are no manned aircraft available. ... UAVs with rotating wings are considered more effective for search and rescue efforts and in large and complex environments due to their ability to hover in place, as well as to perform vertical take-off and landing, making them suitable for observation and human guided or stand-alone inspection, as there may be specific areas of interest that require attention from operators in mapping and detection (Michael et al., 2012; Kochersberger et al., 2014). Also, because UAVs are much smaller than manned aircraft, they cause far less impact from their propellers in operating conditions for the rescue crew and rescue dogs (less scattering, etc) (Albrigtsen; 2016).

4. Challenges and suggestions

The reduced autonomy of UAVs due to a multitude of technological and environmental constraints is a major challenge for researchers in SAR operations, mainly due to the criticality of time (Beard et al. 2005 Quigley et al., 2005) The bibliographic review identifies the following cases:

4.1. Area Mapping and Flight Planning

During SAR missions ground characteristics may have changed significantly (e.g. after landslides or floods). The local map of the region should be reconfigured to guarantee the safety of the SAR team and shorten the rescue time (Sun et al., 2016). Optimizing existing mapping algorithms is a topic of wide debate among researchers.

The limited UAV energy capabilities in terms of flight time, which are often insufficient to cover the entire search area, are an important aspect of the study. Also, sensors (e.g. cameras) have limited operating time because of their limited battery life. However, when a UAV is used in search and rescue mode, it is desirable to maximize the length of time because retrieving, preparing for another flight and resetting can be very time consuming. The key challenge and goal of researchers is to solve an intelligent flight path problem that enables UAV's built-in sensors to cover as many important areas as possible within the allowable flight time. That is, the probability distribution map is used by the programming algorithms, which will automatically generate the flight plan by ensuring that areas with a high probability of finding a missing person are searched first, making the search as effective as possible. At the same time, the strategic choices of the operator must enable the UAV to quickly develop updated probability distribution maps (Goodrich et al., 2008; Lin et al., 2009; Lin & Goodrich, 2010; Clark & Goodrich, 2013).

The search continues in the demarcation of the second priority areas for further UAV flights (Bourgault et al., 2006). The use of tools (e.g. GIS) in SAR operations to compile probability distribution maps or as a platform for integrating data on the behavioral profile of the missing person in support of the search process are also research-oriented issues (Soylemez & Usul, 2006; Ferguson, 2008).

For avalanche SAR missions, the flight plan is modified based on the intensity of the signal being detected (Serre et al.,2012), using the usual methods and procedures for rescue of this kind, taking into account the criticalness of time (Silvagni et al., 2016). SAR applications for these cases are currently very few and do not seem to go beyond the preliminary level of the prototype (SAR Drones, 2016).

Quick coverage (rapid ground mapping) and detection (victim tracking) are two key goals for the effectiveness of SAR operations. However, there is a "tension" between these goals, especially in wiSAR missions. Rapid mapping of an area may not be so detailed for locating people. Conversely, slower mapping will help locate the person but in an unacceptable time for SAR operations. Finding the operational compromise between "coverage" and "detection" is a key problem faced by researchers. The probability of detecting a person as a key factor in search efficiency is translated into a practical constraint. That is, the UAV can fly as high as the human form is at the limit of recognition by the optical sensor. If the human form detection requirement is abandoned and other identifying features such as unusual colors of clothing and other artificial objects are sought, UAV height may reach higher levels (Goodrich et al., 2008; Niedzielski et al., 2018). Therefore, the flight plan over an area should be programmed to operate at altitudes suitable for optical sensing of the sensors.

4.2. Optimization of vision sensors

The images are taken from the UAV sensors pose significant problems that make it very difficult for a person to identify features or objects of interest (Gerhardt., 2007).

Sensing limitations are also related to environmental and meteorological conditions (e.g., density of vegetation, lighting conditions, weather etc). Critical data may not be recognized or there could be false alarms (Goodrich et al., 2008; Wu & Zhou, 2006; Li et al., 2011; Lin & Goodrich, 2014). Detecting people in images is a difficult problem and field trials have shown a lack of effective process. Although significant progress has been made in specialized areas such as pedestrian detection, most approaches work better when people are fully visible and appear in a limited range of positions such as attitude or walking. Many models have been introduced with the application and expansion of various algorithms of the visible spectrum of computational vision, incorporating motion and color features, body sensing, obstacles in moving environments, etc. However, these models often cannot be generalized in the complex scenarios of search and rescue operations, and there are variations and fluctuations in people's positions (Andriluka et al., 2010).

In literature we will also come across a body of knowledge using other types of sensors. Since many UAVs are equipped with laser scanners, significant efforts have been made to use them in human detection. Thermal cameras offer a tremendous advantage in night-time surveillance (as evidenced by their extensive use by military and law enforcement), but they also apply to daytime surveillance. In any case, where the thermal properties of a person are different from the background, the person areas can be detected. Thermal images have been extensively used to detect humans using either specially designed methods or by direct methods originally designed for detection in visible spectrum images (Andriluka et al., 2010). In addition, traditional e-vision problems associated with shadows are minimized. However, field trials that show the recording of outdoor thermal surveillance images of the same scene but taken on different days (morning and afternoon), demonstrate that the usual thermal sensors have their own unique challenges to the results obtained (e.g. low SNR, white / black / cold polar changes occurring around very hot or cold objects). This may overturn the original assumption that the body area is much warmer / brighter than the background, making the process ineffective for detecting the exact locations and human forms. The collection of problems associated with optical sensors has created the need for researchers to address them, with the cooperation of various types of sensors or by designing appropriate algorithms or optimizing existing identification and search algorithms. (Lee et al., 2004; Mikolajczyk et al., 2004; Davis & Keck, 2005; Gerhardt, 2007; Rudol & Doherty, 2008; Sun et al., 2016)

4.3. Other UAV limitations that affect the efficiency of the SAR operations

In addition to the above, UAV technology lags behind in its response to SAR operations also due to a number of other known limitations. For example, the vulnerability of UAVs due to their low weight and their low propulsion power, to environmental and meteorological hazards. The effect of extreme cold temperatures is widely recognized as a problem for battery capacity and hence the flight time of a UAV that could be reduced by up to 50%. Maintaining sufficient pre-flight battery temperature is a common problem for which some technical solutions are being developed (e.g. using a heated and thermally insulated box) (Storvold, 2016). Several tests in conditions with varying degrees of rainfall have been carried out which have shown the ability of UAVs to fly during adverse conditions. However, it is recognized that moisture in electrical circuits and components may cause short circuits or other problems, and several modifications are being made to avoid these issues (Albrigtsen, 2016). The normal UAV of SAR operations is also vulnerable in certain metrological conditions such as winds and turbulences caused at the surface of the ground (as a result of air flow that encounters obstacles such as topography and vegetation), causing disastrous effects on their flying ability (DeGarmo, 2004; Abrahamsen, 2015). At the same time, such disturbances can greatly contribute to reducing the probability of detection (jitter effect of computational vision) (Gerhardt., 2007). Many SARs can be carried out in less than optimal lighting, which could delay or disable the use of UAVs, as navigation and general awareness of the situation are difficult. A possible solution to these working issues is the use of external lighting on the ground or the placement in the UAV itself (depending on its payload) and the research is oriented in this direction.

As for the effect on computational vision from the presence of clouds, it is thought to limit the usefulness of different remote sensors (O'Donnell, 1999; Woodell et al., 2015). However, a recent study has demonstrated the positive effect on improving UAV performance by the presence of clear clouds under specific conditions. The results may have a practical potential in a cloudy weather that UAVs can move and fly at low altitudes, so that cloud cover does not limit the view but gives a transparent blurry image of the ground. Such a flight planning for SAR purposes can improve the performance of human detection algorithms (Niedzielski & Jurecka, 2018).

The autonomy of the navigation system (INS, GPS, SLAM, etc.) and the kinematic limitations of the UAVs (in-flight stabilization, point tracking and over-ground maintenance, avoiding obstacles such as buildings, trees, conflicts, etc.) are issues to be resolved and many modifications and improvements are being made in this direction (Bourgault et al., 2006; Luo et al., 2013; Wang et al., 2014; Masiero et al., 2015).

The size of commonly used UAVs creates limitations on payload and hence on sensors used, the rapid transfer of material (e.g. first aid materials) (Jacoff, 2008) as well as the amounts of data that can be transferred that are transmitted to a ground station, resulting in a difference in their quality with greater noise and deformations.

Supporting ground-based communication with UAVs as flying transponders is an issue that is being studied and researchers are trying to approach the problem by exploiting knowledge and experience from other well-known technologies and protocols (e.g. Wi-Fi, FSO ZigBEE) (Varga, et al., 2015; Μπατιστάτος κα., nd). Although the use of UAV technology in this field is still at an early stage, the few available results suggest that it should be investigated further in order to determine its validity (Tseng et al., 2014).

Researchers' findings on human behavior and the perceptual potential of pilots reveal that "the scale of human control is limited" (Sun et al., 2016), as well as the lack of an effective co-ordination process among the assigned roles in the field, which may lead to abandonment of the UAV flight plan, incomplete and inefficient search (Goodrich, 2008). Larger searches in wider areas may reveal the need for more user-friendly interfaces (Goodrich et al, 2008).

Some regulatory compliance challenges have also been identified (e.g. increasing the risk for other aircraft, especially those involved in rescue is a deterrent to the operation of the UAV), but these were less precarious for implementation (Hohlrieder et al., 2008).

4.4. Design of heterogeneous systems (swarm)

Technological developments have enabled smaller and more flexible UAVs to achieve the same functions as larger ones. However, there are still many scenarios in which the UAVs are deficient due to their inherent limitations. One area of interest for many years has been to address these limitations by using multiple UAVs to perform missions instead of a UAV. This reality, which until recently was not feasible, is mainly due to the improvement of the relevant algorithms (collision, turbulence, optimal flight plan, etc) (Dargar et al., 2002). The design of effective platforms to support SARs underlines the need for heterogeneity and not only between UAVs but on multiple cooperative ground and aerial robots (swarm) that work together to perform a specific task / mission controlled either by operators or autonomously (Vincent & Rubin, 2004; Ollero & Maza , 2007).

The ground robots do not have the same payload limitations as the UAVs and are therefore able to carry larger payloads of sensors, maintain reserved communication links, and operate for longer periods of time. However, UAVs provide mobility and observation capabilities that are not available on ground robots. Therefore, in order to build the efficiency of the instruments used, it is proposed to exploit the advantages of each platform (Michael et al., 2012; Ebrahimi-Oskoei, 2014). Swarms have many benefits over regular UAVs, such as resilience to failures (other robots can continue to search if there is a problem), more flexibility in reorganization as mission progresses and economies of scale (Çayirpunar et al., 2008; Waharte et al., 2009). They are also considered to be the optimal solution for payload limitations in cases where a rapid response is required which depends to a large extent on the portability of the systems (Jacoff, 2008).

Swarms may be the same or may differ in features such as sensors, payload, automation level etc. For this reason, swarms are generally classified as uniform or heterogeneous swarms to determine the similarities of the platforms used within the swarm. Both approaches have advantages and disadvantages. A group of identical UAVs requires a less sophisticated system but is limited in terms of payload, information processing and flexibility. A UAV group with different characteristics (heterogeneous swarm) requires a more complex system, while being beneficial in situations where the diversity of UAVs is critical (Vincent & Rubin, 2004; Ollero & Maza, 2007).

Several examples of projects using such methodological approaches, either on ground or aerial platforms, can be found in the research literature, proving that given the current technology, the design of heterogeneous systems is a viable option (Pratt et al., 2008; How et al., 2009; Murphy et al., 2009; Pellenz et al., 2010; Gonzalez et al., 2011; Bachrach et al., 2011; Michael et al., 2012). The robotic swarm is an innovative field that has many more possibilities and new ways of using it are being studied and many other ways of exploiting and optimizing it can be found in the future.

5. Conclusions

Small UAV technology is currently on an upward course. In this paper we investigate, through different case studies, UAV-based methodologies for supporting and documenting SAR operations. Although UAV's "intelligence" is very high, there are still many issues that need to be resolved to provide full credibility to complex SAR operations. Existing research approaches are very promising and new and innovative solutions are being developed in this direction. At the same time, none of the risks identified by the implementation of the UAVs are considered high, especially when considering the expected benefit for rescuers.

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ISSUES OF GENDER DIVERSITY IN HUMANITARIAN CRISES. DIFFERENT NEEDS – EQUAL OPPORTUNITIES

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Abstract

Purpose and problem: When a disaster hits or a conflict erupts, humanitarian actors move quickly to save lives, meet basic needs and protect survivors. In the rush to save lives and meet the emergency needs of people affected, the special and distinct needs of those with less power or greater vulnerability may be overlooked or put "on hold" to be addressed later by the development agenda. "Paying attention to gender issues" quite simply means recognizing the different needs, capacities and contributions of women, girls, boys and men. Typically, women and girls are unable to compete with men for scarce resources during crises. Pre-existing gender inequalities deepen the vulnerability facing women who are old, have disabilities, live with HIV-AIDS or are marginalized in other ways. At times, men and boys are the acutely disadvantaged. Without a solid gender analysis, that should be integrated into the humanitarian needs assessment, the specific vulnerabilities of women, men, girls and boys hide under a cloak of invisibility.

Methods: study of bibliography, lessons that are been made and new trends and analytical and comparative study

Conclusions: Factors such as gender, ethnicity, social class, poverty, belonging to minority groups or not and the age of a person in a particular society define their rights and access to sources, goods, information and services, whether he has a voice and can participate in political affairs. The interaction of these factors within a society defines the way women, men, boys and girls are affected, prevented, treated and emerging from an emergency.

Keywords: Gender based violence, sex, sexual abuse and exploitation, rape, sexually transmitted diseases, emergencies.

1. Introduction

When a disaster or a conflict breaks out, humanitarian aid workers react as soon as possible to help people in need. In their hurry, the call to consider the gender issue often meets the indifference of relief missioners and is considered unimportant, irrelevant. But it is! Giving attention to issues of gender diversity simply means recognizing the different needs, abilities and contribution of women, girls, boys and men. Ignoring or staying blind to these different needs can bring serious complications to the protection and survival of people affected by a humanitarian crisis (Women, Girls, Boys and Men Different Needs – Equal Opportunities 2006). Natural disasters or conflicts have a very different effect on women, men, boys and girls. Social, cultural, political, economic parameters, before and after the emergency, affect the vulnerability of different groups.

Factors such as gender, ethnicity, social class, poverty, belonging to minority groups or not and the age of a person in a particular society define their rights and access to sources, goods, information's and services, whether they have a voice and if they can participate in political affairs. The interaction of these factors within a society defines how women, men, boys and girls are affected, protected, treated and recover from an emergency (The Sphere Project: 2004). Typically, women and girls can not compete with men for the acquisition of resources that are in short supply during a crisis. Pre-existing racial inequalities and discrimination, as well as the lower social status of women in many societies, increase their vulnerability to the crisis (IASC 2010) they face different risks and can thus be victimized in different ways. The aim of this work is to present these risks and the issue of gender equality in emergencies. Extensive reference will also be made to addressing the particular needs and risks posed by women and men during or after conflicts or wars.

1.1. What does "Gender" means?

While the term "Sex" in English refers to the biological differences between males and females that are universal and non-convertible (Morrison 1998), the term "Gender" is a socioeconomic, political and cultural variable that analyzes the roles, responsibilities, the constraints, opportunities and needs of men and women within any context (UNHCR 2002). "Gender" refers to the social characteristics and opportunities associated with being a man or a woman and the relationships between women, men, girls and boys, as well as relationships between women and those among men (Action Aid International. 2009).

These social characteristics, opportunities and relationships are socially structured and learned through the process of socialization. For example, the division of work into a family is determined racially: housework is considered to be a woman's duty, while the man is the one who brings the livelihood to the family and is considered the head of the home. Although the work that women offer at home is important and necessary for the survival of the family, allowing therefore men to work, this homework is generally underestimated while their significant contribution to family finances- through their engagement with gardens, growing vegetables, animal farming and small-scale trade- is often not recognized by both men and the humanitarian community. In the past, humanitarian agencies and organizations did not take into account the racial dimension when drawing up relief programs, thus contributing to the perpetuation of gender inequalities. It is important to have an understanding and familiarity with the needs and rights of women, girls, men and boys in times of crisis and at the same time make every effort to alleviate discrimination between them.

Emergencies are a fluid period with strong social changes in a community, especially when they involve conflicts. So women often take over roles and responsibilities that they didn't have traditionally before the crisis. When, for example, a woman loses her husband, she alone bears all the burdens and responsibilities for the survival of herself as well as her children or other people who are left behind or dependent on her. Often, such crises may be an opportunity for empowerment of women in social, economic, political and cultural terms, but this crisis can not be turned into a period of intense misery and pain if the humanitarian response does not take into account the rights, the needs and the contribution of women and girls.

1.2. Why is the issue of gender important in crisis situations?

Wars, natural disasters and crisis-related factors have a different effect on the different sexes. They face different dangers and can thus be victimized in different ways:

A. Collapse of social, community and family structures. In times of crisis, people are displaced and lose their way of life. Social and community structures are collapsing and families can be separated, leading to:

- Increase in the number of separated from their families and unaccompanied children and elderly people.
- Husbands and wife’s can be separated and women take the role of the head of the family without the traditional protection of their husband, father or other male relative.
- Without male protection, women and girls are at greater risk of sexual violence when they leave their homes, when crossing the borders and / or in war zones where unofficial checkpoints have been set up and there where they have been displaced.

B. Destruction or deterioration of services in conjunction with the obstacles faced by women in accessing these services. In times of humanitarian crisis, services such as supermarkets, health centers, hospitals, schools and colleges may have been destroyed. In order to provide these services to those affected, humanitarian aid workers should not only think about the construction / rehabilitation of infrastructure, staff or equipment, but also the issue of gender when accessing them. Women who are now in the household are often unable to look for these services because there is no one to take care of children, or help with the collection of water or firewood, or there may be bans or restrictions on their access for cultural reasons. Homes where only men or fathers stay alone with their children often face special needs, such as not having the ability to cook, take care of young children, or do their homework. For cultural reasons, it is not possible for women and girls to be registered and receive humanitarian assistance in their name, to take the appropriate or dedicated to their diet food, to have access to education and health services in times when resources are limited (school fees, high medical costs, etc.)

C. Women and men react differently. In their effort to resist violence, to survive and protect their own, women and men act differently. For example, selling property that is necessary for their survival, men can migrate in order to find a job, young men may feel that they have no choice but to join the armed groups, women and girl can resort to prostitution, the number of early weddings can increase.

D. Changes IN the demographic profile. In cases of warfare, more women than men survive.

E. Gender roles change with age and time. Assumptions and speculations are often based on stereotypes concerning the role of women and men. Men are often perceived as perpetrators of violence and women are passive victims.

- Young boys may face the risk of involuntary engagement in armed forces or can be accidentally abducted and forced to become child soldiers, can be imprisoned, and in some cases they can even be tortured because they considered them as the enemy.
- In some cases, women can be used as fighters.
- In crisis situations, men often face great difficulties in managing their new identity. -the loss of their role as the head of the family. As a result, violence against women may increase. Often women take on new roles or fill the gaps left by men. When roles change for a man, he may feel a humiliated person who can not protect his family and may feel that he is losing his status and power, given that in the crisis the traditional structures of his family and social environment are being destroyed. Men who are the traditional leaders and agents of power may be hostile to women who interfere in man-made fields, for example, providing family protection, bringing home food, or operating in the financial sector. Understanding the different manifestations of being masculinity within the context of the various situations that may arise during the crisis and winning the support of men in order for women and young people to get involved and participate in traditional male activities is crucial for the success and duration of humanitarian intervention.
- On the other hand, women and girls are deliberately victimized and are the ones who receive physical, sexual and psychological violence. (Rape, coercion, childbirth, prostitution, trafficking) (http://oneresponse.info).

1.3 The vulnerability of girls and women in times of crisis

As vulnerability we can define the characteristics of a person or group of people in conjunction with the condition that affects their ability to predict, cope, resist and recover from a hit or from risks. Vulnerability involves a combination of factors (social, economic and political) that affect the extent of risk from an event in a person's or group's life, property, or their resources. Some groups of people are more vulnerable to harm, loss and pain due to gender, social class, occupation, ethnicity, health status, age, etc. (Amjad 2002) The way women experience this vulnerability is completely different from that of men because of gender roles and power relations. Factors such as the lack of access and control of key survival tools and property titles increase the vulnerability (HRW 2003) of women and undermine their ability to cope with the consequences of the crisis (Anderson 1998).

In emergencies, girls can also be affected by additional forms of violence compared to boys. Not only do they face bodily injuries and death but they are also sexually abused. This puts them at risk of being infected with HIV or other sexually transmitted diseases and forces them to cope with the complications of a possible pregnancy at a time when supplies are short due to the crisis. Sexual abuse is likely to have psychological consequences for these girls, especially when they return to communities after the crises considered to be "dirty" because of their experience and are therefore in the margins (HRW 2003). It has been found that in the post-war period the most vulnerable among the population were widows and families headed by women who often had many children under their responsibility. These women were in a particularly precarious position without their own land and tools for their cultivation. Their means of reaction are meager: begging, harvesting of wild fruits and in some cases prostitution.

Some of the sexually defined roles that make women vulnerable to emergencies are:

- Women have limited access to means-social networks and influence, transport, information's, skills (including illiteracy), control on land and other sources of income, mobility, safe housing and work, freedom from violence and control over the own decisions- which are necessary to prepare for disaster relief, alleviation and rehabilitation of the victims.
- Changes in the division of responsibilities between men and women may take a long time and sometimes be permanent (ILO 2006). Women are mainly employed in the agricultural sector and in the informal economy. They are usually underpaid, have no social security and access to health structures. They are therefore the ones that are usually affected by unemployment after a disaster.
- Because women are primarily responsible for the household, caring for children, the elderly and patients, they are restricted to their place without being able to move to other areas for job search as is the case with men.
- Environmental degradation and climate change affect the lives of countless women and girls. When droughts and floods ruin the countryside, men migrate to urban centers to seek work but avoiding natural disasters is more difficult for women, especially for those with dependent children. Women need to work harder to produce crops, walk longer to carry water or collect firewood, and survive with scarce resources. When resources are scarce, sacrifices are often made against women and girls. Seven of the ten people who are hungry are women and girls, according to the World Food Program (UNIFEM 2007).
- Loss of women's property is rarely included in the total loss of a disaster. This is usually the case because men are considered the supporters of the family or possess more productive and sustainable property. Very often homes are being destroyed during emergencies, forcing people to move to temporary camps. Inappropriate venues for day-to-day activities such as cooking, limit the movements of women and make it increasingly difficult for them to find alternative forms of employment and income. All these factors, combined with the increase in violence, greatly increase the vulnerability of women in a crisis, doubting their ability to live a life of basic dignity.
- Women also often have limited access to information about their rights and their ability to obtain property titles and goods from various humanitarian organizations. Surveys show that women are easier to cheat because they are unaware of their rights and have neither the means nor the power to claim them.
- Poor women are usually in the wrong place at the wrong time as they can not improve the quality of their homes, they can not choose a good area to live and they do not have the ability to store sufficient quantity of food for emergencies (Cannon 2002). Men are also physically vulnerable to the dangers but the women are those who are most at risk because of gender inequalities as described above (Enarson 1998).
- Many women have limited skills necessary for their survival in major disasters such as swimming, climbing, understanding and reacting to danger signs or in their involvement in disaster prevention (Castro 2006). In some areas only boys learn to swim or climb to trees, which reduces survival opportunities in cases of floods or other meteorological phenomena. Most women in Bangladesh never learned to swim in their lives (Genanet 2004).
- In many parts of the world, women face limitations in their training, which reduces their ability to receive information and understand warning signs. Occasionally, disaster itself may be a hindrance to accessing education.
    - Of the 876 million illiterate people in the world, two-thirds are women
    - Of the 115 million children who do not attend school, three-fifths are girls (ISDR 2005)
    - after a disaster or some other stressful event many girls are forced to leave school to help with housework or save money (Davis 2005).

- Disasters tend to magnify the existing gender differences in the health sector. Women, for example, are already being fed poor, which is unbearable for them, especially when the face hazards that are related to food production such as drought (Cannon 2002). Women are more affected by food shortages because they have particular dietary needs (especially when they are pregnant or breastfeeding) while in some societies they are the last to receive food in a family. In some areas, women's nutrition is particularly precarious. In southern and south-east Asia, between 45 and 50 percent of women of childbearing age are underweight, while 80% of pregnant women are deficient in iron (FAO 2000).
- Women are more exposed to infections and communicable diseases. For example, in the Lushoto region of Tanzania, plague affects women more often than men, since men are sleeping in beds while women and children are sleeping on the ground where they are in danger of coming into contact with rodents infected with plague fleas (Boender 2004). Women are usually responsible for the preparation of food, resulting in exposure to indoor pollutants during this process, which causes about 1.2 million deaths per year ((WHO 2007).
- Surveys have shown that post-disaster reproductive health of women is worsening. For example, in Israel, 48 hours after an earthquake, there was an increase in births, and an increase in premature births. Also social taboos in relation to menstruation and non-observance of good hygiene practices during the course of many women caused health problems. One survey reported that during a 1998 flood in Bangladesh there were incidences of genital wounds and urinary tract infections in young girls because they were unable to wash and dry adequately their sails used during the menstrual period quot (WHO 2005).

2. Women and girls at risk

Women and girls at risk are those whose rights, security and well-being are or will be at risk because of their sex. They may be at risk of sexual or gender-based violence, persecution, social exclusion, extreme poverty, violent repatriation or any other potentially life-threatening threat or condition. The experiences of women and girls during their flight, relocation, possible exile or after conflicts are totally different from men. Displaced women and girls keep their families united under adverse and inhuman conditions while at the same time putting themselves at risk such as rape, beatings, torture, hunger and abandonment (Office of the Special Adviser on Gender Issues and the Advancement of Women 2001). Identifying women and girls at risk is a painful and difficult process that requires a profound knowledge of the community and an assessment of the risks for their safety. In summary, it would be useful to refer to a number of risks that may result in the victimization and exploitation of women both during their displacement and during their repatriation, or they may be the causes themselves of displacement. Such risks are:

- War
- conflicts
- Violation of human rights
- Poverty
- Inequality / exclusion of women
- Discrimination / marginalization of women and / or ethnic, religious and linguistic minorities

Gender violence

- Fears about physical integrity
- Recruitment by armed groups
- Nutritional insecurity
- Lack of or loss of personal documents

- Unsafe areas for collecting firewood
- Exploitation by people in power
- Harmful traditional practices (early marriages, genital mutilation, honor killings, infant killings)
- Lack of educational opportunities
- Loss of traditional male roles
- Trafficking for sexual or labor exploitation
- Child labor
- Separation of families
- Traditional justice systems that do not embrace international imperatives and laws.
- Traditional power structures that ignore the rights and voices of women.
- Collapse of the structures, ethics and values of a society
- Poor presence of women in international humanitarian or relief staff
- Lack of opportunity to participate in peace and reconstruction processes
- Unemployment occasional or dangerous work
- Unequal hereditary, property rights
- Mines and non-extinct mines (IRIN/OCHA 2005).

3. Emergency: Warfare-Natural Disasters and their Effects on Women and Girls

3.1 War conflicts and their effects on women and girls

Almost invisibly, without their own voice, with limited rights even in peacetime, little girls are perhaps the greatest victims of modern wars. Statistics- and they are not the only ones- are silent, unable to reach a human category that sometimes falls under the "children" column and sometimes in the "women" column. In this way, girls are condemned once again in complete obscurity: they are considered to be "women" when they suffer the consequences of war because of their sex and "children" when their victimization is due to their young age (Gardam 2001). But women are not just "children", girls have a right to a separate approach, even at the level of numbers. The problem seems to be perceived by international organizations, who in recent years have repeatedly had the opportunity to note the relative gaps of their sources. How can one deal with an issue if he does not attempt to describe it before?

The minimum data available are extremely worrying: in armed conflicts that shook the planet, girls are confronted not only with hostile weapons, violent expatriation, hunger, and illness (IRIN 2004). In more and more cases, girls are forced by warriors in a brutal "adulthood": they are transformed into warlike prey and they are treated in such a traumatic way that will accompany them throughout their adult life (Shan 2002).

According to recent evidence, modern armed conflicts -82 measured for the period 1989-1993- show a creepy originality: at the beginning of the century, the proportion of civilians on all the victims of a war did not exceed 5% at the 90's this percentage is already close to 90%, of which about half are children of both sexes. Besides, it has been estimated that the armed conflicts of the past decade cost the lives of two million children, while another six million children have been seriously injured or injured during the same period (Rehn 2002).

Extremely painful for girls are as already showed the mass movements of populations that occur during the war. Violent uprooting from birthplace and the dissolution of family or community ties make girls easy prey of all sorts of attack, on the other hand force them to take over adult roles and take on all the burdens of the younger members of the family. Under these circumstances, girls are forced to mature within a 24-hour period. In addition, in many armed conflicts, girls are employed as a working force responsible for cooking and cleaning the day, while at night they are assigned the role of warrior "spouse". There are still cases where girls are selected to carry hidden explosives, but also to act as "human bombs" (Amnesty International 2004). The justification is simple: the girls are the ones that least move the opponent's suspicions. This is not the end of girls problems in the war. According to existing data, both during and after the conflict girls drop out of school at rates three times higher than those of boys Girls are, moreover, those most often suffering from diseases, especially sexually transmitted infections and those due to the lack of hygiene. There is also a large number of girls who, as Rwanda and Bosnia point out, have to deal with the complex medical problems caused by pregnancy and childbirth at an early age and as a result of rape (Ochieng 2005).

3.2 Natural or man-made disasters and their effects on women and girls

As in the case of armed conflict, women are more vulnerable to the impact of disasters because of their socially defined, different roles and responsibilities than men have, and because of their inequality in access to resources and decision-making.

The relatively low value attributed to girls in some societies may be fatal when combined with disasters. Men, on the other hand, may be disadvantaged in different situations and for different reasons than women, due to their socialization based on the role of gender. The role of the protector that men have can place them with greater responsibility because they are more at risk during a disaster and the subsequent period, both for their family's and when they take on volunteer and rescuer roles (IRIN 2004).

4. Conclusions

It is widely known that emergency situations have a different effect on women, men, girls and boys. The social, cultural, economic and ecological context both before and after the crisis affects the degree of vulnerability of the different groups. Factors such as gender, ethnicity, social group, poverty, belonging to a minority group or not and age in a particular society determine its rights and access to sources, information, services, political participation and the free speech. The interaction of these factors within society determines how women, men, girls and boys are affected, protected, confronted and emerged from crisis situations.

Humanitarian organizations and actors tend to reproduce and perpetuate many of the inequalities that are established in the societies that they are called upon to act. As a result, women are often excluded from all humanitarian "response" processes in a crisis. This is not just an unfortunate oversight or a lack of understanding of the tribal peculiarities. The violation of woman’s rights: in their participation in decision-making, in information, in humanitarian aid, in the acquisition of survival means, in the knowledge of how they can reduce the risk of future crises and can better prepare them, deprives them of dignity and their right to security. It underestimates their active action, weakens them and strengthens inequalities. It also deprives families and communities of the benefits of woman's contribution. Emergencies are often periods of intense social unrest. But they also offer an opportunity to redress the existing inequalities between men and women through faith and commitment to social change and transformation.

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IMPLEMENTATION OF CONTINGENCY PLANS AND BUSINESS CONTINUITY PLANS AT PPC's LIGNITE MINES

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Abstract

For the Public Power Corporation S.A (PPC), people are its most valuable resource. Within the frames of protection of employees, visitors and infrastructure, PPC has developed and maintains plans and procedures to identify the potential for, and responses to, incidents and emergency situations for its Mines and Power Plants. Especially for Mines, it is in progress the development and implementation of Business Continuity Plans having as ultimate goal the recovery of operation of its critical activities after a disruption. Environmental Emergency Preparedness Plans are also developed and implemented. Through the implementation of Health & Safety Management System, Business Continuity Management System and Environmental Management System a common platform is formulated for the identification and assessment of risks and for the management of emergency situations. The development, implementation and certification of these Plans shows the respect of PPC Group to its employees, the society and the environment as well as the interest and respect to its customers and its commitment to continuous and uninterrupted provision of high level services to them.

Keywords: emergency preparedness, business continuity, contingency plans, risk management

1. Introduction

The nature of mining can often present a range of uncertainties, which arises due to the complex inter-relationships between technical, environmental, economic and even social risks. The inherent riskiness and peculiarities of mining activities combined by the incremental likelihood of natural disasters, demands a growing concern about employees and local communities' safety and wellbeing. Within this frame, Mines Business Unit of Public Power Corporation address the complex and often interrelated mix of risks through the development of Health & Safety, Environmental and Business Continuity management systems. Emergency response, crisis management and business continuity plans and capabilities are valid and important elements of mitigating controls for operational risks.

2. Mines Business Unit of Public Power Corporation

The Public Power Corporation SA (PPC) is the leading producer and supplier of electricity in Greece, with approximately 7.2 million customers. Its infrastructure extends from lignite mines to power stations. The installed capacity of generating units amounted to 12.445 MW corresponding to approximately 61% of total installed capacity in the country. Its subsidiaries, Hellenic Distribution System Operator SA and PPC Renewables SA own and operate the distribution system and renewable energy installations respectively. Fuel for the Power stations includes lignite and natural gas (for interconnected system).

PPC operates five open-cast mines which are located at the West Macedonia - Northern Greece and at Peloponnese-Southern Greece with an annual lignite production of about 35Mt (2017).

The complicated structure of the lignite deposits, combined with the mining system, is strongly related to the main production risks of the mining stages (Vlachos 2018).

2.1 Certified Management Systems at PPC's Lignite Mines

Currently, at PPC's lignite mines the following management systems standards are implemented which are certified by independent Certification Bodies:

- ISO 22301/2012 (Business Continuity Management System)
- OHSAS 18001/2007 (Health & Safety Management System)
- ISO 14001/2015 (Environmental Management System)
- ISO 9001/2015 (Quality management System)

In order to fulfill the requirements of these management systems, Mines Business Unit has developed (Vlachos 2018):

- Business Impact Analysis
- Risk assessments for production risks, health & safety risks and environmental risks
- Risks Registers
- Emergency Contingency Plans
- Business Continuity Plans
- Environmental Emergency Preparedness & Response Plans
- Safety Rules for Main Mine Equipment, Auxiliary Mine Equipment, Conveyor Belts and Maintenance facilities
- Relevant Performance Indicators
- Risk mitigation measures
- Roles and responsibilities regarding these activities
- Relevant procedures and guidelines regarding incident and near-misses investigation, corrective and preventive actions, internal audits, employees' actions in emergency conditions (earthquakes, severe weather conditions, fire, floods), handling and storage of hazardous materials etc
- Full scale exercises with the participation of external authorities (fire department, police, medical services)

3. Rationale for the development of Emergency Preparedness Plans

PPC's Mines Business Unit has established and maintains plans and procedures to identify the potential for, and responses to, incidents and emergency situations. Within this framework, MBU designs Emergency Contingency Plans, Business Continuity Plans and Environmental Emergency Preparedness & Response Plans and periodically reviews its emergency preparedness and procedures, in particular after the occurrence of incidents or emergency situations. They also periodically test such procedures in cooperation with external organizations such as local Fire Department and Police Department.

These Plans aims to:

- minimize the interruption of operation due to unplanned events,

- limit the extent of losses and disasters and prevent their escalation,

- implement in advance alternative operation modes,

- train mine stuff in emergency procedures,

- plan for the fast and smooth recovery of operation,

- minimize financial implications.

These Plans provides a number of properly trained employees so as to react immediately in an emergency in order to address the effect of it.

Emergency Preparedness Plans could also provide type of metrics, among others, for health & Safety, Environmental and Business Continuity management systems, as indicated in Figure 1 (Kadar 2013).

4. Contingency Plans

Emergency response includes the fixed and mobile equipment and human capacity needed to minimise the physical impacts of an event. Firefighting and mines rescue are typical emergency response capabilities required at an operating mine site

Metric	Description	Measure
Existence of plans	Essential facilities and business processes (high "Tier") have plans	Plan inventory/count, compliance to standards
Relevance of plans	Plans address scenarios (risks) of most concern	Scenarios addressed
Viability of plans	Demonstrated in exercises	Plan exercise dates, problems corrected
Currency of plans	Plans are reviewed periodically, teams are trained	Plan review dates, training dates

Figure 1: Plans Performance Indicators

An Emergency Contingency Plan contains:

- Area and Operations' description
- Risks that will initiate the Plan
    - Earthquake
    - Fire
    - Floods
    - Explosions
    - Land sliding
- Organizational structure of the Plan (roles, responsibilities and authorizations)
- Procedures for initiation of the Plan
    - Incident assessment and decision making for initiation of the Plan
    - Incident warning procedure
- Plan implementation
    - Evacuation procedure
    - Site secure
    - Response
    - Recovery & standing down procedures
- Training of actions teams
- Necessary equipment for plan's implementation

5. Business Continuity Plans

Business continuity is the management structures and pre-investment in capacity and other arrangements designed to minimize the period that business is interrupted by the emergency.

Before the development of a Business Continuity Plan, a Business Impact Analysis (BIA) is conducted. BIA examines each business process that makes up the overall operation and asks what would happen to the operation if that process stopped. Business Impact Analysis results in the identification of critical activities, the required recovery time in the event of disruption and the impact of disruption of each activity in mines' operation. Each critical activity is examined to see what it depends on, what it delivers and what depends on it. The critical output from the BIA is the chain of critical activities. This identification process establishes the timeframe within which the critical activities must be resumed after the disruption event. The identified critical activities are:

- Lignite delivery in Power Stations (quantity and quality characteristics)
- Lignite Stockyards operation
- Excavation
- Conveyors' Belts Control Room operation
- Lignite and overburden materials transfer through conveyor belts
- Electrical and Mechanical Support

- Dumping of overburden materials

The identification of critical activities and the criticality order were achieved through the use of three parameters “impact”, “alternative activity” and “recovery priority”. For each of the critical activities, risks which, if materialized could have negative impact, were identified and assessed. The risks assessed through a semi-quantitative method, under ISO 31000 principles and guidelines. Interdependencies between critical activities are also identified.

Recovery procedures through the form of Business Continuity Plans were developed for each identified critical activity and respective risks, adding in special steps as required by the differing exposures of each activity.

Business Impact Analysis together with Risk Assessment and Business Continuity Plan forms the Business Continuity Management life cycle (Hour 2012) as indicated in Figure 2.

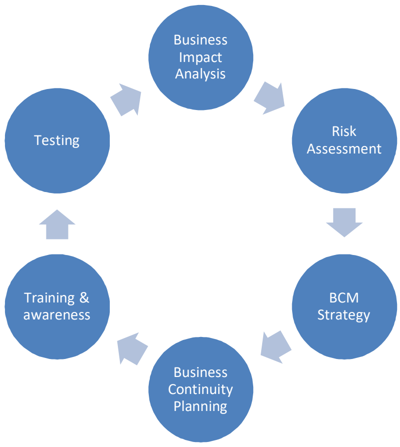

Figure 2: Business Continuity Management life cycle

A Business Continuity Plan contains:

- Scope and objectives
- Mine’s infrastructure
- Response Plans
- Recovery Plans
- Defined roles and responsibilities for people and teams having authority during and following an incident
- Members of Actions (response and recovery) Teams
- Sub-contractors which might involve and provide assistance during an incident
- Appropriate documents’ forms for Communication and Incident Warning
- Emergency contacts (Fire Department, Police department, Emergency Medical Services)

A Recovery Plan for each critical activity and respective risk contains:

- Consequences on the activity because of risk materialization
- Recovery Time Objective (RTO) and Maximum Tolerable Period of Disruption (MTPD)
- Roles, responsibilities and authorities
- Recovery Actions (implementation procedures), which consists on how to recover the activity within the predetermined timeframes (RTO & MTPD)
- Required resources (human resources, equipment, infrastructure, sub-contractors)

Regardless of circumstance, a valid recovery plan must cater for all possible disaster events. It may well be that the event is so far reaching, such as a natural catastrophe, that one's own recovery plan becomes a mere sub-set of an overall strategy. Nevertheless, all possibilities must be catered for at some level of planning. The recovery plan scope defines what each plan does and points to where each excluded recovery is covered. There can be no circumstance that has neither a planned recovery response nor an explicit exclusion.

6. Environmental Emergency Preparedness & Response Plans

Environmental Emergency Preparedness & Response Plans are an ISO 14001:2015 Standard requirement and are developed according to ISO 14004:2016 Standard guidelines. In preparing these plans, consideration is be given to the initial environmental impact that can result as well as and any secondary environmental impact that can occur as a result of responding to the initial environmental impact. In order to determine environmental emergency situations MBU follows the risk assessment methodology according to ISO 31000 Standard. The form of Environmental Emergency Plans are similar to those of Business Continuity Plans and they include:

- The most likely type and scale of an emergency situation
- Equipment and resources needed
- Actions required to minimize environmental damage
- Roles, responsibilities and authorities

7. Periodic Testing of Emergency Response Procedures

To receive the maximum benefits from a management system (health & safety, business continuity, environmental), we need to make sure our staff are adequately trained. The most reliable way to evaluate the effectiveness of training is to conduct exercises and drills.

Exercises are activities designed to examine the staff's ability to effectively respond, recover and continue to perform assigned business functions when faced with specific disruptive scenarios (ISO 22313).

Full scale exercises (FSE) are conducted periodically for each Plan with the participation of local Fire Department, Police Department and Emergency Medical Services. The roles in exercise management team includes:

- Exercise coordinator
- Response/Recovery Teams
- Assessors/evaluators
- Observers

Drills are conducted to test a single specific action (evacuation, communication, firefighting)

Apart from full scale exercises and drills, scenario based table top exercises (TTX) are also conducted. A table top exercise is based on a relevant scenario with a time line which may run in "real time" and include key personnel discussing simulated scenarios that involve disruptive event in an informal setting [around a table].

Before conducting the exercise, a start-up briefing is used to inform observers for the scenario and for all participants to avoid confusion between simulated and actual events.

After the completion of each exercise, post exercise activities include:

- Debriefing sessions to review exercise results and identify actions for improvements
- Post-exercise reporting
- A comprehensive summary with recommendations

Testing is focused on failure not success, so we are looking for things wrong with the recovery procedure. For a better test a vital process or support may be removed or inhibited. For example, by trying to put a fire out without any telecoms. Testing goes on as long as it can be afforded, each cycle looking to see what happens if a vital process cannot be used and trying out alternatives.

8. Integration of Emergency Preparedness Plans

As it is mentioned at ISO 14004:2016 Standard (Environmental Management Systems-General Guidelines on implementation): "In planning for emergency preparedness, the links with other management systems relating to business continuity and occupational health and safety can be considered".

The integration of Contingency Plans, Business Continuity Plans and Environmental Emergency Preparedness & Response Plans, formulate an integrated solution for emergency response, disaster recovery and crisis management (Escalera et al. 2015) as indicated in Figure 3.

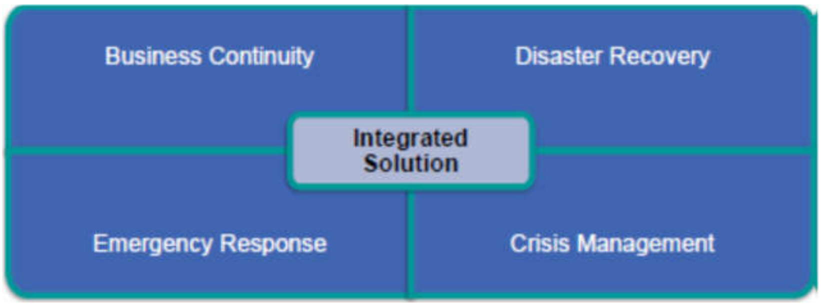

Figure 3: Integrated solution for emergency preparedness

By integrating those Plans, we could formulate a common emergency preparedness platform by following the strategy of 4Rs (Risk reduction, Readiness, Response, Recovery) embedded in a holistic approach of risk management. A single-platform QEHSBC (Quality, Environmental, Health & Safety, Business Continuity) System centralizes tracking to better identify and eliminate systemic risk which is a main goal of operational excellence. Siloing quality and EHS management creates roadblocks to achieving operational excellence, while an integrated QEHSBC System streamlines the path forward (Vlachos 2018).

9 Conclusions

The vulnerability of open cast mines due to increasing risk over time of weather related hazards combined with geological related risks and technical related hazards draw the riskiness picture of mining which could be confronted by proactive actions and preparations. Emergency Plans are a tool to allow an organization to consider the steps necessary to confront an unintentionally, intentionally and natural caused incidence (disruption, disaster or emergency). They are considered as a pro-active movement in order to react effectively in an emergency. Integration of emergency plans formulates common response and recovery activities for a broad range of incidents regarding health & safety, environmental and operational, which ultimately assures business continuity and a resilient organization. All the above are based on sound risk and business continuity management processes which are important aspects of mining business success. Business Continuity practices can be used in advance of any potential emergency event to pave the way for quicker recovery.

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DEVELOPING A SOCIETAL PREVENTIVE CULTURE THROUGH A LIFE-LONG LEARNING STRATEGY

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Abstract

The scope of this paper is to present an approach to achieve the development of a preventive culture through a life-long learning strategy for the benefit of the society at large.
The author's 30-year experience and his relevant studies in assessing risks and managing crises show that prevention is not part of societal culture especially in Greece but in the EU as well, resulting in a chaotic response in case of extreme events that usually result in large-scale crises at a price of multiple life losses as well as asset degradation.
This paper presents an overall specific tri-fold strategy of systems-communication-enforcement that has been successfully employed in high-risk workplace environments and achieved impressive results. This strategy is supported by a six-pillar approach that was successfully implemented in the abovementioned workplace environments.
Then, the paper focuses and presents a life-long learning strategy that can gradually lift the barriers that shape the culture of larger than the workplace populations by proportionally implementing this approach through the involvement of larger-scale educational structures from schools to universities as well as the corresponding institutional support. Some time scale, though definitely culture-dependent, is also proposed.
Using the recommended approach as a backbone, states can start building or enhancing their preventive culture at a larger scale that will activate collective reflexes in emergency or even extreme situations to minimize human and asset loss, a cultural index representative of a civilized societal environment.

Key words: life-long learning, strategy, education, training, crisis

1 Introduction

Experience has shown that assessing and managing emergencies and their development in time is still largely problematic. The recent disastrous events that results in death scores as well as unprecedented property loss due to large-scale forest fires in Mati as well as in California only justify this argument. Despite the knowhow that is being constantly upgraded as well as the supporting technical means provided by the latest technological developments, it seems that this infrastructure remains largely ineffective to provide full, or at least more effective, civil protection.
In the beginning of the 21st century, the value-centered technology has and will continue to provide solutions that improve the human standards of living of the users as well as in the preservation of human life, yet it seems that most system-user designers forget the basic fact that effectiveness relies not only on the reliability of the technological systems but mainly on the one of the user. Since, as the ancient Greeks supported, the starting point of all must be established through education, this paper presents an initiating framework that could provide long-term benefits regarding Civil Protection based on a strategy that will allow the embedding of the prevention and preparedness concepts not in the knowhow of trained professionals or volunteers but in the culture of the society at large. This strategy has a name: Life-Long-Learning or in brief L^3 (L cube). The symbolism is clear; this strategy should extend and serve equally all directions. In this sense, a society needs leaders with competitive intelligence, followers with critical thinking and a societal involvement that understands the value of a L^3 Strategy and combats complacency and indifference.
The expected strategic plan to achieve the strategic goal of minimizing human (and why not property as a positive side-effect) loss is to raise social awareness and sensitivity that will lead to extended social integration into the existing Civil Protection Structures (systemic, technological, specialized human resources) in order to

be able to activate collective disciplined reflexes during Crises. This teamwork-driven behavior results in enhanced Crises Management effectiveness that in turn is bound to minimize human loss.

2 Defining the challenge

Since this paper deals mostly with learning, one must first clarify the basic misconceptions among general population as well as most specialists. Throughout my career as an instructor, consultant as well as a developer of crisis management systems, I realized that the general population lacks the reliable information that can make a difference when facing extreme situations; most of this information is basic (How to survive 1982). The source of the problem is that instructors throughout their learning process do not provide them with clear definitions of the important concepts. In this paper one must first clarify the material difference between the concepts of crisis versus that of an emergency (Beck, Holzer 2007).

An emergency situation comprises a predictable incident scenario that results in a more or less controllable sequence of events given the fact that a minimum state of preparedness has been established prior to the event.

A crisis, on the other hand, is a far less predictable incident scenario, in some cases described, by the ones involved and survived, as “unimaginable” hence resulting in an uncontrollable sequence of events that escalate to a disaster. Of course, an emergency situation can also lead to a disaster should the preparedness level of the responsible State Structures is substandard. But the two cases must be distinguished and managed differently (Roberts, Madsen, Desai 2007).

A large-scale fire at a high-rise building is not unpredictable; in fact it is one of the prevailing incident scenarios expected and is, or at least should be, usually contained without human loss. Hence, its disastrous results are linked to inadequate fire protection specifications by the designers, lack of resources of the facility management, insufficient preparedness on behalf of the residents and so on. Owing to this fact, a high death toll because of a building fire is something not anticipated and could result in a crisis as it happened at the incident of the Grenfell Tower. On the other hand, a large-scale fire at a high-rise building because of airplanes ramming into its structure, as in the November 2011 Twin-Tower incident, is such an unexpected scenario that could be described as “unimaginable”. Therefore, no design specifications or training schemes seem sufficient to confront effectively such an incident once it happens. In this case, the incident itself leads to a crisis irrespective of the human loss factor.

The L^3 Strategy focuses on human loss prevention through preparedness to expect the unexpected by creating a Social Preparedness Culture.

Culture is linked to behavioral consistency, which in turn means that as a concept it must be characterized by (a) resistance against time, (b) self-sustainability and (3) resistance against adverse socio-environmental influences. A Socio-Cultural environment leads to disciplined hence reliable behaviors against situations that may affect social peace.

The L^3 Strategy focuses on creating a social safety culture focused on preserving life at a larger scale less self-centered level which, in any case, is instinct-driven.

3 Factors affecting Social Culture

The development of behaviors travels a quite cumbersome path until each individual adopts its own behavioral pattern as depicted in Figure 1 below.

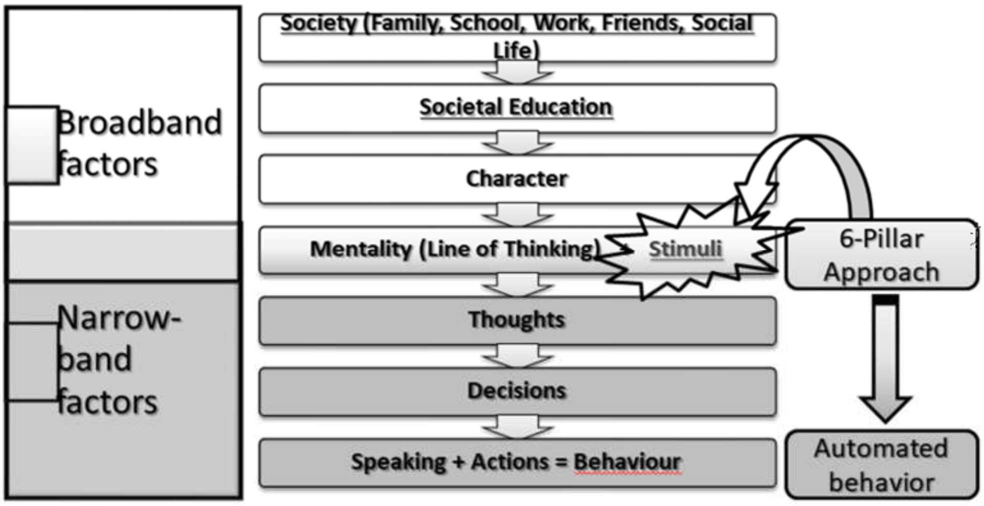

Figure 1: Factors affecting Social Culture; "The Six Pillars of Safety Culture" (Scroubelos 2014)

People are influenced at the beginning by their narrow social environment comprising family, school and friends and, later on, by their broader one comprising work and social life, a societal education which shapes their character. These are factors that can be macroscopically identified and studied hence we can characterize them as broadband factors that gradually shape a person's mentality or line of thinking.

Yet the process of external stimuli is continuous and gradually produces a more consistent, thus predictive, mentality according to which thoughts are born and evolve in the brain from which decisions are derived. When externalized, decisions result in behavioral patterns comprising speaking and actions. Most of this continuous stimuli-response process is invisible hence unidentifiable therefore these factors can be characterized as narrowband whose only visible part is behavior, a usually inconsistent and thus unreliable factor governed by individual survival instincts when it comes to confronting threat (Weick 1993). This means that people are usually not interested in large scale disasters because they believe that that the probability of happening is meagre (Burton, Luecke 2004).

By examining Figure 1 one can realize that to achieve consistent behavioral change so as to establish a cultural change in large populations, the only factor that can be influenced is the stimuli. Hence, any culture-oriented strategy must focus in providing stimuli that must have the specific gravity to create the desired behaviors (Kontogiannis 2017). Implemented in difficult working environments where the subjects were already adults with already formulated characters and embedded risky behaviors, the author developed a 6-Pillar approach that managed to provide the influential stimuli to create automated workplace behaviors under both day-to-day as well as critical circumstances (Scroubelos 2014). Since workplaces bear similar, if not more challenging, characteristics to Society, this method was modified to fit a broader environment that will result in creating the same results, i.e. the behavioral consistency required in larger populations in case of emergency. This behavioral consistency, if preserved, creates the desirable cultural result.

An L^3 Strategy provides stimuli in the form of continuous information to the Society in order to drive the appropriate automated behaviors that will improve the safety of civilians against all risks (BS 25999:2006).

4 The L3 Strategic Focus

A large-scale Crisis is characterized by two factors that must be effectively managed: (1) time pressure and (2) uncertainty to reduce the adverse effects of a crisis (Hagiwara 2007), (Pearson & Clair 1998). The only available tool during such a situation is the brain and its quality characteristics of (a) knowledge, (b) critical thinking, (c) social discipline and (d) behavioral consistency. During times of crises only a knowledgeable, disciplined brain has higher survival probabilities. If knowledge and discipline are introduced in social behaviors a lot of time is saved and uncertainty can be balanced by team initiatives.

The L3 Strategic Focus promotes both education for knowledge acquisition as well as training for skills acquisition at a social level in order to enhance the brain's quality characteristics including its ability to retain the knowledge acquired, one of the most important factors in training (Kontogiannis 2017).

5 The L3 Strategic Plan via the 6-Pillar Approach at a Social Scale

As discussed above, the Six-Pillar approach creates culture if implemented within a group of people sharing the same objectives; at a social scale these pillars can be slightly adapted and listed in a sequential order in the sense that each pillar is a quasi-prerequisite for the next as shown in Figure 2 below.

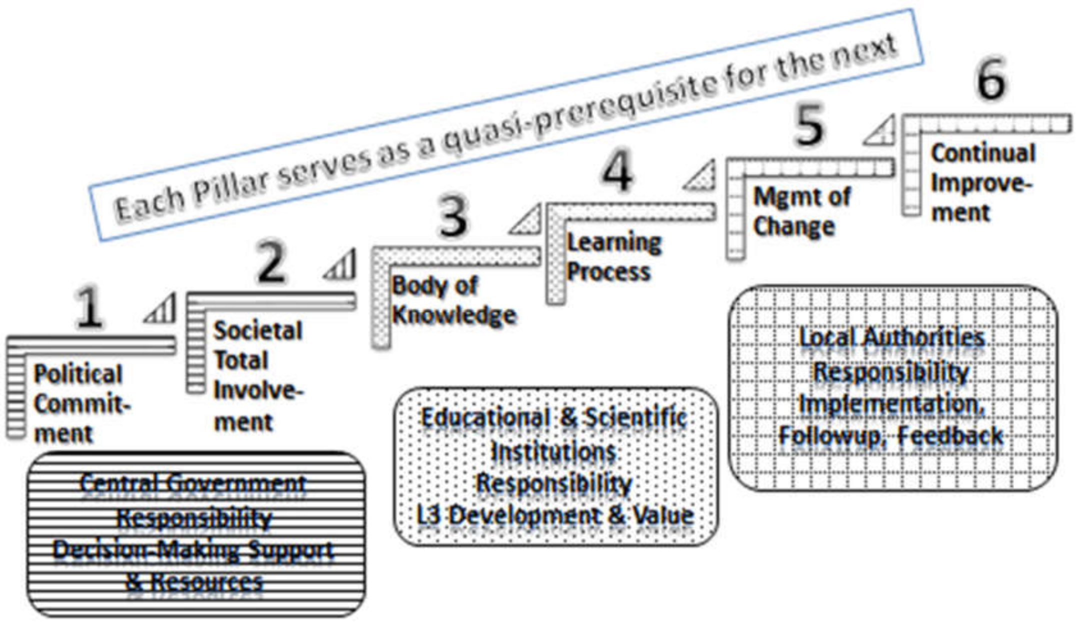

Figure 2: The Six Pillars adopted for implementation at a Social Scale

Political commitment is the absolute driver; without it nothing can be achieved to a degree that will bring substantial results in Civil Protection as it is the Central Government's responsibility to provide the legal framework to enforce as well as the budgetary resources to support a L^3 Strategy.

Societal involvement is the core of the L^3 Strategy and it is the responsibility of the Central Government to ensure that such a strategy is endorsed by the whole Society; an L^3 Strategy should be a part of any political declaration irrespective of orientation.

The Body of Knowledge (BoK) is the identity of the L^3 Strategic Plan; it describes the context of the necessary information the public should be made aware of in order to be able to respond as one should an emergency occur, even when and if it evolves into a crisis, depending on the individual societal needs. It is clearly the Educational and Scientific Institutions that must undertake this task under the support of the Central as well as Local Authorities with minimum political interventions.

A Learning Process is the communications tool of the L^3 Strategic Plan; such a process is the dynamic part of societal education and training based on the BoK. Pedagogical principles should be implemented to enhance the effectiveness of the stimuli on the Society (Calixto 2015), (Ikehara 1999).

Management of Change is the prerequisite for progress; Societies must learn that change is constant, new data arise and the unimaginable is always a realistic possibility; in this sense Societies must be lead to stay vigilant otherwise complacency will certainly result in disaster. This task is easier to be handled in smaller scale groups of the Local Societies governed by Local Authorities. Small-scale implementation models result in understanding the flaws in a management scheme at a larger scale functioning usually as a magnifying glass. Change is always easier to be adopted in smaller groups therefore at local scale.

Continual Improvement is the goal; again, it is easier to narrate, i.e. achieve, a success story at the smaller local scale where civilians may face challenges of common characteristics. Hence, Local Authorities should encourage and communicate these efforts as feedback to the Central Government as well as the Educational and Scientific Institutions in order to maintain the 6-Pillar process active by renewing the political commitment, achieving a broader societal involvement and so on.

6 The L3 BoK Development and Communication Process

The initial BoK must be developed at high-level; consultation with top experts and mentors is imperative. This will allow an Educate-the-Educator/Train-the-Trainer process to create the future instructors at all educational tiers in order to achieve the knowledge transfer to all social levels in an effective way. The Central Government must also support the continual testing, reviewing and improving this BoK according to the latest developments.

7 Competency Requirements for achieving Life-Long Learning (L^3)

The Central Government should develop policies that distinguish between the BoK context that leads to qualification of the acquired knowledge and the BoK context that leads to certification of the acquired skills. Qualification is provided at the education level while certification is provided at the competence level.

Most strategic approaches include in their Strategic Planning either the educational aspect or the competence aspect or maybe both by they are very rarely interlinked. In order to create a Social Culture the State Structures must develop a cohesive strategy that includes all educational levels and continues throughout the entire life of the individual. This plan is not ambitious; wireless communications technology was introduced in the 1990's and within less than 25 years the population from as early as the kindergarten has familiarized themselves with the use of cell phones or the internet for example. The problem discussed now is that the abundance of the available knowledge leads to inflation which diminishes the added value; that is why the learning process must be controlled and critical thinking must be developed in parallel as described in Pillar 4.

When developing a L^3 Strategic Plan, one must take into account that all Social Groups must be involved as described in Pillar 2. However, not all social groups need to have the same level of information hence education and training; the L^3 Strategic Plan defines the minimum levels of education and training depending on the role-play of each social group.

The proposed L^3 Strategy defines four information *aptitude (education/ training) levels*:

- High to be acquired at higher education (Universities, Institutes of Technology)
- Good to be acquired at College or equivalent
- Average to be acquired at high school
- Basic to be acquired at primary school

The *BoK context* has to address the following thematic units:

- Legal knowledge
- Technical knowledge
- Managerial skills
- Leadership skills
- Communication skills
- Disciplinary mentality
- Management tools

The above units must be assigned to the *various involvement societal groups* that will undertake the role-play, which are:

- Mentors/ Educators
- Trainers/ Scientists
- Civil Authorities/ Group leaders
- Civilian Volunteers
- Social Workers/ Group Leaders
- Civilians at large

The relationship of the above is depicted in Figure 3 below:

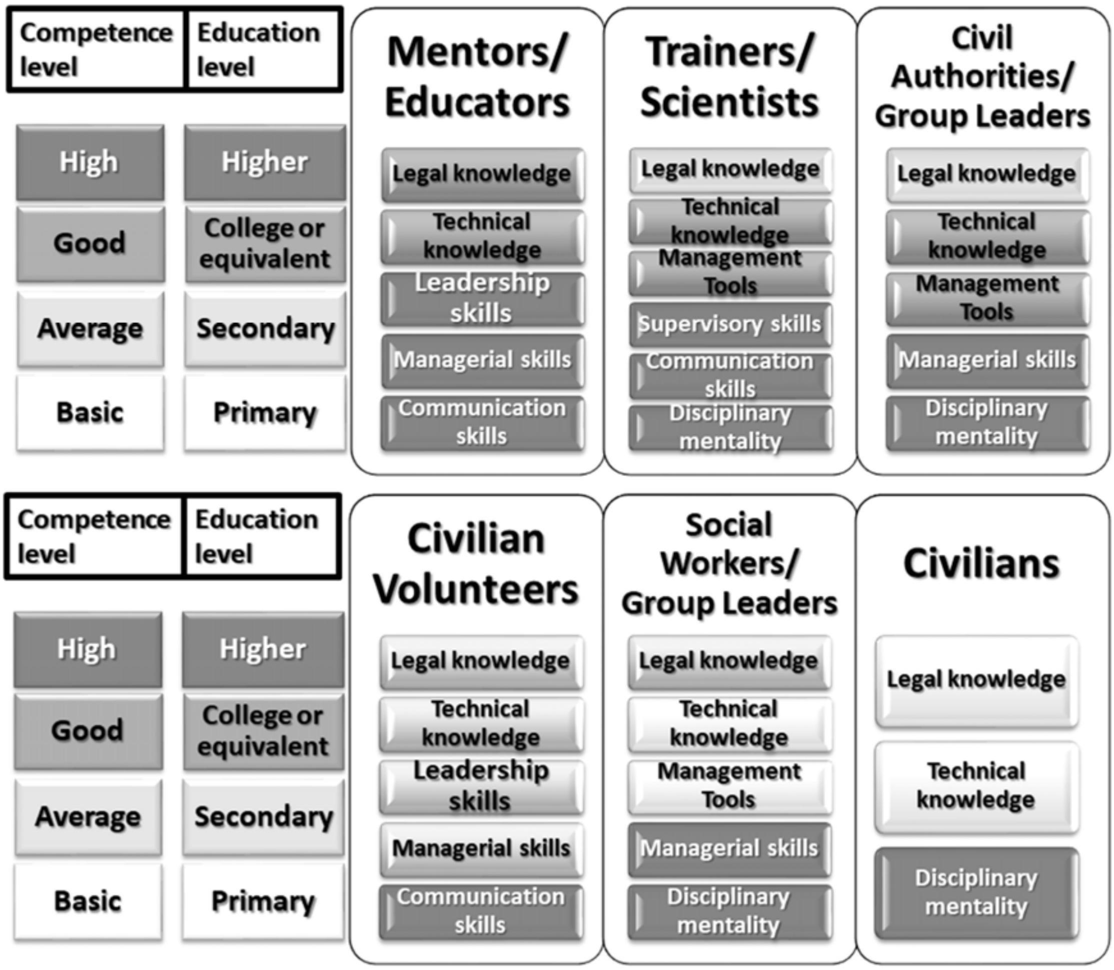

Figure 3: Body Of Knowledge (BoK) competence requirements at a Social level; the relationships between the aptitude (competence/ education) levels, the BoK context and various involvement societal groups is exhibited according to the L^3 Strategy

In order to be more specific regarding the duration that will determine the required resources, the L^3 Strategic Plan proposes the following scheme.

1. Education Level for knowledge acquisition
   1.1. Primary education: 144 hours
   1.2. Secondary education: 144 hours
   1.3. College or equivalent: 220 hours
   1.4. Higher education: 400 hours towards Qualification
2. Training Level for skills acquisition towards Certification with a 3-year validity span
   2.1. Basic: 70 hours
   2.2. Average: 140 hours
   2.3. Good: 210 hours
   2.4. High: 280 hours

Irrespective of the qualification which could be of life-long validity, the Certification must be compulsory and with limited validity over time to allow for all Social Group Members to update their know-how on the latest developments. Of course, qualification must be necessary to belong in the group of mentors, educators, trainers and scientists while the rest of the group members should bear certification in order to be able to participate in the rest of the groups save the civilians.

8 The 7-step Roadmap to Creating a Social Preparedness Culture

Once the infrastructure is in place, a 7-step Roadmap can be designed to measure progress against the goal, each step serving as a milestone.

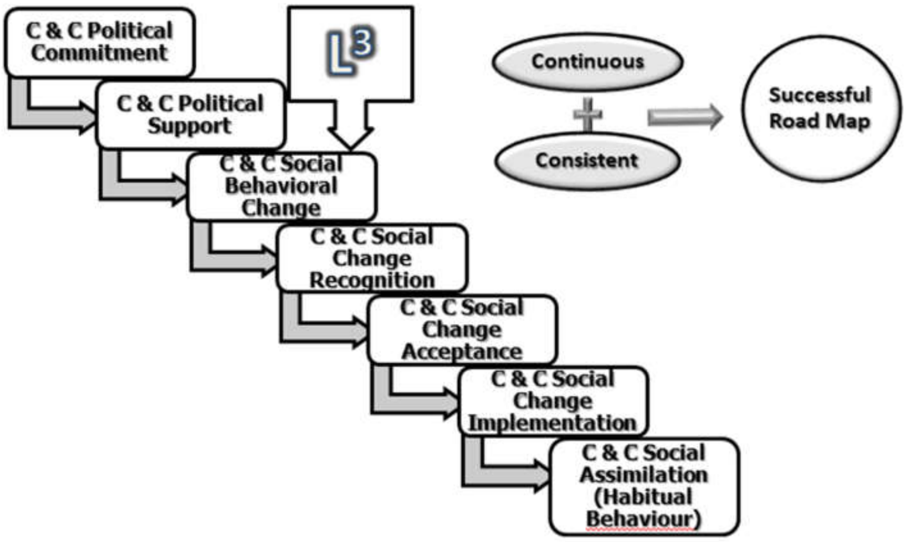

Figure 4: The 7-step Roadmap with clearly identifiable milestones; the L^3 Strategy is intervenes after political commitment and support is assured, the success thereon depending on the continuous and consistent (C&C) implementation

For the Roadmap to be successful and not an endless wish-list, continuity and consistency (C&C) must be present at each step as a prerequisite; also, as shown in Figure 4 above the L^3 Strategy is introduced only after the political parameter is assured as the learning process must not have political orientation as it addresses all civilians. If the policy makers (Central & Local Authorities) provide the resources to create and support reliable knowledge providers (Schools, Colleges Universities & Training Institutions, Steps 1-2), then the learning process will spread in the society and bring a broader behavioral change (Step 3) that will gradually be widely recognized (Step 4) and accepted (Step 5) as a necessity since the benefits will become apparent. Subsequently, the society will embed this new behavior in its social behavioral patterns by expanding the implementation (Step 6); this will result in gradual social behavioral assimilation, a social behavior that will be recognized as characteristic of the social environment. This habitual behavior is characterized by high automation driven by high quality education and training. At this stage the social culture has moved to a new cognitive level.

9 Conclusions

To minimize the impact of catastrophic consequences, defined as extensive life and asset loss, when crises occur, societies must react fast and synchronized to face the main crises characteristics of uncertainty and time, the first being an unequivocal fact and the latter an unbeatable parameter. The only barrier standing tall is a collective fast reaction at a social scale, which can only be achieved by adopting a Life Long Learning (L^3) Strategy at a Social Level embedded in a preventive time-frame in order to create the societal culture that, in time of crisis, will in turn activate a collective behavioral response in a timely and effective manner to achieve loss minimization.

In the era of continuous change of the sociotechnological environment in which new risks appear and develop into crises faster than ever, the society's only defense, the human brain has to adapt to raise the survival stakes. More specifically, the brain's naturally slow learning process and individual perception has to be enhanced by the knowledge of how to respond effectively and collectively to crises management in a strategic framework through education at first, to acquire the knowledge, and life-long-learning later, to acquire the skills and maintain the initial knowledge thus resisting generational memory loss.

This, in turn, means that the policy makers have to work together with scientists and educators to develop a Life Long Learning strategic planning that must introduce the necessary knowledge to all educational levels; such a scheme is presented in this paper and could serve as a milestone for further development and adaptation depending on the societal individual needs. The key to success is the fact that total societal structure involvement is imperative.

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BUILDING DAMAGE INDUCED BY THE SEPTEMBER 2017 MEXICO EARTHQUAKES AND FACTORS CONTROLLING THEIR DISTRIBUTION

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Abstract

On September 7, 2017, an M 8.2 earthquake struck Southern Mexico with epicenter located offshore in Tehuantepec Gulf, almost 750 km southeast of Mexico City. It caused 98 fatalities. On September 19, 2017, an M 7.1 earthquake struck Central Mexico with epicenter determined onshore, about 130 km south of Mexico City. This earthquake claimed the life of 370 people in Central Mexico. The dominant building types are reinforced concrete (R/C) buildings with R/C frame and infill-partition walls, masonry structures with masonry load-bearing walls, adobe structures and mixed types. The first earthquake caused damage to Chiapas and Oaxaca states (Southern Mexico). All the aforementioned building types suffered damage varying from negligible to slight non-structural damage comprising hair-line cracks in very few walls and fall of small plaster pieces to heavy structural damage including partial or total collapse. The second earthquake caused damage to Mexico City and Puebla and Morelos states (Central Mexico). About 40 buildings collapsed in Mexico City, while hundreds of others suffered considerable non-structural and structural damage forcing residents to evacuate. Damage is attributed to the violent and prolonged shaking due to extreme amplification of seismic waves and the duration of intense ground motion within the Mexico basin, the differential settlement of buildings under the earthquake loads, the building pounding, the effect of the horizontal component of the earthquake ground motion especially in Mexico City and the effect of the vertical component in the majority of the affected areas in Puebla and Morelos states.

Keywords: Mexico, earthquakes, building damage, adobe,

1. Introduction

Mexico is located in the south part of North America and from the geotectonic point of view in the east of the Central Mexico Subduction Zone, where the Cocos plate subducts under the North American Plate (Fig. 1) resulting in large subduction thrust earthquakes with moment magnitude up to Mw 8.0 every 40-60 years. Mexico is affected not only by interplate seismic events along the Central Mexico Subduction Zone, but also by intraslab earthquakes in the subducting Cocos plate, and crustal earthquakes along the Mexican volcanic belt (Fig. 1).

The interplate earthquakes rupture Cocos - North American plate interface along the Pacific coast of Mexico. The faulting occurs on a low-angle thrust plane at a relatively shallow depth of about 15-25 km. The intraslab earthquakes are generated in the Central Mexico. The faulting occurs at a depth of ~40-80 km and indicate normal faulting.

Mexico City is also affected from earthquakes having different origin. There exist four types based on Rosenblueth et al. (1989): (1) local earthquakes; (2) continental plate earthquakes; (3) intermediate depth earthquakes and (4) subduction earthquakes. The subduction earthquakes occur at distances of more than 300 km from the city, while the intraslab earthquakes at distances close to 150 km from the city (Fig. 1). It has been observed that the normal-faulting and subduction earthquakes are the most dangerous events for Mexico City.

A characteristic example of a subduction earthquake is the September 19, 1985 Mw 8.0 Michoacán event. It caused unprecedented damage to the building stock of Mexico City with more than 4000 buildings suffering very heavy structural damage including total or partial collapse and consequently more than 10000 human losses. Based on statistical analysis of the 1985 earthquake, it is concluded that damage distribution was not random (Booth et al. 1986; Butcher et al. 1988; Iglesias et al. 1988; Iglesias 1989). The distribution was strongly related to the distribution of the lacustrine sediments of the Mexico basin and the height of the damaged structures (Booth et al. 1986; Butcher et al. 1988; Iglesias et al. 1988; Iglesias 1989). More specifically, high-rise buildings with 7-12 storeys founded on lacustrine sediments of the affected basin suffered very heavy structural damage, in contrast to low-rise buildings that suffered lighter structural or heavy non-structural damage.

The last destructive geodynamic episodes in the evolution of Mexico occurred during September 2017. On September 7, 2017, an M 8.2 earthquake struck Southern Mexico with epicenter located offshore in Tehuantepec Gulf, almost 750 km southeast of Mexico City. On September 19, 2017, an M 7.1 earthquake struck Central Mexico with epicenter determined onshore, about 130 km south of Mexico City. This earthquake claimed the life of 370 people in Central Mexico.

The aim of this paper is to present the building damage induced by the September 2017 earthquakes and observed by the authors during a field survey in the affected areas of Mexico shortly after the generation of the earthquakes. Moreover, the factors controlling building damage distribution along with the geological setting of Mexico basin and the dominant building types of the affected areas are also discussed.

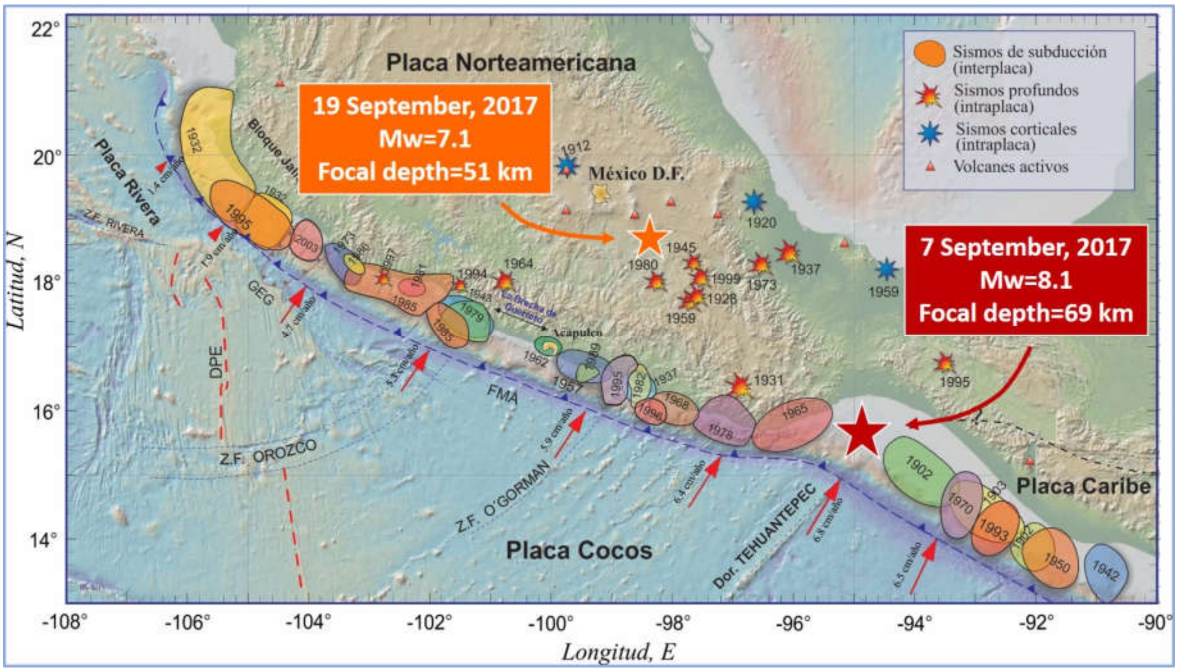


Figure 1: The Central Mexico Subduction Zone, where the Cocos plate subducts under the North American plate, along with interplate historical and recent earthquakes and its seismic gaps. The intraslab earthquakes within the subducting Cocos plate and the crustal earthquakes along the Mexican volcanic belt are also illustrated. The epicenters of the September 2018 Mexico earthquakes are also illustrated (modified from http://usuarios.geofisica.unam.mx/vladimir/images/EQ_map_2013_es_clear.jpg).

2. Geological setting of Mexico basin, amplification of the seismic motion and aggravation of earthquake-induced damage

The Mexico basin is a closed, ellipsoidal basin, having a major axis measuring about 100 km from the Sierra de Pachuca to the north, to the Sierra de Chichinautzin to the south (Fig. 2). The minor axis has a length of 80 km measured from the Sierra de Las Cruces to the west, to the snow covered peaks of Iztaccihuatl on the east. The mountain ranges that bound the Mexico basin are of volcanic origin, have chemical composition from intermediate to basic and have ages that vary from Middle Oligocene to recent (Juárez-Camarena et al. 2016) (Fig. 2). The central part of the area consists of lacustrine soft clay deposits (Ql), which are surrounded by alluvial deposits (Qal) that also extend below the lacustrine deposits (Fig. 2). More specifically, Mexico basin is divided into three main zones: (Zone I) the Hill Zone, where tuffs dominated; (Zone II) the Transition Zone, formed by alluvial fans at the base of the hills; and (Zone III) the Lake Zone, corresponding to the soft lake beds (Fig. 2).

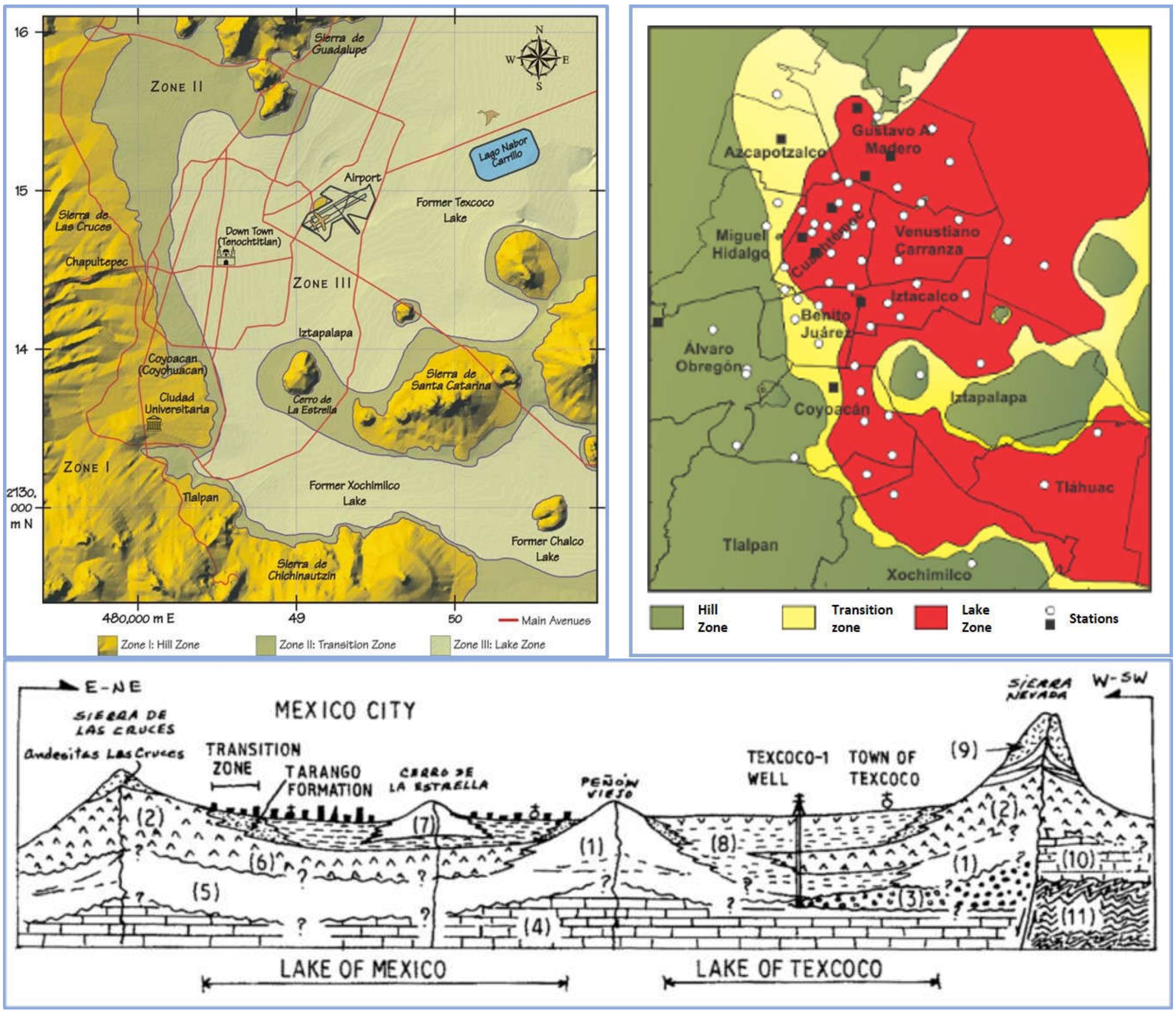


Figure 2: (up left) Mexico basin bounded by mountain ranges of volcanic origin and age from Middle Oligocene to recent (from Flores-Estrella et al. 2007). (up right) Mexico basin is divided into three main zones (modified from Marsal and Mazari 1959). (down) Schematic geologic section through Mexico basin. 1: Oligocene-Miocene; 2: Miocene-Pliocene; 3: Texcoco conglomerate; 4: Cretacic limestone; 5: Latites, dacites, andesites and basaltic andesites; 6: Tufas, lavas and pyroclastic flows, mainly of andesitic composition; 7: Tufas; 8: Lacustine sediments and evaporates; 9: Andesites and dacites from the Iztaccihuatl volcano; 10: Cretacic limestones; 11: Schists of the Acatlan group (from Sanchez 1989).

The Mexico City occupies the area of the former Lake Texcoco and settlements in the Prehispanic Mexico basin (Fig. 3), where soft lake sediments occur. The negative impact of the ancient lake deposits to the buildings is that Mexico City experiences some of the largest seismic site effects worldwide. Besides the extreme amplification of seismic waves, duration of intense ground motion from large subduction earthquakes exceeds three minutes in the lake-bed zone of the basin, where hundreds of buildings collapsed or were seriously damaged during the 1985 Mw 8.0 Michoacán earthquake. Different mechanisms contribute to the long lasting motions, such as the regional dispersion and multiple-scattering of the incoming wavefield from the coast, more than 300 km away from the city (Cruz-Atienza et al. 2016).

By means of high performance computational modeling, Cruz-Atienza et al. (2016) showed that, despite the highly dissipative basin deposits, seismic energy can propagate long distances in the deep structure of the valley, promoting also a large elongation of motion. The simulations of Cruz-Atienza et al. (2016) revealed that the seismic response of the basin is dominated by surface-waves overtones, and that this mechanism increases the duration of ground motion by more than 170% and 290% of the incoming wavefield duration at 0.5 and 0.3Hz, respectively, which are two frequencies with the largest observed amplification. This conclusion contradicts what has been previously stated from observational and modeling investigations, where the basin itself has been discarded as a preponderant factor promoting long and devastating shaking in Mexico City.

Figure 3: Mexico basin and surrounding mountain ranges. Panoramic drone view from the Mexican Federal Highway 150D (Mexico – Puebla) (From Lekkas et al. 2017).

3. The September 2017 M 8.2 Chiapas And M 7.1 Puebla-Morelos Earthquakes

On September 7 2017, at 23:49 CDT (local time; 04:49 on the 8th UTC) a great earthquake struck Mexico. Its magnitude was measured M 8.2 (UNAM, 2017) or 8.1 (USGS, 2017) and its epicenter was determined offshore Chiapas and more specifically in the Gulf of Tehuantepec, almost 750 km away from the Mexico City (Fig. 4). It has been largely felt in Mexico City and in Guatemala City located more than 350 and 1000 km away from the epicenter respectively.

Based on the focal mechanisms provided by several seismological organizations and observatories, the earthquake was generated by the activation of a NW-SE striking normal fault (Fig. 4). At the epicentral area, the oceanic floor of Cocos plate converges with the continental edge of the North America plate at a rate of about 76 mm/yr in a northeast direction. The Middle American Trench, located in a distance of about 100 km southwest from this earthquake epicenter, is a major subduction zone extending from Central Mexico to Costa Rica with a length of 2750 km and a maximum depth of 6670 m. It constitutes the boundary between the Rivera, Cocos, and Nazca plates on one side and the North America plate on the other.

Based on the epicenter location, the focal depth and the focal mechanism of the M 8.2 September 7, 2017 earthquake, it is concluded that this earthquake can be characterized as an intraplate seismic event within the subducting Cocos slab. The rupture surface is approximately 80 km along strike and 60 km along downdip direction, while the seismic moment release based upon this plane is 2.5e+28 dyne.cm (USGS, 2017).

This earthquake caused 98 fatalities, 80% of which occurred in Oaxaca and 800000 in need of humanitarian aid in Oaxaca and Chiapas. In Guatemala, 44000 people were affected and 5835 people were displaced based on the reports of the United Nations Office for the Coordination of Humanitarian Affairs (UNOCHA, 2017).

As regards the earthquake environmental effects, this earthquake caused the generation of tsunami waves of 1.75 m above tide level resulting in issue of tsunami alerts for the surrounding coastal areas.

Twelve days after the generation of the M 8.2 Chiapas earthquake, another major earthquake struck Mexico. On September 19, 2017, at 13:14 CDT (local time; 18:14 UTC) an M 7.1 earthquake struck the central part of the country. Its epicenter was determined onshore, about 55 km south of Puebla City and 130 km south of Mexico City (Fig. 4). Unfortunately, the earthquake claimed the life of 370 people in Central Mexico due to building collapse attributed to violent and prolonged shaking, while 6011 were injured due to building collapse and falling debris. Very heavy structural damage and maximum intensities were observed in the Greater Mexico City area and in the Mexican states of Puebla and Morelos. As regards Mexico City, more than 40 buildings suffered heavy structural damage including total or near total collapse resulting in 228 fatalities.

Based on the focal mechanisms provided by several seismological organizations and observatories, the earthquake was resulted by normal faulting at a depth of 50 km (Fig. 4). It is also considered as an intraplate seismic event within the subducting Cocos slab.

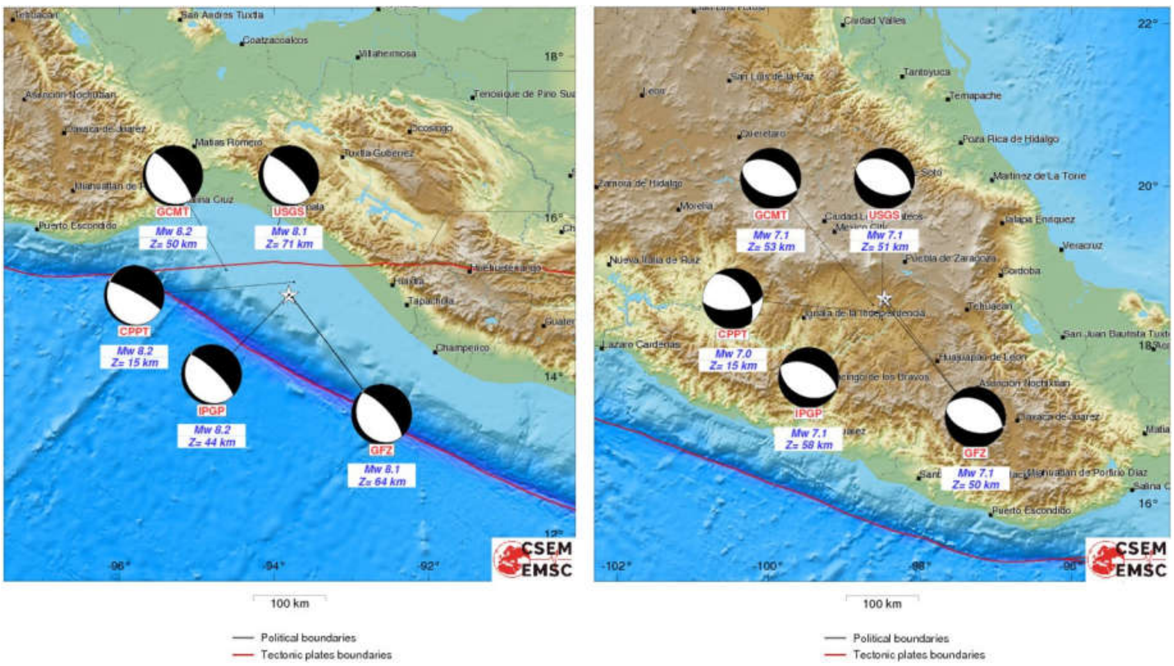


Figure 4: Epicenters, focal depths and focal mechanisms for the September 7 (left) and the September 19 (right) 2017 Mexico earthquakes provided by several seismological observatories and institutes (USGS, GCMT, CPPT, IPGP, GFZ).

As far as the induced environmental effects is concerned, the earthquake triggered the eruption of the Popocatépetl volcano. The volcano burst into life sending a large plume of smoke into the sky. Based on local authorities, a church collapsed resulting in 15 fatalities in Atzitzihuacán on the slopes of the volcano. Earthquake-induced landslides were also generated in El Jale, Ixtapaluca, Mexico City. Moreover, anomalous river waves were observed in a canal of Xochimilco River close to Mexico City, which was turned into a frothing torrent as the September 19, 2017 M 7.1 earthquake hit.

The M 7.1 earthquake coincidentally occurred on the 32nd anniversary of the September 19, 1985 Mexico City earthquake that claimed the life of thousands of people and occurred as a result of thrust faulting on the plate interface between Cocos and North America plates located at a distance of 450 km to the west of the September 19 2017 earthquake epicenter. The 1985 Mexico earthquake disaster led to changes in building codes and enhanced emergency preparation measures, including the annual nationwide drills. This seismic event was commemorated and a nationwide earthquake drill was held with more than 7 million people participating, at 11 a.m. local time, just two hours before the 2017 earthquake. Millions of employees from various official entities and private companies, students from colleges and universities participated to this drill and more than 17000 buildings were successfully evacuated.

4. Dominant building types in Mexico City and the surrounding areas affected by the 2017 September earthquakes

Few days after the earthquake, members from the Faculty of Dynamic Tectonic Applied Geology of the Department of Geology and Geoenvironment of the National and Kapodistrian University of Athens visited Central Mexico in order to conduct a geological reconnaissance and a field macroseismic survey in the earthquake-affected areas of Mexico.

Based on field observations, it is concluded that the dominant types of buildings in the affected area of Central Mexico are: (a) reinforced concrete (R/C) buildings with R/C frame and infill-partition walls (Fig. 5, 6, 7), (b) adobe structures (Fig. 8) and (c) mixed types of buildings (Fig. 9).

The R/C buildings constitute the majority of structures in the affected area of Mexico City and are classified into:

(a) 1-6 storey buildings with R/C frame members with non-ductile detailing and unreinforced masonry plain infill of bricks, clay tiles or concrete blocks with bricks being most common,

(b) 7-12 storey buildings with R/C frame members with non-ductile detailing, reinforced single diagonal strut and unreinforced masonry infill of bricks, clay tiles or concrete blocks with bricks being most common,

(c) 7-12 storey buildings with R/C frame members with non-ductile detailing, supplementary reinforced elements (post and beam) and unreinforced masonry infill of bricks, clay tiles or concrete blocks with bricks being most common and

(d) 7-16 storey buildings with R/C frame members with non-ductile detailing, reinforced concrete diagonal bracing and unreinforced masonry infill of bricks, clay tiles or concrete blocks with bricks being most common.

It is significant to note that many structures in Mexico City have been retrofitted and reinforced mainly after the 1985 Mexico earthquake with external steel systems (external bracing of) (Fig. 6, 7). These systems offer advantages such as the ability to accommodate openings and the minimal added weight of the structure. Furthermore, the minimum disruption to the full operationality of the building is obtained. Two types of bracing systems were observed: (a) the concentric bracing system and (b) eccentric bracing system.

The masonry buildings are composed of masonry load-bearing walls that consist of bricks, clay tiles or concrete blocks. They constitute the majority of buildings in the earthquake affected Puebla and Morelos states.

The adobe structures were mainly observed in Puebla and Morelos states. Adobe (sun-dried brick) is the oldest and most common building material known to man. It is a mixture of sand, sometimes gravel, clay, water, and often straw or grass mixed together by hand, formed in wooden molds, and dried by the sun. The straw adds strength and prevents cracking.

Rammed earth (pise) is damp or moist earth, with or without an additive. It is rammed (tamped) in place between temporary moveable formworks. The best soils for rammed earth contain about 30% clay and 70% sand. The use of horizontal courses of adobe bricks prevents total detachment of rammed walls due to vertical cracks.

(a)

(b)

(c)

Figure 5: (a) Reinforced-concrete buildings with non-ductile detailing with unreinforced infill walls comprising bricks, clay tiles or concrete blocks with bricks being the most common material. (b) Pre-1985 high-rise reinforced concrete buildings in Mexico City with unreinforced brick infill walls. (c) Modern high-rise reinforced concrete buildings in Mexico City with unreinforced brick infill walls (from Lekkas et al. 2017).

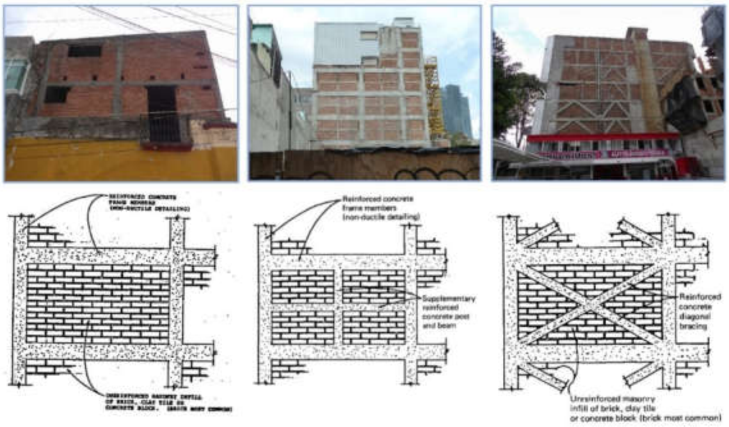
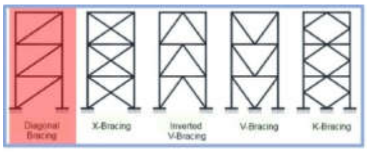


Figure 6: Typical methods for reinforcing masonry infill: diagonal cross-bracing frequently used in low-and medium-rise constructions.

Foundations play an important role in the structural behavior of adobe buildings during earthquakes. Buildings with larger and stronger foundations are less vulnerable to earthquakes. Foundations are usually made of stone rubble with mud or lime mortar. To prevent water erosion, the first few courses of a wall above the foundations (plinth) are constructed using stone rubble or fired brick and lime mortar. The height of plinth should be above the flood water line or a minimum of 35 cm above ground level. After completing the plinth, masonry a damp proof course should be installed.

Massive adobe structures in Mexico are in generally good condition because natural lime plasters that helped the adobe materials breath had remained in use, rather than cement which traps moisture causing the adobe to crumble.




(a)


(b)


(c)

Figure 7: Reinforcement of buildings comprising external steel systems in Mexico City after the September 19, 1985 M 8.1 Michoacán earthquake. There are various types of bracing frames observed such as (a) diagonal bracing, (b) x-bracing and (c) inverted v-bracing frames.

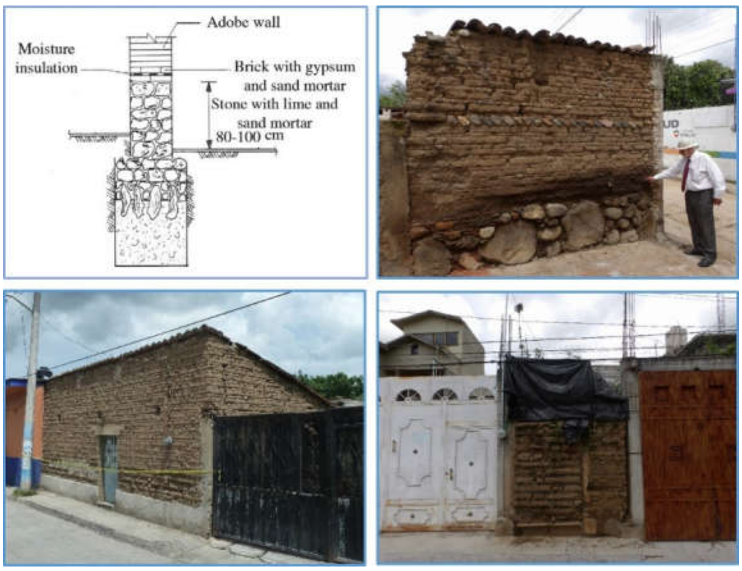


Figure 8: Details of the foundations of the adobe buildings (up left) and details of adobe structures that comprise the majority of buildings in Pueblas and Morelos states of Central Mexico.

Figure 9: Mixed types of structures observed in Puebla and Morelos states and affected by the second earthquake on September 19, 2017.

5. Building Damage Due To The September 2017 Earthquakes In Mexico City And Central Mexico

Several R/C buildings with exterior non-structural damage were observed in the Oaxaca and Chiapas states induced by the first earthquake and in the Greater Mexico City area and Puebla and Morelos states induced by the second earthquake (Figs. 10, 11). This damage comprised horizontal and subhorizontal cracks in the infill walls mainly in Oaxaca and Chiapas states induced by the first earthquake and diagonal cracks in the Greater Mexico City area caused by the second earthquake (Fig. 10, 11). Moreover, detachments of plaster pieces from the infill walls, detachment of the infill walls from the surrounding R/C frame, and partial or total collapse of infill walls as well as damage to window, parapets on balconies and ornamental molding along the roof line of older buildings induced by both earthquakes (Fig. 10, 11). The generation of horizontal and subhorizontal cracks is attributed to the prevalence of the vertical component of the earthquake ground motion, while diagonal cracks are due to the prevalence of the horizontal one.

R/C buildings in Oaxaca and Chiapas states suffered very heavy structural damage from the first earthquake (Fig. 12). The common characteristic of the inspected buildings was the decomposition of the concrete in the columns of the ground floor due to crashing resulting in failure of columns and the subsequent tilting or the vertical collapse within the plan of the ground floor, while the upper floors of the structures were left practically intact. This damage is typical of an earthquake with prevalence of the vertical component of the earthquake ground motion over the limited horizontal component (Carydis et al. 2018; Mavroulis et al. 2019). As regards the impact on the building stock of Mexico City, there was no damage reported by the first earthquake. Only some buildings were trembled forcing residents to evacuate.

R/C buildings in the Greater Mexico City area and in Puebla and Morelos States suffered structural damage from the second earthquake ranging from light to very heavy. Immediately after the event, the Mexican government reporting to public media indicated 9722 affected buildings with 1632 of them suffering total or partial collapse, 279 schools in need of repairs and 17 hospitals in poor condition. Based on the spatial distribution of the 38 totally collapsed buildings in the city (Mayoral et al. 2017; based on data from CICM, 2017), it is concluded that they were concentrated in the western and southwestern part of the transition zone (zone II, dominant site period ~1 s) and in the lake zones (IIIa and IIIb, dominant site period ~2 s) (Fig. 13). In comparison with the distribution of damage induced by the 1985 Mw 8.0 Michoacán event, the majority of the collapses occurred in the softest lake bed sediments in the zones IIIb/IIIc (dominant site period ~2 s) (Booth et al. 1986; Butcher et al. 1988; Iglesias et al. 1988; Iglesias 1989). Based on the detected distribution, it is concluded that site effects must have played an important role in determining the damaged zones within the Mexico City from the September 19, 2017 earthquake. Moreover, the total collapses induced by the second September 2018 earthquake were observed in buildings that appeared to have structural deficiencies including soft stories, structural irregularities, and discontinuous or incomplete lateral load paths (Fig. 14).

The most common structural damage to the RC buildings in the Greater Mexico City area was mainly attributed to differential settlement (Fig. 15) and the subsequent foundation movement and to building pounding (Fig. 16). Buildings affected from these phenomena were still standing after the earthquake. They either tilted due to differential settlement (Fig. 15) or suffered heavy damage due to pounding (Fig. 16).

The adobe buildings suffered non-structural and structural damage by both September 2017 earthquakes. The non-structural damage generally comprised detachment of plaster from and light cracking of the walls (Fig. 17). In Oaxaca and Chiapas states affected by the first earthquake, the structural damage to the adobe and masonry buildings comprised extended cracks in the load-bearing walls and partial or total collapse of the walls. The presence of horizontal or subhorizontal cracks in the majority of the observed structures, damage in the upper part of the structures, the symmetrical distribution of damage in the upper corners of the structures as well as the partial collapse with the still standing part left intact by the earthquake (Fig. 17) are damage indicative of the prevalence of the vertical component of the earthquake ground motion over the horizontal one (Carydis et al. 2018; Mavroulis et al. 2019). In Puebla and Morelos states affected by the second earthquake, similar structural damage were also observed (Fig. 18).

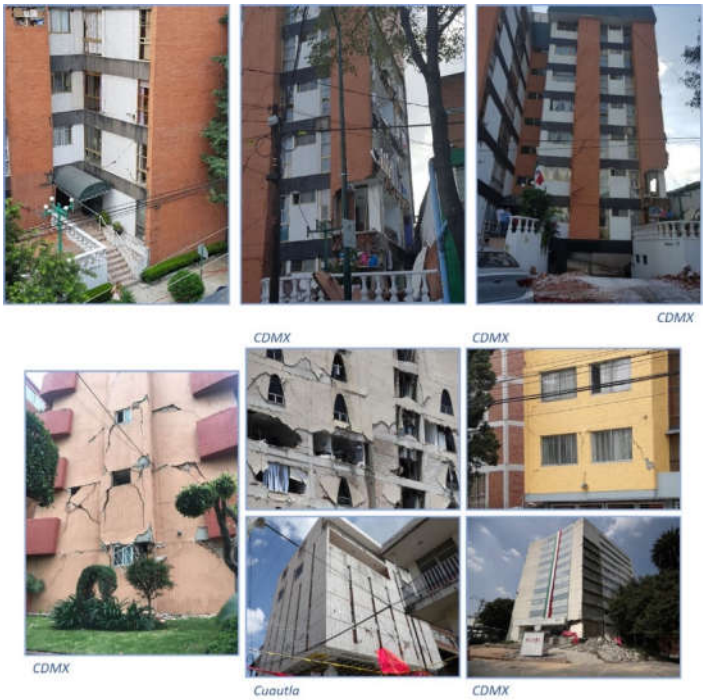
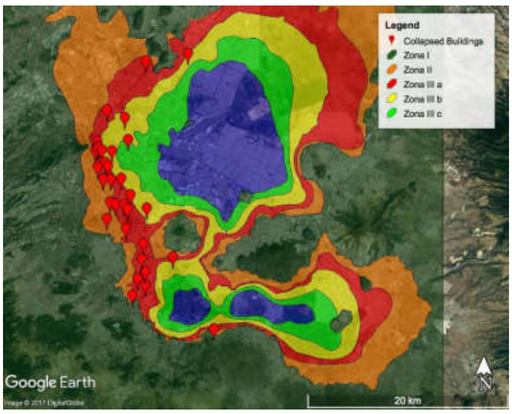


Figure 10: Non-structural damage in RC buildings in Mexico City (Ciudad de México: CDMX) and Cuautla (Morelos State) (From Lekkas et al., 2017).

Figure 11: Non-structural damage to R/C and mixed type buildings in the affected area due to the September 19, 2017 M 7.1 Puebla-Morelos earthquake. Cracks in the infill walls and detachment of pieces of plaster from the infill walls.

Figure 12: R/C buildings in Oaxaca State with damage induced by the September 7, 2017 earthquake.



Zone	Number of buildings		
	Collapsed	High Risk	Security Uncertain
I	2	4	2
II	9	45	52
IIIa	15	110	58
IIIb	12	140	125
IIIc	-	36	32
IIId	-	5	1
Total	38	340	273

Figure 13: Collapsed buildings as included in the CICM database as of October 24, 2017 overlaid with geo-zones in Google Earth (Mayoral et al. 2017, based on data from CICM 2017).

Figure 14: Very heavy structural damage (total collapse) of buildings in the Greater Mexico City area induced by the second earthquake in September 2018.

Figure 15: Tilting of buildings in Mexico City due to the September 19, 2017 earthquake and the related differential displacement affecting the building foundation (from Lekkas et al. 2017). The structural components of the building were generally undamaged.

Figure 16: Damage induced by pounding between closely spaced buildings due to the September 19, 2017 earthquake (from Lekkas et al. 2017).

6. Conclusions

Based on the field survey conducted by the authors in the September 2017 earthquake-affected areas of Mexico City and the Chiapas, Oaxaca, Puebla and Morelos states, the following conclusions can be drawn:

The September 7, 2017 M 8.2 Chiapas earthquake caused damage to the building stock of the Chiapas and Oaxaca states in southern Mexico. All types of the aforementioned buildings suffered damage varying from negligible to slight non-structural damage comprising hair-line cracks in very few walls and fall of small pieces of plaster to heavy structural damage including total or near total collapse.

The September 19, 2017 M 7.1 Puebla-Morelos earthquake caused damage to the buildings of Mexico City and the states of Puebla and Morelos in Central Mexico. 38 buildings collapsed in Mexico City, while hundreds of others suffered considerable non-structural and structural damage forcing residents to evacuate.

Damage are attributed to the prevalence of the vertical component in Chiapas and Oaxaca states, the violent and prolonged shaking due to extreme amplification of seismic waves, the duration of intense ground motion within the Mexico basin, the differential settlement of the lake sediments under the earthquake loads, the building pounding, the prevalence of the horizontal component of the earthquake ground motion especially in Mexico City, the prevalence of the vertical component in the majority of the affected areas in Puebla and Morelos states.

The damage induced by the second earthquake was extremely concentrated and focused in specific areas. The damaged buildings were concrete frame structures with masonry infill, which is the dominant building type in Mexico City and especially in these constructed prior to 1985, with mid-height and 4 to 8 stories. Many of them were non-ductile structures and characterized by structural deficiencies and irregularities.

Figure 17: Non-structural and structural damage induced by the first earthquake on September 7, 2017 to the adobe and masonry buildings in Oaxaca and Chiapas states (from Lekkas et al. 2017).

Figure 18: Non-structural and structural damage induced by the second earthquake on September 19, 2017 to the adobe and masonry buildings in Puebla and Morelos states (from Lekkas et al. 2017).

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"PLAY AND LEARN ABOUT NATURAL DISASTERS": AN IMPLEMENTATION OF A RESILIENCE ENHANCEMENT PSYCHOEDUCATIONAL PROGRAM IN VULNERABLE CHILDREN

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Abstract

The purpose of this project is to investigate the relationship between socioeconomic status and resilience in the face of risk, the prior knowledge and perceptions about natural disasters of vulnerable children and how they can tackle a bad event, like a natural disaster. The researching question is how vulnerable children from various socioeconomic background react in a risk situation, and what their perceptions about their impacts in their resilience are. Taking into consideration their socioeconomic background, these children feel insecurity and fear, due to the limited access to information and to their socioeconomic districts. The children learn about natural disasters in a game-based and interactive context through multi- modal and psychoeducational methods. The implementation of the project took place in the Daily Care Center "A hug for children" of the Volunteer Organization "Keletron Love for Children" in Kastoria and lasted for 6 weeks. 15 students, aged 6- 12, from vulnerable familiesparticipated in this project. Through 10 interventions the students learned about natural disasters, how to tackle a risk situation through experimental games, they developed their problem-solving skills and their citizenship awareness. Findings suggest that vulnerable children need intervention programmes to enhance resilience, and learn to cope with risk conditions.

Key words: resilience, natural disasters, socioeconomic background, vulnerable children

1. Introduction

Resilience is a new upcoming term in psychology field, which becomes more and more popular and widespread, raising the interest of researchers to investigate more the factors which affect people's resilience. The emergence of resilience has been a topic of interest and research from 90s (Masten, 1999). The aim of this study is to investigate if vulnerable children are resilient enough to confront and overcome natural disasters, and if a prevention psychoeducational program could develop student's resilience.

There is a variety of meanings for the term "resilience". Sometimes, it refers to the process of overcoming the negative effects of risk exposure, coping successfully with traumatic experiences, and avoiding the negative trajectories associated with risks (Fergus & Zimmerman, 2005), or otherwise, defined as "the process of, capacity for, or outcome of successful adaptation despite challenging or threatening circumstances" (Masten, Best & Garmezy, 1990, page 426). Other researchers define the term of resilience as "*a dynamic process encompassing positive adaptation within the context of significant adversity"* (Luthar, Cicchetti & Becjer, 2000). High exposure to adversity and risk circumstances and positive adaption of the negative effects, are the two acquired conditions to define resilience as a process (Masten, Best & Garmezy, 1990). Fergus and Zimmerman (2005) clarified that positive adjustment is a "resilience outcome", and resilience is the process of getting over the threat or risk.

Masten and Coastworth (1998) define resilience as "the manifested competence in a context of significant challenges to adaption or development", and there are two required judgments in order to identify resilience: first, if the individual have experienced a risk situation with significant threats, and individual has been exposed to a serious adversity, and second, the positive and quantitative adaption or development at the following phase.

1.1 Models of resilience

According to Masten and Powell (2003) there are three models of resilience:

-Compensatory model is a process in which promotive factors counteract exposure to risk through an opposite, direct, and independent effect on outcomes (Model 1, Figure 1).

-Protective model: A process in which promotive factors moderate the negative effects of risks for predicting negative outcomes. In this case, protective factors neutralize the negative impacts of risks or threats (Fergus & Zimmerman, 2005), (Model 2, Figure 1).

-Challenge model: Operates as inoculation, with exposure to average levels of risk actually helping youths overcome subsequent exposure. Risk and protective factors are taken into consideration in order to moderate exposure (Model 5, Figure 1).

Fergus and Zimmerman (2005, p. 402) represents the three models and add other three, in an attempt to explain the correlation between risk and negative outcome (Figure 1):

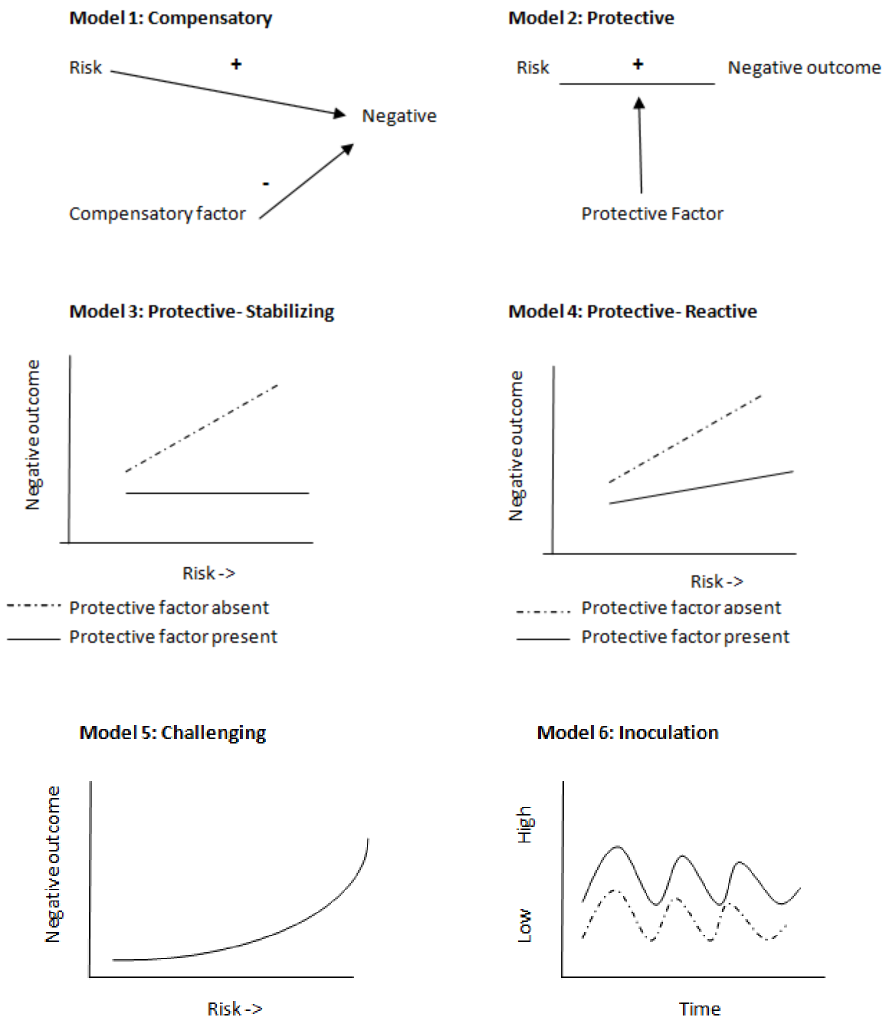

Figure 1: Models of resilience according to Fergus and Zimmerman (2005, p. 402).

Luthar et al (2000), as mentioned in Fergus and Zimmerman (2005, p. 402), refers to protective-stabilizing model (Model 3, Figure 1), where the protective factor minimizes the risk or the threat, and protective-reactive model (Model 4, Figure 1), where the protective factor is not present, but exists.

1.2 Risk factors

Risk factors are these which have negative impacts and operate as threatened influencers (Waller, 2001). According to many researches, poverty, traumatic events, community violence, low commitment to school and poor parental supervision are important risk factors. A risk factor can be defined as "a characteristic at the biological, psychological, family, community, or cultural level that precedes and is associated with a higher likelihood of problem outcomes (O'Connell, Boat, & Warner, 2009). Children experiencing two risk factors were four times as likely to develop emotional and behavioural disorders compared to children not exposed to any risk factor or who were exposed to only one (Rutter, 1987).

1.3 Protective factors

Many researchers use the term "protective" in order to describe the ameliorative effects on individual resilience (Luthar, Cicchetti, & Becker, 2000), which are external to child (Fleming, & Ledogar, 2008). According to Sadler (2001) there are three protective resources, moderating the effects of adversities. Firstly, individual qualities as self -esteem, problem - solving skills enhance resilience. Secondly, family also operate as a protective factor, if the family members are supportive, and thirdly, the community and other social structures as schools also can be preventable to adverse outcomes. Waller (2001, p 292) based one other researcher gather protective factors in one table:

Table 1

PROTECTIVE FACTORS ACROSS ECOSYSTEMIC LEVELS

INDIVIDUAL FACTORS	**FAMILY FACTORS**	**EFFECTIVE Curricula/ learning/ counselling**
Active, easy, outgoing temperament	Competent parents	Focus on instilling self- esteem, personal responsibility, goal setting, clear communication, problem- solving
Reflectiveness	Model competent behaviour	Collaboration between family & school
Positive responsiveness to others	-Provide access to knowledge	Free lunches
Appealing to adults	-Resilience	Mentoring initiatives
Sense of humour	-Self efficacy	Rites of passage programs
High intelligence	-Authoritative parenting style	Sense of community
Problem solving skills	-Interpersonal warmth	Community well- being, stability, cohesiveness
Emotional regulation	-Noncritical	Availability of prosocial role models, norms, values
Verbal / communication skills	-Value children' s accomplishments	Supportive friends, neighbours
Realistic appraisal of the environment	-High but realistic expectations of child	Employment opportunities
Self-efficacy	Educational attainment	Opportunities for belonging & meaningful involvement in prosocial school, sports, religious, community activities

Self-worth	Reading to children	Well- delineated community
Hopefulness	Involved in schools	**CULTURE/ ETHNIC IDENTITY**
Recognized talents	Connections to other competent adults	Strong, positive ethnic identity
Trust on people as resources	Family cohesion	Resistance to oppression/ ethnic activism
Social skills	Socioeconomic advantages	Identification traditional beliefs/ values
Competence in normative roles	Religious faith/ affiliation/ participation	Participation in traditional practices
Empathy	Marital harmony	Racial/ ethnic socialization
Self- confidence	Children have family/ household duties	
Strong, positive ethnic identity	**COMMYNITY FACTORS**	
Faith/ religious affiliation	Adequate resources for children care, nutrition, health care	
Religious participation	Good schools	
Educational aspirations / school commitment	Clear rules	
Sense of direction or purpose		

Table 1: Protective Factors across Ecosystemic Levels according to Waller (2001, p. 292)

1.4 Resilience and children

Many researchers focused on "resilient children" and make efforts to identify those factors which differentiate children. The resilient children often are described as "hardy", "invulnerable" or "superkids" (The results show that personal qualities as self- esteem and autonomy maybe reinforce children's' resilience, but also external factors are responsible for high resilience. According to Masten and Garmezy (1985) there are three factors connected with the development of resilience: first, the personality of the children, second, family's perspective and third the aspects of their social environment.

Masten and Coatsworth (1998) gather the characteristics of resilient children and adolescents, which are presenting in the following table 2.

According these findings, it is obvious that these three sources mentioned above are determinative for children's resilience development. Children do not acquire from birth abilities and competencies in order to confront a threat or a risk, but they develop these abilities through human development (Masten & Coatsworth, 1998).

2. The project "Play and learn about natural disasters": an implementation of a resilience enhancement psychoeducational program in vulnerable children"

The aim of this project is students to a) develop resilience b) develop cognitive skills and their knowledge about natural disasters c) tackle a risk situation like a natural disaster. Many researchers showed that prior knowledge about natural disasters is correlated with preparedness for natural disasters, minimize the damage and improve individual' s resilience (Ozmen, 2006; Muttarak & Pothisiri, 2013; Cvetković, Dragićević, Petrović, Mijalković, Jakovljević & Gačić, 2015).

Table 2

Characteristics of Resilient Children and Adolescents

Source	Characteristic
Individual	Good intellectual functioning
	Appealing, sociable, easygoing disposition
	Self-efficacy, self-confidence, high self-esteem
	Talents
	Faith
Family	Close relationship to caring parent figure
	Authoritative parenting: warmth, structure, high expectations s
	Socioeconomic advantages
	Connections to extended supportive family network
Extra familial context	Bonds to prosocial adults outside the family
	Connections to prosocial organizations
	Attending effective schools

Table 2: Characteristics of resilient children and adolescents

The implementation of this project took place in the Daily Care Center "A hug for Children" of the Volunteer Organization "Keletron Love for Children". Fifteen students aged 6 to 12 years old from vulnerable families participated in this project, which lasted 6 weeks.

2.1 Students profile

Students belong on vulnerable children are generally described who are at higher risk of missing out on schooling, living in households with less food security, suffer anxiety and depression. Specifically, in this research 67% of parents are 36-45 years old and they completed only the primary. Also, 56% of parents have 2 children and 27% are single parents. The students in their free time spending time with their friends and they have not any other interests.

2.2 Materials and Method

The materials of this project are articles, games, problem-solving activities, cooperative activities videos and anti- stress activities. The project includes 11 thematic units: 6 units about Natural Disasters (Earthquakes, Floods, Volcano Eruption, Landslides, Extreme Weather Conditions, Climate Change), 1 Unit about Problem Solving Steps, 1 Unit about Social Skills and Feelings, 1 Unit about Positive and Non-Positive Thoughts, and 1 Unit which called "Learning to Relax".

The project took place in a Task- based Context, as tasks are goal- directed activities (Van Den Branden, 2006). According to Wills (1996) task- based learning follows the above framework:

Pre- task: Introduction to the topic

At the Pre-task phase, students read an article about a natural disaster all over the world. According to Lintner (2006), "Through the use of newspapers, magazines, and the Internet, students can seek first-person narratives of a disaster's effects from the different perspectives of survivors, aid workers, media representatives, and government representatives. This activity is a powerful way to personalize human reactions to natural disasters". Studying current events in the classroom connecting students with the outside world could be very beneficial for students. Students read about floods in Thailand, fires in Greece and other natural disasters which took place all over the world.

2.3 Task Cycle:

The Task Cycle includes Worksheets, Experiments and Role play games. Three experiments about volcano eruptions, tide and greenhouse effect took place in order to help students construct their knowledge about these phenomena.

Worksheets with interactive and cooperative activities helped students to recycle their knowledge. These cooperative activities end to role play games. Role play games aim to reinforce student's knowledge, understand the reaction of an average citizen, and develop civic responsibility.

2.4 Follow up phase:

The Follow up phase includes experiential games, in which students feel like a rabbit in a fire, a boy during a flood, and other activities. Experiential learning is a powerful approach to promote students' engagement in the learning process and enhance their learning (Kolb & Kolb, 2005). Students construct their own table game about natural disasters, their volcano and other constructions. Also, they take part in relaxing activities.

3. Evaluation of the Project

Both summative and formative processes were conducted to evaluate the project.

-A pre-test and post-test were used to evaluate students' prior knowledge. The results showed that students had limited knowledge about natural disasters, but after the implementation of the project, there is a significant difference between right answers. Also, the students feel more prepared to confront a natural disaster and their fear about natural disasters has been decreased.

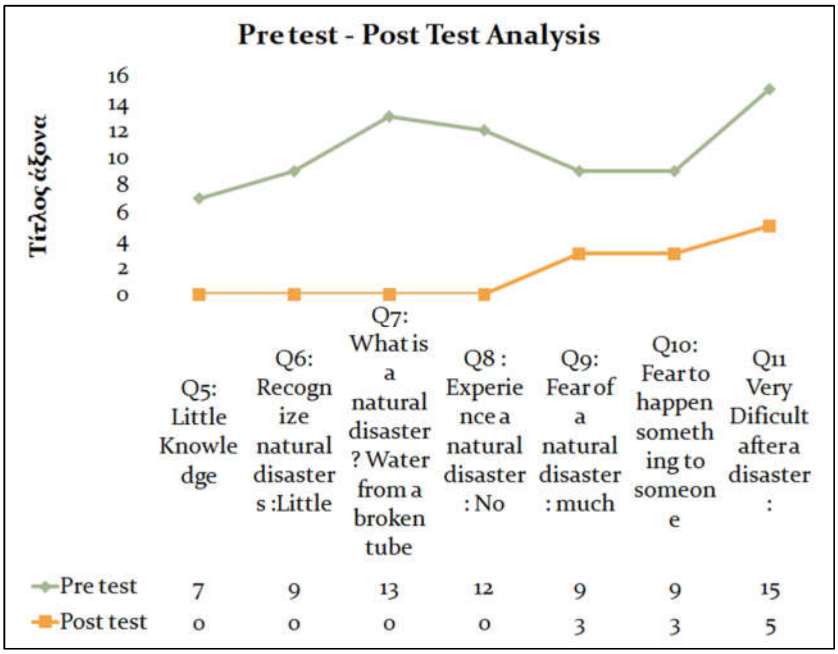

Figure 2: Pretest- Post Test Analysis

- Cognitive Emotion Regulation Questionnaire (CERQ)

This is a self-report questionnaire which is used to “measure cognitive strategies” that characterize the individual’s style of responding to stressful events (Garnefski & Kraaij, 2006). According to CERQ Questionnaire, the students after the project feel more ready to tackle an unpleasant situation, and to accept an unpleasant situation. Also, students stated that they start thinking in a more positive way.

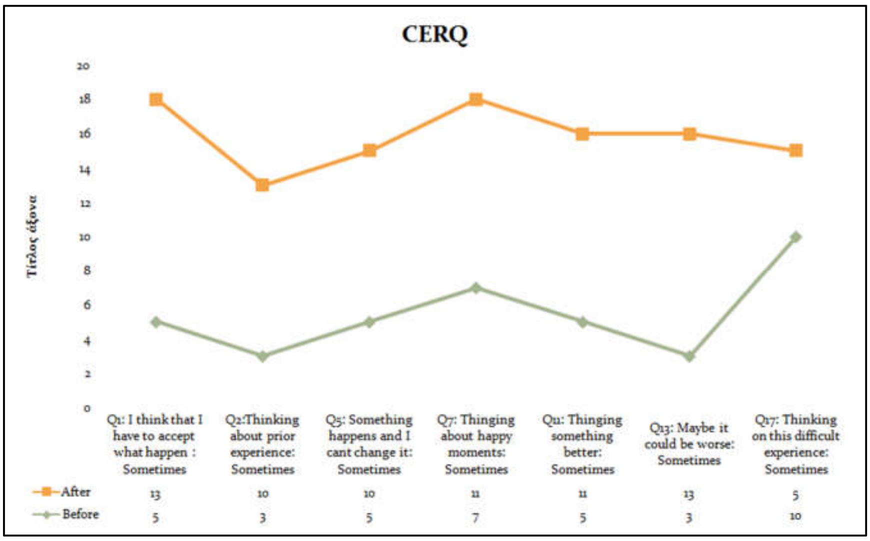

Figure 3: CERQ Analysis

The results showed significant difference between before and after the implementation of the project answers.

-Parents questionnaire

A questionnaire was constructed to collect information from parents. The 67% of the parents are age 36-45, 60% completed the elementary education and 56% of the parents has 2 children. About natural disasters, the 90% have not experience a natural disaster, the 56% of the parents believes that has enough knowledge about natural disasters, as 40% that they can confront a natural disaster. The 40% of parents answered that has fear about losing home, 90% feel fear for losing someone of family, while the 60% feel fear for losing everything and live on the road. Although, the 40% of the parents hope to have help from community. The results also showed that the most parents have not spoken yet with their children about natural disasters.

-Satisfaction Questionnaire

A satisfaction questionnaire was constructed in order to evaluate the students’ satisfaction. The results showed that:

-95% of the students support that this project is very useful for everyone

-85% of the students stated that they want to be continued

-100% of the students want to participate in similar projects

-93% of the students stated that they earned new knowledge

These results showed that projects motivate students to learn, and a game- based context motivates them to participate.

4. Conclusion

According to researchers’ findings, there are many ways to develop children resilience, in order to be prepared to confront risks and adverse circumstances. Individual qualities as self- regulation skills (Buckner, Mezzacappa

& Beardslee, 2003), self- esteem (Byrne & Mazanov, 2001), Life Skills (Greenberg, Weissberg, O'brien, Zins, Fredericks, Resnik & Elias, 2003), could be effective in resilience development. Children from vulnerable families need to develop these skills in order to be more resilient and prepared to address a challenge in future, like a natural disaster. Also, interventions to parents and children would be useful, as parental factors are critical, and in this way, they would be both more prepared to be exposed in a risk situation (Fergus & Zimmerman, 2005). Also, it is very important to develop students’ knowledge about natural disasters. In this way, students feel more secure and also they feel the need to learn more and more (Cvetković, Dragićević, Petrović, Mijalković, Jakovljević & Gačić, 2015).

Nevertheless, given the limited number of the target population and the restricted context of conducting this project, the results cannot be regarded conclusive. New research with school interventions, parent training programmes and enriched intervention should take place, in order to have conclusive results.

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CONTRIBUTION TO LANDSLIDE HAZARD ASSESSMENT. THE CASE OF FLORINA-KASTORIA ROAD

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Abstract

Landslides pose important danger to residential areas and to infrastructures that are located very close to unstable slopes. Landslides can provoke lifeline's performance malfunction, injuries or fatalities and may diminish accessibility to critical facilities. They can be triggered by natural phenomena (earthquakes, changes in water table, rapid snowfalls or rainfalls) or by human activities.
The prediction of the exact time, location or magnitude of landslide is not feasible because of the complex synergy of geologic, geomorphology, tectonic, hydrologic conditions and soil formations. The occurrence of slope failures in the area of Vitsi nearby Drosopigi village (20km from Florina –Greece) mainly in the form of rockfalls and debris flow, as result of its mountainous terrain with the heavy snowy winters and high rain precipitation and low seismicity in the previous years, lead to further investigations. A probabilistic seismic hazard analyses was implemented taking into account three seismic scenarios with different earthquake recurrence period (50, 100, 475years). Peak Ground Acceleration (PGA) was estimated according to Ambrasey's et al (1996) attenuation relation. Rain precipitations and terrain inclination were necessary input to classify the landslide's susceptibility of the area according to Mora & Vahrson (1994) methodology for the case of 100y earthquake return period. Furthermore, landslide's hazard was estimated using HAZUS methodology for static and seismic conditions for the 3 seismic scenarios for different soil moisture conditions ("dry" and "wet").
Concluding, this study provides Civil Protection Services of the Municipality of Eastern Macedonia (Greek) with empirical first-level identification of the areas in Florinas – Kastorias roadline with "high landslide's risk" via GIS maps.

Key words:

Seismic Hazard, Florina, Landslides, HAZUS, Mora & Vahrson methodology, Roadline Risk.

1 Introduction

Landslide hazard zonation became a very valuable tool for disaster mitigation and preparedness as slope instability problems impose important threats in modern societies and promote serious socioeconomic issues. A review of landslide hazard zonation was given by Varnes (1984), emphasizing the importance of local geologic, geomorphic, hydrologic and climatic conditions. Einstein (1988) developed a determination procedure consisting of five different levels: state-of-nature mapping, danger mapping, hazard mapping, risk assessment and landslide management.

Moreover, landslide susceptibility has been studied on national or regional scale for Cuba (Castellanos Abella and Van Westen 2007), Pakistan (Peduzzi 2010), Serbia (Marjanovic et al. 2011) and Turkey (Nefeslioglu et al. 2011).

Nevertheless, there are limited models applicable to large areas in regional scale that give reliable results. Mora & Vahnson (1994) developed a simple grid unit-based expert system in order to determine landslide hazards where accurate quantitative field data is scarce. Its inputs are simple morphodynamic (geomorphic) indicators such as the intrinsic landslide susceptibility (SUSC), determined from the combination of a slope factor (Sr = relative relief), a lithology factor (Sl) and a factor representing the relative soil humidity conditions (Sh) and the triggering factor (TRIG), determined from the combination of Ts = seismic and Tp = precipitation (rainfall) intensities. For each factor, an index of influence is determined by a reference value through a specific weight. By multiplying and summing these indexes through equations, a relative hazard level (H) is determined. Spatial distribution of these factors and indicators can be mapped via Geographical Information Systems (GIS). The results can allow the identification of the most susceptible and problematic area, leading to appropriate decisions p.g as to where detailed geotechnical field and laboratory studies should be made.

Moreover, HAZUS methodology (NIBS, 2004), estimates landslide susceptibility for static and for seismic conditions using three geologic group, six slope angles, two different groundwater condition and different seismic scenarios. Spatial distribution of the results can be also mapped via Geographical Information Systems (GIS)

2 Study area

The area under investigation is located in the North-West end of Greece especially in the area of Florina (Fig. 1). It is a mountainous area, about 360km^2, with heavy snowy winters and high rain precipitation in spring and autumn.

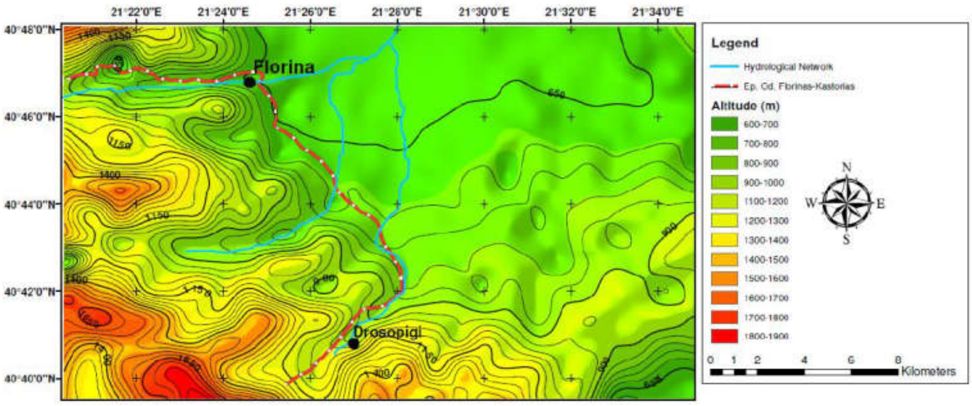
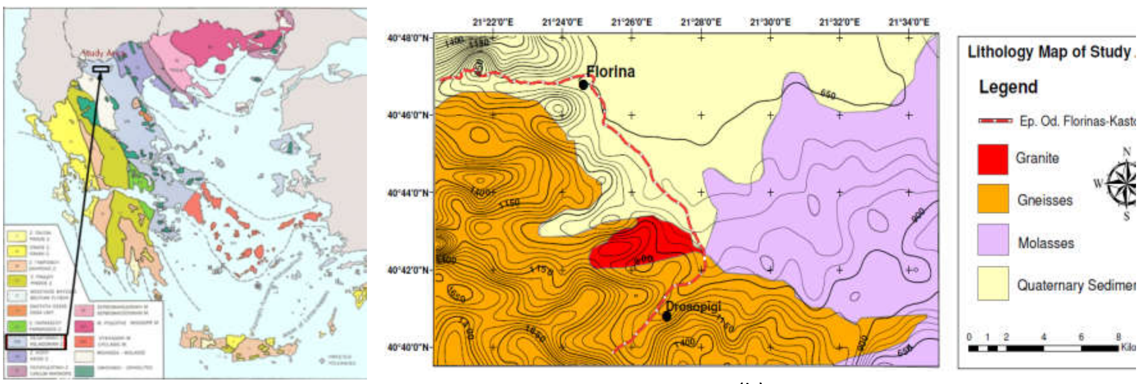


Fig.1 Topography of the study area via Roadline under investigation

The district of Florina belongs to the Pelagoniki Geotectonic zone of Greece. Pelagoniki zone consists mainly of crystalline schistoid (slate, gneisses, amphibolite) semi metamorphic (volcanic rocks), carbonic (limestone, marbles), ophiolite and sedimentary rocks (Fig. 2a). Florina region consists of Gneisses (cover the north part of the district) along with Granites (small appearances), quaternary sedimentary rocks (follow the trail formed by streams and tributaries) and volcanic-sedimentary rocks (sitting alongside Gneisses and Granites)- Fig.2b.



(a) (b)

Fig. 2(a) Geotectonic zones of Greece (http://www.orykta.gr/geologia-oryktologia/geologia-elladas), (b) Geological formation of district Florina (A. Rassios, 2004)

The combination of the structurally adverse discontinuities in the weathered front of gneiss, the rugged topography with steep slopes with gradient varied from 40^0- 60^0, are responsible for slope instability problems.

2.1 Hydrological conditions

The total annual value of rainfalls for Florina region (Period 1961- 2000) according to National Meteorological data (EMY) is between 500-700mm and the rainfall intensity ranges between 51-58mm/day (January – May), with peak hourly rainfall 83,7mm and 102,0mm (24h) in winter months. Table 1, shows the average rainfall and total days of rain for a period of 10years for the Florina region (Period 1996-2016).

Table 1 Average rainfall and total days of rain (Florina)- (EMY data)

Months	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Octob	Nov	Dec
Average precipitations (monthly)mm	**57.6**	**52.3**	**57.9**	**57.9**	**58.9**	**37.3**	**34**	**31**	**41.1**	**62.1**	**69.4**	**86.2**
Total days of rain	**12**	**12**	**12.3**	**11.3**	**11.2**	**7.4**	**6.1**	**5.8**	**6.1**	**8.4**	**10.8**	**12.9**

Moreover, heavy snowfalls have been observed in the area in the period 2013- 2015 with a minimum temperature falling down to -15^0C (winter 2014-2015) and -24^0C (winter 2019).

2.2 Seismicity

Six large shallow earthquakes (Kozani, 1695, M=6.5, VII; Kastoria, 1709, M=6.0, VII; Kastoria, 1812, M=6.5, VIII; Siatista, 1894, M=6.1, VII; Albania, 1960, M=6.5, VIII+; Grevena, 1995, M=6.6, IX+) occurred in the broader territory in the last 300 years. Moreover, 6 active faults were recognized in the study area (Fig. 4). The biggest active fault of Florina district is the one that passes through the villages Nimfaio, Xino Nero and ends in the lake Petron. This fault's angle direction varies among 40^0 and 50^0 and has a general direction in NE-SW while the dip of the fault is 60^0 in SE. It crosses transversely the tectonic basin of Florina-Ptolemaida (D. Mountrakis, 1983).

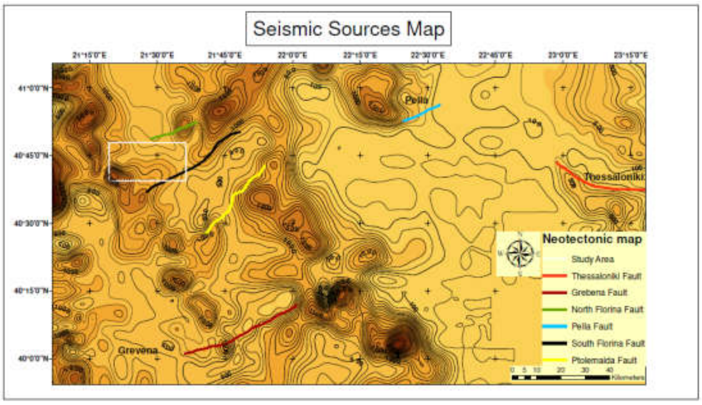


Fig. 4 Active faults near the study area

2.3 Seismic Hazard

Probabilistic Seismic Hazard Analysis (PSHA) for the area is conducted using CRISIS 2007, a code developed by Professor M. Ordaz and co-workers of the "Institudo de Ingenieria de la U.N.A.M", Mexico City. The present application is performed based on area's sources zone modelling. The seismotectonic zonation of Greece and consequently of the region is developed by Papazachos & Papazachou, 1997; Papaioannou & Papazachos, 2000 and Vamvakaris et al, 2016. One seismic zone affects mainly the study area (N-E11). The seismic parameters of that zone are derived from data of previous earthquakes after completeness analysis (Papaioannou & Papazachos, 2000; Vamvakaris et al, 2016). Poisson earthquake model and Ambrassey's (1996) attenuation relations are used for the evaluation of PGA (gal). Soil is characterized according to Ambrasey's (1996) classification.

The obtained results in terms of PGA for the first two scenarios (50, 100 years) fluctuated among 0.12g and 0.16g for the first scenario and 0.20g and 0.30g for the second, quite close with the values suggested by Greek Aseismic Code (0.16g for 50 years earthquake return period and for rock sites). The results of the third scenario (475 years) fluctuate among 0.50g to 1.50g (Fig.5).

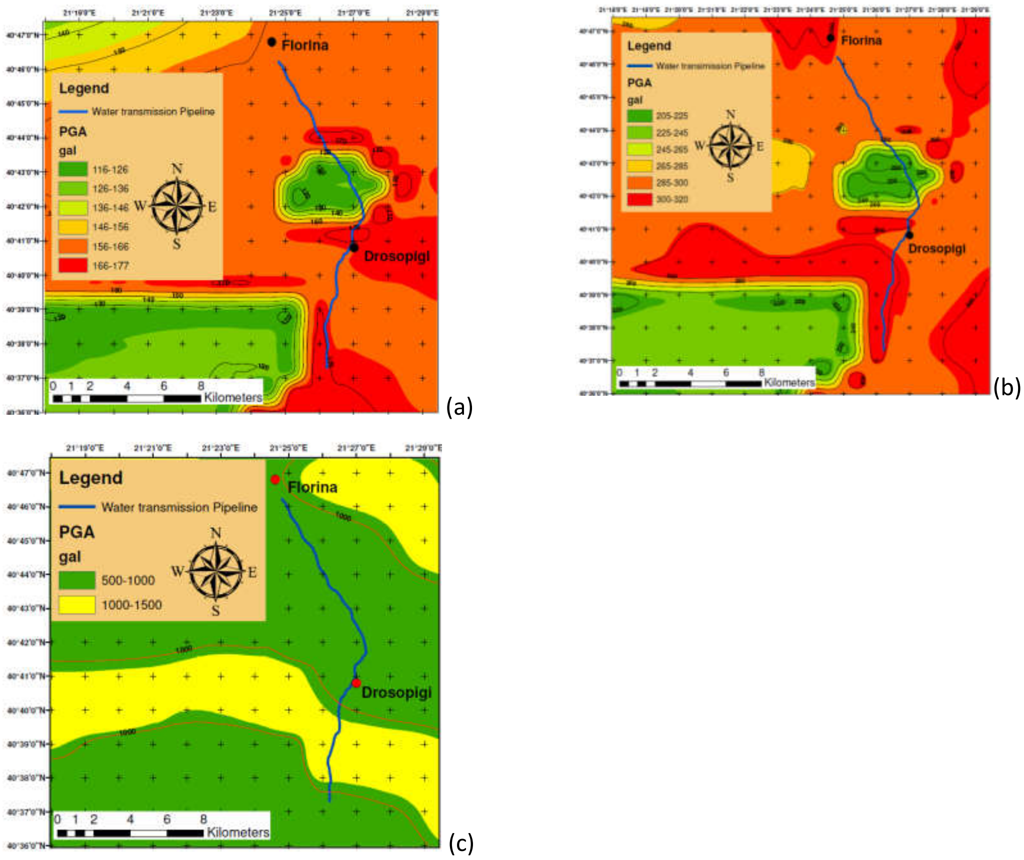


Fig. 5 Spatial distribution of PGA (ArcMap 10.2). Method: Probabilistic. Attenuation relations: Ambrassey, 1996, Earthquake return period: (a) 50 years, (b) 100 years, (c) 475 years

Moreover, according to Greek Aseismic Code and seismotectonic zonation of Greece, the area is located in Zone I, with maximum value of PGA, 0.16g.

3 Landslide Hazard Assessment

In the area under consideration a number of slope failures had occurred over the last decades along the roadline. In August 2015, three landslides (L1, L2, L3) were observed mainly in the form of rockfalls and debris flow that destroyed part of the road that connect Drosopigi village to the top of Vitsi Mountain (Fig.6).

Fig. 6 General view of Vitsi landslides (L1, L2, L3)- Ambas et al, 2016

Because of the heavy winters, the high rain precipitation, the rugged topography the existing soil formation and the limited time and personnel of Civil Protection Services of the Municipality of Eastern Macedonia (Greek), a landslide hazard assessment is needed in order to minimize the area needed immediate investigation. Two methodologies were applied in the area: Mora & Vahrson and HAZUS.

3.1 Mora & Vahrson methodology

The relative hazard level (H) was determined according to Eq. 1.

H = SUSC * TRIG = (Sr * SI * Sh) * (Ts + Tp) (Eq. 1)

The study area was divided in subareas of 1km^2. For the evaluation of Slope Factor (Sr), the relative relief (the difference of highest and lowest altitude) was calculated for each km^2. The categorization of the area was based on Table 2 and the results were depicted in Fig. 7.

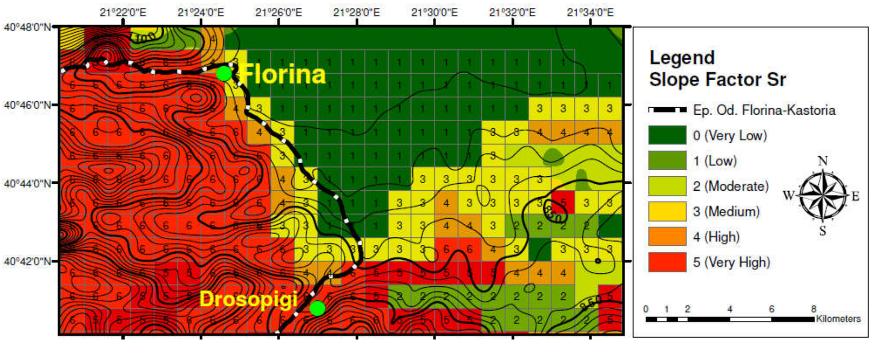


Fig. 7 Slope Factor (Sr) map

Table 2 Relative Relief per Km^2 via Slope Factor (Sr)

Relative Relief $(H_{max}-H_{min})/Km^2$ (R_r)	Classification	Slope Factor (S_r)
0-75	Very Low	0
76-175	Low	1
176-300	Moderate	2
301-500	Medium	3
501-800	High	4
>800	Very High	5

For the evaluation of Lithology Factor (Sl), the categorization of the region (Fig. 8) was based on the geological formations of the area and Table 3.

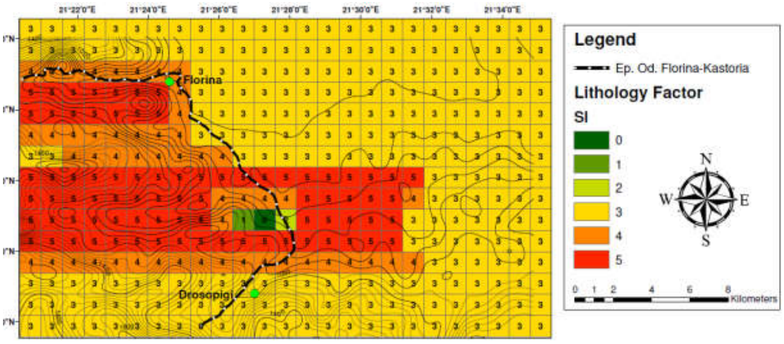


Fig. 8 Lithology Factor (SI)

Table 3 Lithology Factor (SI) via geological formation

Classification	Lithology Factor (S_l)	Geological formations
Very Low	0	**Granite** (massive rock)
Low	1	
Moderate	2	-
Medium	3	**Mollases** (medium strength), **Quaternary sediments** alluvial depositions)
High	4	**Gneisses** (corroded, medium strength)
Very High	5	**Gneisses** (corroded)

Landslides in residual-regolithic soils on steep slopes are very commonly triggered by short but very intense rainfalls. Deeper-seated landslides are often triggered, reactivated and/or accelerated by less intense, but longer and volumetric precipitations. In order to cover both types of phenomena, a factor was developed based on the determination of one hundred-year maximum values of daily (24 hr) precipitations, analyzing time series often 10 years or more. The soil humidity (Sh) of the area is equal to 1 (Very Low) based on the qualification of the accumulated values of precipitation indices (0-4) derived from National Meteorological data of monthly rainfall precipitation collected for the last 10 years in the area of Florina according to the data provided in Table 1.

The seismic intensity factor Ts is determined by analyzing landslides triggered by earthquakes to establish the influence of seismic intensities within similar lithologic, climatic and geomorphic conditions. Different sets of intensities (Modified Mercalli Scale) of approximately comparable seismic sources were correlated with parameters of landslide density and surface destruction. The obtain PGA derived from the probabilistic assessment of seismic hazard (100 years earthquake return period) was converted to seismic intensity according to Koliopoulos et al. (1998) relation:

$$\ln PGA=0.55*Imm+1.30*R^2 \quad \text{(Eq. 2)}$$

Tp index was evaluated equal to 2 (Low) taking into account the maximum monthly precipitation in the area of Florina for the last 10 years (Rainfall n<10 yr, average) and Mora & Vahrson classification (51-90mm).

According to the results obtained by combining all the above mentioned parameters through Equation 1, the value of the landslide hazard indicator Hl is classified and evaluated for each particular site as shown in Table 4. The total landslide hazard (Hl) ranges between Very Low (1) and Medium (4), with a clear predominance of medium landslide hazard in the northern part of Florina and near Drosopigi village (Fig. 9).

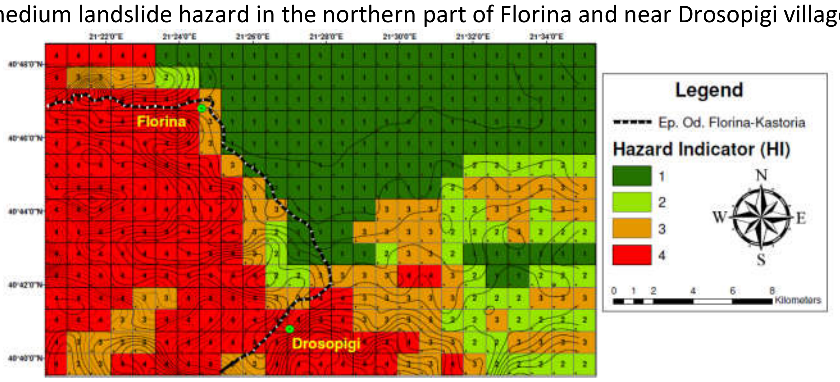


Fig. 9 Classes of HI per km2

Table 4 Classification of the landslide hazard Hl

Value of HI	Class of HI	Classification
<6	1	Negligible
7 to 32	2	Low
33 to 162	3	Moderate
163 to 512	4	Medium
513 to 1250	5	High
>1250	6	Very high

3.2 HAZUS methodology

A characterization of landslide susceptibility is performed for static and for seismic conditions based on HAZUS methodology (NIBS, 2004). The site condition is identified using three geologic groups (A: Strongly Cemented Rocks, B: Weakly Cemented Rocks and Soils, C: Argillaceous Rocks) and six slope angles ($0\text{-}10^0$, $10^0\text{-}15^0$, $15^0\text{-}20^0$, $20^0\text{-}30^0$, $30^0\text{-}40^0$, >40 degree). Groundwater condition is divided into dry (groundwater below level of the sliding) or wet condition (groundwater level at ground surface) according to Table 5.

Table 5 landslide susceptibility (Static conditions)

	Geologic Group	Slope Angle, degrees 0-10	10-15	15-20	20-30	30-40	>40
(a) DRY (groundwater below level of sliding)							
A	Strongly Cemented Rocks (crystalline rocks and well-cemented sandstone, c' =300 psf, ϕ' = 35°)	None	None	I	II	IV	VI
B	Weakly Cemented Rocks and Soils (sandy soils and poorly cemented sandstone, c' =0, ϕ' = 35°)	None	III	IV	V	VI	VII
C	Argillaceous Rocks (shales, clayey soil, existing landslides, poorly compacted fills, c' =0 ϕ' = 20°)	V	VI	VII	IX	IX	IX
(b) WET (groundwater level at ground surface)							
A	Strongly Cemented Rocks (crystalline rocks and well-cemented sandstone, c' =300 psf, ϕ' = 35°)	None	III	VI	VII	VIII	VIII
B	Weakly Cemented Rocks and Soils (sandy soils and poorly cemented sandstone, c' =0, ϕ' = 35°)	V	VIII	IX	IX	IX	X
C	Argillaceous Rocks (shales, clayey soil, existing landslides, poorly compacted fills, c' =0 ϕ' = 20°)	VII	IX	X	X	X	X

Landslide Susceptibility in static condition is estimated according to geologic group, slope angle and groundwater level (ground water below of level of sliding). It is categorized from scale I (less susceptible) to X (most susceptible). About 2km of the road need immediate attention for the case of dry conditions and 4km for wet conditions (Fig. 10) after the application of the methodology.

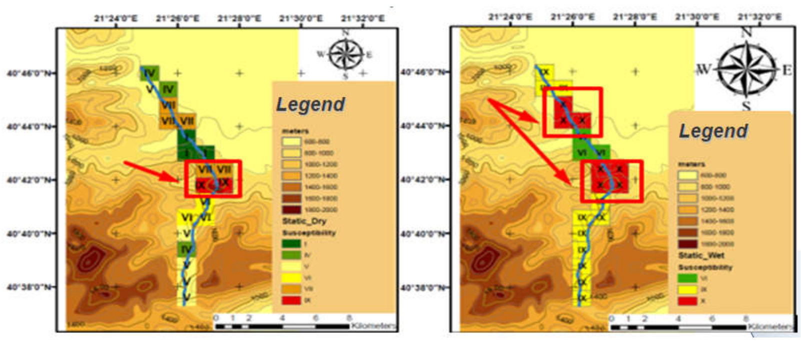


Fig. 10 FEMA Static conditions, Dry (left) and Wet (right) conditions

For seismic conditions, Critical Acceleration (Ac)- the horizontal seismic force that causes a landslide when Safety Factor is equal to 1 (Fig. 11) and Peak Ground Acceleration (PGA)- as derived from seismic hazard- are needed for the identification of the most susceptible areas according to Ac/PGA index.

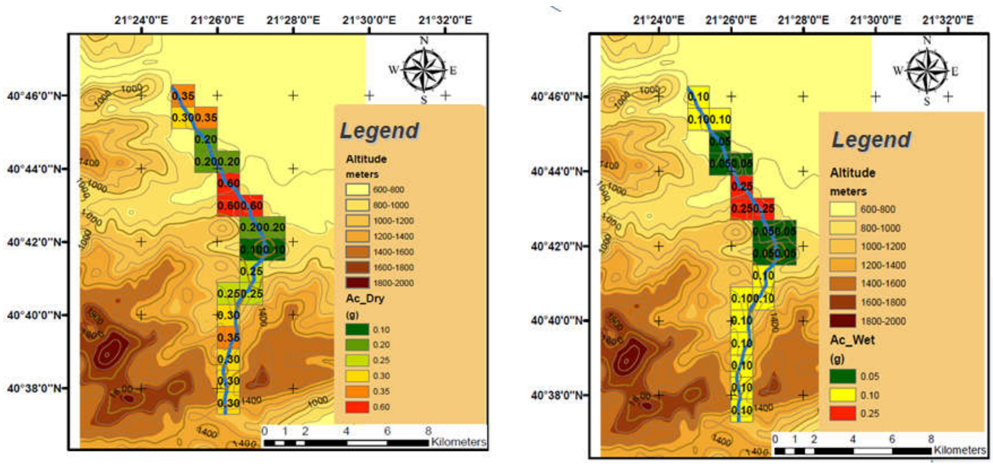
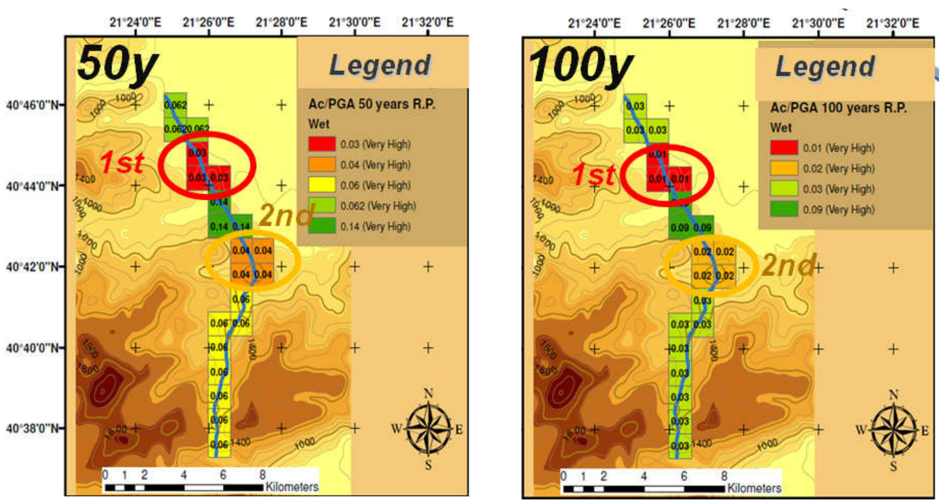


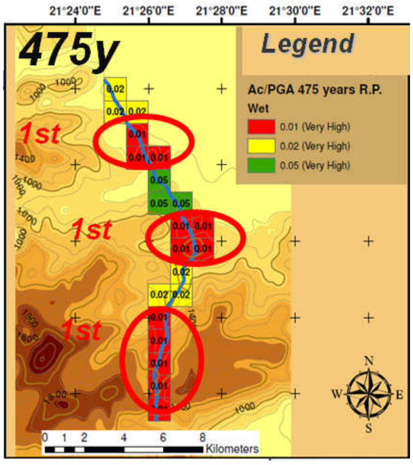
Fig. 11 Critical acceleration (Ac) according to landslide Susceptibility category for dry (left) and wet conditions (right)

The area was classified, in term of landslide susceptibility, subjectively into six categories (Table 6) according to Ac/PGA index for the case of seismic scenarios and for dry and wet conditions. The 1st and the 2nd priority areas for in-situ investigations and laboratory tests were identified via GIS for wet conditions as illustrated in Fig.12. The area of about 2km that is in the northern part of the roadline is 1st priority area for pre-earthquake action in terms of slope stabilization for the seismic scenarios of 50, 100 and 475years.

Table 6 Landslide susceptibility categorization according to Ac/PGA Index

Classification	Ac/PGA Value
Very High	<0.3
High	0.3-0.6
Moderate	0.6-0.8
Low	0.8-1.0
Very Low	1.0-3.0
None	>3.0





(c)

Fig. 12 Landslide risk factor (Ac/PGA index) for shallow landslides (wet conditions) for seismic scenarios of (a) 50y earthquake return period, (b) 100y earthquake return period, (c) 475y earthquake return period

4 Conclusions

Possible areas with landslides were identified based on Mora & Vahrson (1994) methodology for the case of 100y earthquake return period. According to Mora & Vahrson methodology, the most “susceptible for landslides” parts of the road are in North-West and South-West of the study area (Moderate- Medium Susceptibility), where the inclination increases. About 10km of the slopes of the road line have “Medium” probability to slide. Moreover, the results are in good agreement with RECALL Project (Real Landslide’s Locations).

HAZUS methodology was also used for landslides identification for static/ seismic and for dry/ wet conditions. “Very High” Landslide’s Potential (Dry/ Wet) were estimated in specific parts of the roadline for static conditions.

Three seismic scenarios of 50, 100 and 475 earthquake return period for different soil moisture conditions (“dry” and “wet”) were assumed. “Very High” Landslide’s Potential was estimated for the area (expect of 2km with “High”) for the seismic scenario of 50y earthquake’s return period and for dry conditions. All slopes beside the roadline had “Very High” landslide’s potential for the Scenario of 100y & 475y earthquake’s return period.

Concluding, this study provides Civil Protection Services of the Municipality of Eastern Macedonia (Greek) with empirical first-level identification of the areas in Florinas – Kastorias roadline with “high landslide’s risk” via GIS maps.

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THE BOILOVER PHENOMENON: REQUIREMENTS FOR ITS DEVELOPMENT, CALCULATION OF ITS MANIFESTATIONTIME AND FIREFIGHTING TACTICS

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Abstract

Boilover is a violent ejection of certain liquid hydrocarbons due to their prolonged burning during a storage tank fire. It happens due to vaporization of the water sub-layer which usually resides at the base of crude oil storage tanks, resulting in the ejection of hot fuel from the tank, an enormous fire enlargement, a fireball formation, and an extensive ground fire. It is a very dangerous accidental phenomenon, which can lead to serious injuries especially to emergency responders. The boilover can occur several hours after the fuel in a storage tank caught fire. The delayed boilover occurrence is a rather unknown but important parameter for the emergency response operators. The purpose of this paper is the analysis of the circumstances in the creation of this catastrophic effect and the estimate of the time the effect needs to be manifested, using a simple mathematical model for a number of crude oil tanks of different geometries. The importance of this assignment lies in the empirical calculation of the time needed for the manifestation of the effect in Greek refinery tanks. The information of the imminent manifestation of this effect is a crucial factor for the firefighting operation since the first concern in such a kind of technological accident is the safety of the emergency responders, as well as the protection of the surrounding tanks and the timely evacuation of the neighboring area to minimize the casualties. Using a semi-empirical model, we are trying quantitatively to make a timing prediction of the final phase of the boilover phenomenon.

Key Words: Boilover, hot zone layer, tank fire, crude oil, firefighting.

1. Introduction

The industrial development of our modern civilization is directly linked to the increased consumption of energy sources such as liquid fuels. This has resulted in the subsequent development of refineries and liquid hydrocarbon storage units across the globe in order to meet the market demand for fossil fuels. This development, however, has been accompanied by a series of industrial accidents, which in many cases have had severe consequences, both on human losses and on environmental and economic impacts in the regions where they have occurred (Broeckmann & Schecker 1995).

One of the most serious accidents that may occur in a fuel storage tank is the Boilover phenomenon. It is a violent ejection of certain liquid hydrocarbons due to their prolonged burning during a storage tank fire. It happens due to vaporization of the water sub-layer that commonly resides at the base of a storage tank, resulting in the ejection of hot fuel from the tank, enormous fire enlargement, formation of a fireball and an extensive ground fire. Boilover is a very dangerous accidental phenomenon, which can lead to serious injuries, especially to emergency responders. It is also noteworthy that the boilover can occur several hours after the fuel in a storage tank caught fire (Buang 2014). This delay in the boilover occurrence is, nevertheless, a rather unknown parameter in emergency response operations (Garo et al 1999).

To this purpose, a number of theoretical models have been developed in recent years by fire engineering specialists, in order to predict the time until this phenomenon occurs as accurately as possible (Casal 2008, Mirdrikvand et al 2016). The purpose of this study is to analyze the estimated time of boilover occurrence in 12 crude oil storage tanks located in Greece, each of different characteristics, in order for the firefighters and emergency responders to have a first estimate of the expected time of its development, and also to suggest some practical measures to be applied when operating in such incidents.

2. The Boilover phenomenon

In liquid-fuel processing and storage facilities, one of the most significant risks is the occurrence of the boilover phenomenon. It usually occurs in floating-roof tanks containing crude (unprocessed) oil and it requires the following basic conditions to be created (HM Fire Service Inspectorate 2000):

- A full surface fire development in an open tank containing asufficiently thick fuel with high viscosity. Some of the most commonly known possible causes of fire in liquid fuel storage tanks include: lightning strikes, static electricity, malfunctioning of tank operations, earthquakes, sabotage, and thermal radiation from a nearby fire (domino effect)
- The presence of water or oil emulsion at the bottom of the tank. Water being heavier than crude oil is concentrated in the lower part of the container. The presence of water can be attributed to a variety of causes, such as its penetration due to faults in the tank shell and the introduction of rainwater through gaps in the roof float, or even from the moisture contained in the fuel (e.g. crude oil) itself.
- Creation of a thermal wave in the burning liquid descending to the bottom of the tank. This isothermal wave is also commonly referred in the international literature as “hot zone” (Koseki et al 1991).

Boilover occurs when the residues from surface burning become denser than the unburned oil and sink below the surface to form a hot layer, which progresses downward much faster than the regression of the liquid surface. Oils subject to boilover consist of components having a wide range of boiling points, including both light ends and viscous residues (NFPA 2000), such as crude oil, for example. The temperature of the oil in the heat wave may reach up to almost 300 °C (Jarosz 2011), which is well above the boiling temperature of the water.

As the fire continues in a fuel tank, the thickness of the hot zone layer constantly increases (Koseki et al 1991). When the hot wave reaches the bottom of the tank, it causes the violent boiling of the water. The water turns into steam and rapidly expands, since its volume increases by approximately 1500 to1700 times (Liu & Kim 1999, LASTFIRE 2016). Vapor increases the pressure inside the tank and its violent upward expansion causes a rapid explosion and ejection of burning fuel out of it and dispersion of the fragments of the tank to a large distance (Figure 1).The phenomenon takes place after several hours of uncontrolled burning of the surface of the reservoir and depends mainly on the depth of the tank's crude oil, the height of the water at the bottom and the downward velocity (rate of descent) of the hot zone layer to the bottom of the fuel tank on fire. The rate of the hot wave expansion per hour, depending on the fuel type varies between 76 mm/hr and 889 mm/hr for heavy oils and light or heavy crude oil fuels (HM Fire Service Inspectorate 2000).

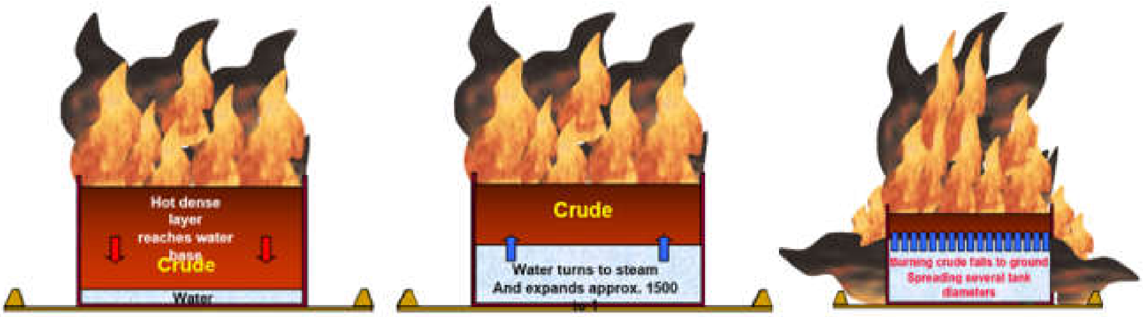

Figure 1. Phases of the evolution of the Boilover phenomenon (LASTFIRE 2016)

Even though it is not common in all fire incidents, some indications for the upcoming violent manifestation of the boilover phenomenon after a fire development on the surface of a fuel tank are: the increasing size of flames followed by white colour due to steam escape, the sound of burning-like frying sound with wheezing becoming ever more intense (because of the escaping vapour) and the ejection of large droplets of the burning fuel out of the tank (LASTFIRE 2016).

3. The effects of Boilover

The boilover is considered as one of the most devastating fire incidents which can occur in a liquid hydrocarbon storage facility. The consequences of this phenomenon may include human casualties and injuries in the field of events, environmental impacts, as well as economic impacts, both for the oil company managing the storage and the safe supply of petroleum products and for the local community as well (Jarosz 2011). These effects are categorized as follows:

3.1 Human Casualties

Human casualties due to the boilover are common, due to the severity of the phenomenon may include serious injuries, burns and deaths of responders to the fire incident, which could also be the case for the personnel working in the oil storage facility (Mirdrikvand et al 2016). Some reported fire incidents leading to the onset of the boilover phenomenon, including human losses and injuries are the accident of 1968 in Sheel's Pernis Refinery at Netherlands (2 dead-85 injured), the boilover in the Czechowice-Dziedzice Refinery, Poland in 1971 (33 dead – including several firefighters), and the boilover incident in Tacoa, Venezuela on 19th December 1982 with over people 150 dead, and approximately 500 injured (Buang 2014).

3.2 Environmental impacts

The environmental impacts due to the boilover phenomenon are mainly attributed to the effects from the fireball development and the oil spilled outside the storage tank area. The hydrocarbon-rich fuel vapoursare ejected from the fuel tank to the atmosphere, where they mix with air and ignite, creating a "mushroom" shaped flame, commonly referred as “fireball”, reaching a significant height above the tank (Figure 2).According to literature data, its height may reach up to 10 tank diameters at a vertical distance (LASTFIRE 2016). A typical is one the previously mentioned accidents in Tacoa, Venezuela with a fireball reaching about 330 m in vertical height after a boilover in a tank with a diameter of 55m. It was also reported that the erupted burning oil from the tank was thrown approximately 8 tank diameters downwind, causing severe fatalities and environmental damages (Buang 2014). The environmental effects include the increase of toxic pollutants in the surrounding area, due to the emissions from the dense cloud of black smoke following a fireball, and the oil spread to the area, including harmful substances (D’Amico 2015).

3.3 Financial Consequences

The financial effects due to boilover are related to the cost of repairing plant and equipment damage, tanks construction costs, fuel loss, and most important to the refinery shut down for a long time, including a long-term stopping of fuel transportation to the final processing stage. In addition, the extinguishing operation is long and costly, since it includes the use of fire extinguishing foam in fairly large quantities. Moreover, in case of a Domino Effect equally devastating effects are expected since the explosion may spread the fire to the adjacent tanks of the oil refinery. The development of such a phenomenon due to boilover occurrence includes a horizontally spread thermal radiation and thrown tank fragments which can affect neighbouring fuel storage and processing facilities around 5 times the diameter of the tank, up to nearly 400m (Casal 2008). Its actual distance covered depends on the amount of fuel involved, the amount of the vaporised liquid and the wind direction (Khan & Abbasi 2001). The potential damage to several tanks in such a case is significant, while the full extinguishing process is expected to be completed after several days.

Figure 2. Boilover in a crude oil tank at the Milford Haven accident (*Courtesy of Mid and West Wales Fire and Rescue Service from Dyfed County Fire Brigade, 1983)*

4. Mathematical model to predict Boilover phenomenon occurrence time

In this study we attempt to approximately calculate the boilover occurrence time in a number of selected crude oil storage tanks in a Greek oil refinery. We use a number of semi-empirical models applied to the tank and fuel dataprovided fromthe refinery, aiming to determine the hot zone layer descent speed and to approximately estimate the time required for the instantaneous ejection of the burning fuel.The occurrence time required for the Boilover phenomenon in a tank ($\boldsymbol{t_{bo}}$) is calculated according to the following equation (Broeckmann & Schecker 1995):

$$\boldsymbol{t_{bo}} = \frac{\boldsymbol{z_f}}{\boldsymbol{v_{hz}}}$$

Where:

z_f: the initial depth of fuel in the tank (m)

v_{hz}:the speed of the base of the hot zone layer(m/sec)

The speed of the base of the hot zone layer($\boldsymbol{v_{hz}}$) can be calculated from the following equation(Broeckmann & Schecker 1995):

$$\boldsymbol{v_{hz}} = \frac{\boldsymbol{M_0}}{\boldsymbol{A_T} \cdot \boldsymbol{\rho_0}}(\dot{\boldsymbol{n}}_{\boldsymbol{L}} + \dot{\boldsymbol{n}}_{\boldsymbol{V}})$$

Where:

M_0: The fuel's initial molecular weight (kg/mol)

A_T: The fuel surface area (m^2)

ρ_0: The fuel's initial density (kg/m^3)

$\dot{n}_L$: The fuel's molar flux of fraction remaining in the liquid phase (mol/sec)

$\dot{n}_V$: The fuel's molar flux of vaporized fraction (mol/sec)

In total, a number of 12 oil storage tanks is included in our analysis. It is assumed that 87% of each tank's volume is filled with Arabian Light Crude Oil 850. All necessary data, including the tank diameters, the fuel's initial height and the fuel surface area in each tank were used from local providers and are presented in Table 1 and Table 2 below. For the purposes of our analysis, two reference case scenarios were included: one for a 0.5m water layer and one for a 0.7m water layer at the bottom of each tank.

With the use of the data provided from a domestic oil refinery, and their application to the aforementioned equations for the calculation of the speed of the hot zone layer's base ($\boldsymbol{v_{hz}}$)and the time required for the occurrence of the boilover phenomenon($\boldsymbol{t_{bo}}$) in each oil storage tank, the relevant results for each of the 12 tanks are provided in the Table 1 and Table 2 of the next chapter.

5. Results

The results from the mathematical modelling of the boilover occurrence time for each of the 12 Arabian Light Crude Oil 850 tanks used in this study are presented in the Tables 1 & 2 below, for a 0.5m water layer in the tank bottom and a 0.7m water layer in the tank bottom reference case scenario in each Table, respectively.

Table 1. Calculation results of the expected boilover occurrence time (0.5m water layer on tank bottom)

Tank No	*Tank Diameter (m)*	*Tank Height (m)*	*Z_f (m)*	*A_T (m^2)*	*t_{bo} (hrs)*
1	52.5	14.45	12.07	2163.6	18.01
2	54.5	17.15	14.42	2332.8	21.52
3	56	19.1	16.11	2463	24.05
4	42.7	20.5	17.33	1432	25.87
5	76.5	18.9	15.94	4596.3	23.79
6	83.3	21.5	18.2	5449.7	27.17
7	88.5	19.5	16.46	6151.4	24.57
8	58.8	15.5	12.98	2715.4	19.38
9	73	16	13.42	4185.3	20.02
10	77.22	17.08	14.35	4683.2	21.43
11	80	10	8.2	5026.5	12.23
12	68.7	16.2	13.59	3706.8	20.28

Table 2. Calculation results of the expected boilover occurrence time (0.7m water layer on tank bottom)

Tank No	*Tank Diameter (m)*	*Tank Height (m)*	*Z_f (m)*	*A_T (m^2)*	*t_{bo}(hrs)*
1	52.5	14.45	11.87	2163.6	17.71
2	54.5	17.15	14.22	2332.8	21.22
3	56	19.1	15.91	2463	23.75
4	42.7	20.5	17.13	1432	25.57

5	76.5	18.9	15.74	4596.3	23.49
6	83.3	21.5	18	5449.7	26.87
7	88.5	19.5	16.26	6151.4	24.27
8	58.8	15.5	12.78	2715.4	19.08
9	73	16	13.22	4185.3	19.73
10	77.22	17.08	14.15	4683.2	21.13
11	80	10	8	5026.5	11.94
12	68.7	16.2	13.39	3706.8	19.99

The average value estimated for the speed of the base of the hot zone layer was approximately 0.67 m/hr. This value is considered as acceptable, since it confronts to the relevant data provided by the literature: typical values of the heatwave downward travel rate range between 0.38 m/hr to 1.27 m/hr (HM Fire Service Inspectorate 2000).

5.1 Boilover occurrence time

In all cases studied here, the boilover occurrence (fuel eruption) takes place after several hours since the formation of the hot zone layer in the tank, after a full surface fire development.Depending on the dimensions of each of the 12 tanks studied in this paper, the time required for the boilover onset in the burning tank varies between approximately 12 hrs until 27 hrs the latest, as shown on Tables 1 & 2 above. For example, in tanks No.4, 6 and 7 it is expected that boilover can be developed after a continuous fire lasting over 24 hours (1 day).It is clear from the results, though, that the tank dimensions and the water layer at the bottom of each tank are important factors to consider, since there is a noticeable link between the height of the water layer to the time to boilover, also considering the tank height. For example, the tank No.11 with a 80m diameter, a 10m height, and a water layer height of 0.5 m is expected to develop a boilover after 12.23 hrs. By comparing it with the tank No.6, which has an approximately similar diameter (83.3 m) but almost a double height (21.5 m), where a boilover is expected to occur at 27.17 hrs for the same 0.5m water layer at its bottom, we can conclude that the smaller the dimensions of the tanks, and especially their height, the faster the oil burst in the tank is expected.

As for the impact of water height at the bottom of the tank, by comparing the boilover occurrence times between Table 1 and Table 2, we can observe that their values (in hrs) for tanks with a 0.7 m water layer are always shorter than those for a water height of 0.5 m. This is because the higher the water level accumulated at the bottom of the tank, the faster the descending thermal layer will encounter the concentration of water, causing its violent vaporization and, consequently, the occurrence of the boilover phenomenon.

Finally, an equally important factor for the estimated time of occurrence of the phenomenon, even though not mentioned in detail on Tables 1 & 2 is also the fuel capacity within the tank. In tank No.7, for example, for a water height of 0.5 m at the bottom and assuming that it stores fuel at 87% of its capacity, the potential eruption time is 24.57 hours. Assuming that the same tank is full at 70% of its capacity, this time drops dramatically down to 19.5 hours. Therefore, a lower fuel level within the tank causes a quicker boilover occurrence time.

5.2 Results comparison with actual boilover events

By comparing our study's results with real data from accidents occurred worldwide, we can evaluate the validity of the estimated data presented here in this study. In the accident of the Czechowice-Dziedzice Refinery in Poland (1971) the boilover occurred after t_{bo} = 17.5hrs in a 33m diameter and 14.7m height tank, filled with crude oil at 79.59% of its capacity. In the Amoco Refinery accident in United Kingdom at 1983, the boilover occurred after t_{bo} = 15h 25minin a 78m diameter and 20m height tank, filled with light crude oil at 50% of its capacity (Buang 2014). Even though in our study we assume tanks filled at 87% of their capacity, if we take the tank No.5 of Table 1 as a reference case example close to the accident of Amoco Refinery, and we assume it is half-full (50%), the estimated time to boilover in this case is approximately 14h 35 min.

Looking at the comparison between our research results and actual events, we can see that despite the assumptions we have used in our study's mathematical model, the deviation of the estimated times is acceptable. The deviations observed are below 1h, which is considered as an acceptable difference between our study's estimated time and the time to boilover from real reference cases. It must be also noted that the actual time depends on many parameters including the exact dimensions of the tanks, the exact height of the water at the bottom, the temperatures developed within the tank, the fire extinguishing activity either with the external cooling of the tanks or by attempting to foam the burning fuel on the surface of the tank, as well as with the properties of the various types of crude oil contained in tanks.

5.3 Model Importance

By applying the simple empirical boilover time prediction model used in our study in real case crude oil tank fire scenarios, can be proven a very useful tool that can be used during a fire-extinguishing operation by emergency responders, provided that all necessary data are available. As long as we know the fuel type and its chemical properties, the dimensions of its storage tank, the volume occupied by the fuel inside the tank, and the amount of water accumulated at the bottom, the expected time to boilover in case of a fully developed surface fire in the fuel tank can be estimated with relatively good precision. The use of modern technology (sensors, level gauges) and thermal imaging cameras, can also be proven to be a valuable tool in order to determine the hot layer zone inside the tank, perhaps also the amount of water accumulated at its bottom, so that data can be readjusted to the actual conditions occurring in the event. This dynamic process of continuous data evaluation will lead to providing safer information to firefighting supervisors in order to follow the appropriate fire-fighting tactics for the estimated time of event.

6. Firefighting Guidelines

The measures taken are divided into two main categories: the measures taken to prevent the boilover phenomenon from occurring in a tank and the countermeasures referred to firefighting actions applied during a fire development in a liquid fuel storage tank, in order to prevent or delay the boilover occurrence so as to ensure the safety of the emergency responders and the personnel of the oil refinery as well. Some of the most commonly applied prevention measures include the use of fire detection systems in crude oil tanks, and the building of dikes around the storage tanks' perimeter to prevent the contents of the tank from spreading in case of overflow or collapse.

In case, however, that a fire has been developed in the surface of a crude oil storage tank, leading to a full surface fire which can lead to the formation of a hot zone layer moving downwards to the tank bottom, it is rarely the case that such a fire will be fully extinguished, according to statistical fire incident data (Lönnermark& Persson 2004). A continuous cooling of the tank walls may, however, delay the time of the hot zone formation and its downward velocity, resulting to a considerable delay in the time until the boilover phenomenon occurs (Figure 3).

Figure 3. External cooling of tank walls in a full surface fire (HM Fire Service Inspectorate 2000)

The use of fire extinguishing systems in oil tank fires includes the use of permanent or semi-permanent applications. Typical examples of permanent fire extinguishing systems include foam generators being installed on the tank ceiling for foam spraying and also a permanent piping system installed at the external side of the tank for cooling its walls. Semi-permanent fire extinguishing systems may include special purpose fire engines and the use of canon foam type applications. It may also include the presence of firefighters at the top of the tank roof, in case of a small-scale fire not yet fully developed at the entire tank surface. It should also be emphasized that the foam spray on the roof of the tank should be wisely taken care, since if excessive amounts of foam are applied, it might result into the sinking the floating roof, thus increasing the fire magnitude. Foam spraying should take place to the walls of the tank and have a smooth flow to the burning surface. Shots directly on the burning surface will feed the fire are considered as ineffective. Suitable firefighting foam in such incidents is the AFFF foam type (NFPA 11).In cases of fuel tank fires in oil refineries, it is also of utmost importance for thermal radiation zones to be characterized around the fire incident zone, for the protection of personnel and civilians located nearby.

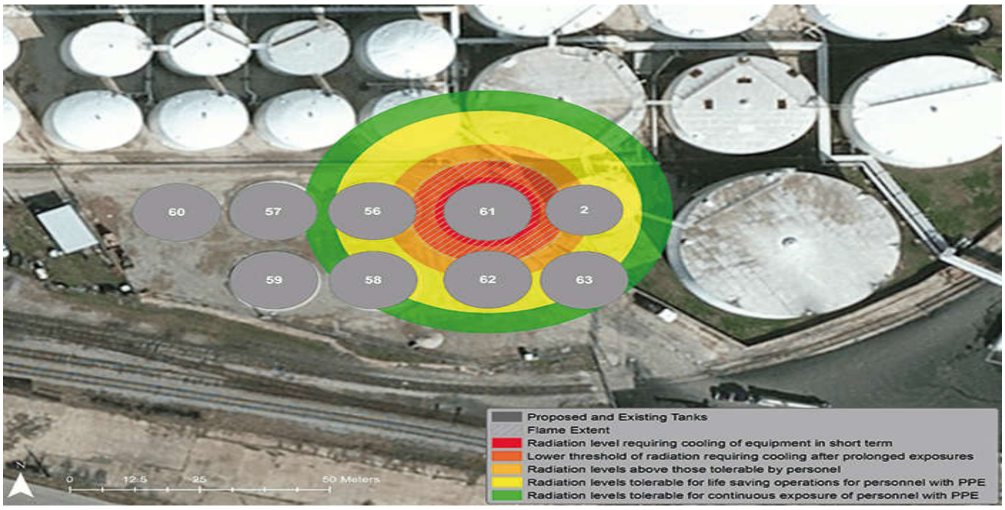

Figure 4. Thermal radiation zones in refinery fuel storage tanks in case of fire (D'Amico 2015)

Finally, it is of utmost importance that communication between all involved response teams in case of a fuel tank fire is extremely useful for the success of operation. It is strongly suggested that if fire extinguishment has not been achieved by the time the hot zone layer has reached a point about 1.5m above a known water bottom level in the tank, all personnel must be immediately withdrawn from the area (HM Fire Service Inspectorate 2000).Since a heatwave inside a crude oil storage tank is not visible from the outside, the use of thermal imaging cameras can help firefighters and emergency responders to visualize the inside of a tank under fire, so as for them to get a better estimation of the heatwave development before it reaches the tank's bottom.

7. Conclusions

Early beginning of the firefighting operation on-site is of great importance for boilover prevention, since in case a pool fire occurs, and its elimination is not possible, the risk of boilover occurrence in crude oil storage tanks increases significally, especially if a heatwave moving downwards is developed. According to the modelled data from the study's calculations, the average expected time to boilover occurrence in tanks filled with Arabian Light Crude Oil 850 for some typical tanks used in the Hellenic refineries ranges between 12hrs and 27 hrs, depending on the size of tank, the level of water layer at its bottom, and the tank's fuel capacity (initial height of fuel in tank at the time when the fire occurs). Tanks in oil refineries with lower initial fuel heights and larger levels of water layers accumulated at their bottoms are very likely to result in significally shorter boilover occurrence time intervals, in contrast to tanks with higher levels of fuel storage and lower levels of water accumulation at their bottom. The results of this study can be considered as a useful starting point for evaluating the occurrence time of the boilover phenomenon in fuel storage tanks of the refineries located in Greece, with respect to the same type of fuel used here, so as for the emergency responders to get a better understanding of the time available for operating in case of a fire incident, and also the dangers imposed for the personnel operating on-site.

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A LOW COST EARLY WARNING SYSTEM FOR EARTHQUAKE - INDUCED LANDSLIDES

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Abstract

This work introduces the development of a low cost monitoring network focusing on earthquake-induced landslides. Emergency Planning and Disaster Risk Management are emerging fields of research in the field of Informatics (Subedi , 2010), (Asimakopoulou & Bessis, 2010). The decision making process for all stakeholders involved in emergency situations is demanding and requires a huge amount of information and complex methodology in order to make informed decisions (Bouafia & Khairi, 2017). A significant interest of international research is therefore to deeply comprehend potential landslide triggering factors, through deployment of early warning systems. Landslides can be characterized as multifactorial events, as instability and slide are usually due to a combination of factors (morphological, geological, geotechnical, environmental and human interventions), (Guzzetti, Carrara, Cardinali, & Reichenbach, 1999), (Wen-Fei, Chein-Lee, Shih-Tsu, & Shing-Tsz, 2009), (Binaghi, Luzi, Madella, Pergalani, & Binaghi, 1998). Apart from that, however, much emphasis should be placed on the instrumental monitoring of active landslides as well as on slopes which show increased landslide susceptibility occurrence (Intrieri, Gigli, Mugnai, Fanti, & Casagli, 2012). It is obvious that there is a necessity to obtain a more complete understanding of the landslide triggering, so as to mitigate risk before failure, as well as after its occurrence, with management stages. The abovementioned can be accomplished by developing a landslide monitoring network for upcoming events, using MEMS (Microelectromechanical System) acceleration sensors. Main advantage of our proposed methodology is the extremely low cost and consequently the possibility of using a large number of units so that, through efficient algorithm development locate precisely the landslide initiation time.

Keywords: earthquake induced landslides, early warning system, low cost sensors and disaster risk management

1. Introduction

This study is at initial implementation stage and constitutes a first approach to valid and on time detection of an upcoming landslide, using a low cost system. To begin with, landslides are usually the combined result of acting factors like morphological, geological, environmental as well as human interventions (Guzzetti, Carrara, Cardinali, & Reichenbach, 1999), (Wen-Fei, Chein-Lee, Shih-Tsu, & Shing-Tsz, 2009), (Binaghi, Luzi, Madella, Pergalani, & Binaghi, 1998). These geomorphological features serve to detect landslide susceptible areas. Typical areas for landslides occurrence are highly weathered steep slopes that are under the status of erosion and disintegration, water gathering areas, as well as fault zones with intense tectonic deformation (Highland & Bobrowsky, 2008), (CERRI, REIS, GRAMANI2,, GIORDANO, & ZAINE, 2017). Undoubtedly, slope inclination constitutes an important parameter when examining its stability. In particular, any slopes' inclination increase provoked by seismic loading, changes the internal geometry of the material and may cause failure (Donnarumma, Revellino, Grelle, & Guadagno, 2011), (Chen, Liu, Chang, & Zhou, 2016). When an earthquake on loose or low-cohesion consisted slopes occurs, a reduction between grains interlocking has been observed, leading to failure (Donnarumma, Revellino, Grelle, & Guadagno, 2011), (Chen, Liu, Chang, & Zhou, 2016) . Therefore, the need arises to obtain a more complete aspect of landslide generation so as to mitigate or even avoid the risk before it occurs and after its management event. This can be done by developing a monitoring network for possible triggering alarm, acting as an early warning system.

2. Materials and Methods

The system we developed is capable of recording at sampling frequencies up to 125 Hz. Each unit is made up of an Arduino Uno R3 single board microcontroller, as well as a low-cost triaxial MEMS accelerometer sensor GY-61 (cheap version of ADXL335 analog sensor). Rechargeable batteries (3400mAh 3.7V) were used while data are being stored in an SD memory card. Each file contains the acceleration values on the 3 axes (X, Y, Z) along with the timestamp (DD/MM/YYYY HH:mm:ss), giving accurate determination of failure's time initiation. In figure 1 a typical daily record is shown, having in the first 2 columns date and time and then follows the voltage values per axis in mV. With a simple conversion (ADXL335 Datasheet, p. 3), we can get acceleration values per g. Current sampling frequency allows continuous recording up to 4 days, with record size up to 85MB per daily file.

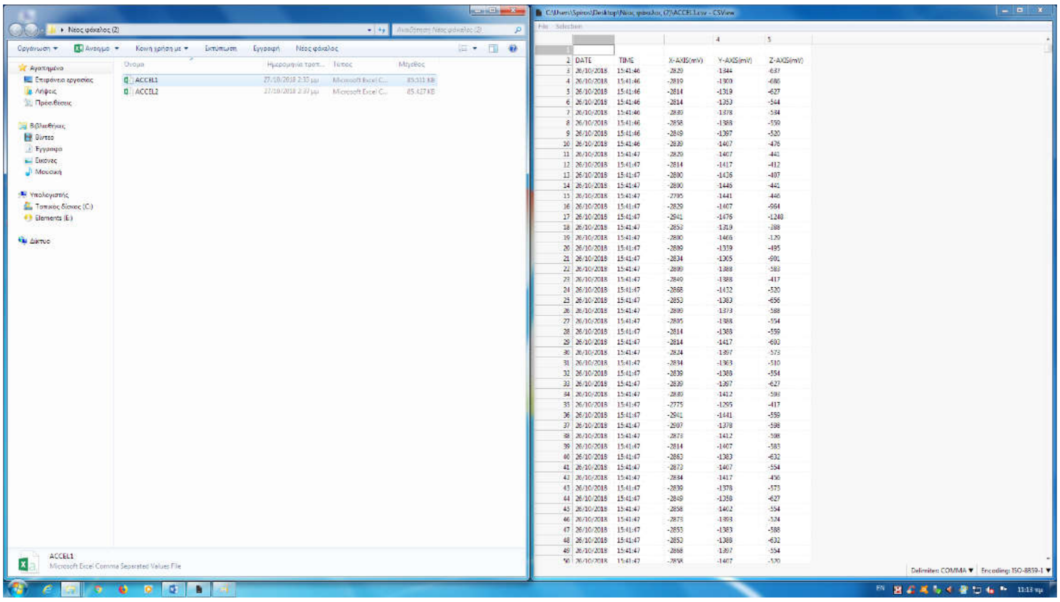

Figure 1. Two daily .csv files on the left and a typical record's interface on the right.

Before installing our system on the field, a landslide simulation in a small scale laboratory model, deemed necessary. For this reason, two similar devices were used. The first unit one was steady (in order not to move) while the other was left to slide onto a lean wooden surface for about 7 cm. Figure 2 shows an aspect of our experimental model (side view), where we can see the two wooden surfaces and a simple laboratory-constructed tool (car jack) to gradually increase the sliding level. On the right are two identical (devices) to look at. By increasing the slope, the left one slid for 7 cm while the other on the right was stuck, in order to remain stable and not to move at all. There is a necessity to point out that the slope was initially increased at the desired inclination level and then the recording had started. Keeping in mind that the inclined plane was constant, both devices had the same reference level in the vertical axis Z. The shifting we analyzed was along Y-axis, so results retrieved from experiments with composite sliding, along Y and X axis (as shown in figure 2 – lower part), were considered invalid.

3. Results and Discussion

As far as signal processing is concerned, figure 3 illustrates acceleration over time comparison for sensor 1 (on the left) against sensor 2 (on the right) for the three conducted experiments. In the upper part of figure 3, which concerns the first experiment (EXP1 - 9 degrees inclination), we see on the left g values over time for sensor 1 (which did not move) while on the right we see g values over time for sensor 2 that slipped over the inclination level for 7 centimeters along Y axis. A clear outbreak point is observed with almost three times larger amplitude than the peak noise level. With a further examination of this part of the signal, as shown in figure 4 (upper part), we can precisely determine the slip start and end time, so we calculate both the slip duration and additionally the speed. In second experiment (EXP2 - 12 degrees inclination), a significant increase in accelerations amplitude can be found, approximately three times larger, compared to the peak noise level. Similar to EXP1, we calculate slip start and end time, so we specify both the duration and speed, as shown in figure 4 (middle part). In the last experiment (EXP3 - 18 degrees inclination) the presence of an outbreak point which has about four times larger amplitude than the peak noise level is shown. By determining exactly sliding's start and end time, we calculate the total duration and the sliding speed, as shown in figure 4 (lower part).

In table 1 the results of the performed experiments analysis can be found. Comparing aggregated these first results, a clear increase in outbreaks acceleration values against noise acceleration values is observed. To be more specific, peak noise level was 0.01667 g and was the same for all experiments. As for the outbreaks acceleration values, for experiments one and two was 0.04667 g and for experiment three was 0.06333 g. Dividing the outbreak value to peak noise level value determines the outbreak-to-noise ratio equal to 2.79964 for first and second experiment, as well as 3.79904 for the third one. Analyzing better this part in all signals (as shown in fig.5), we define with great accuracy the slide's start and end times for all the experiments. Subtracting the end time from the start time, the slide's duration arises, to 0.6 seconds for experiment 1, to 0.592 seconds for experiment two and to 0.552 seconds for experiment three. In addition, sliding length was the same in all experiments - 7 centimeters. Dividing now displacement with slide duration allows velocities to be calculated. Slide duration was 0.6 seconds for EXP1, 0.592 seconds for EXP2, and 0.552 seconds for EXP3. Therefore, for EXP1 which had 9^o inclination, velocity was 11.67 cm/sec, for EXP2 (inclination 12^o) was 11.82 cm/sec and finally for EXP3 (inclination 18^o) was 12.68 cm/sec. We notice that with a constant sliding length of 7 centimeters, increasing the inclination level increases also the velocity and reduces the sliding duration, as expected.

Regarding precursor activity, further investigation of signal's domain between the outbreak point (slide start time) and the point where we had acceleration values larger than the peak noise level, clearly specified the precursor activity duration to 4ms for EXP1 and 8ms for EXP2 and EXP3. To be more specific, figure 5 (upper part: EXP1, middle part: EXP2, lower part: EXP3) depicts the precise determination of precursor's activity initial (t_0) and final (t_1) points. Final points (t_1) correspond and signify with slide initiation time.

Figure 2. Pre-failure (upper part) against post-failure (middle part) view for sensor 1 and sensor 2. Invalid experiments view (lower part), showing composite sliding.

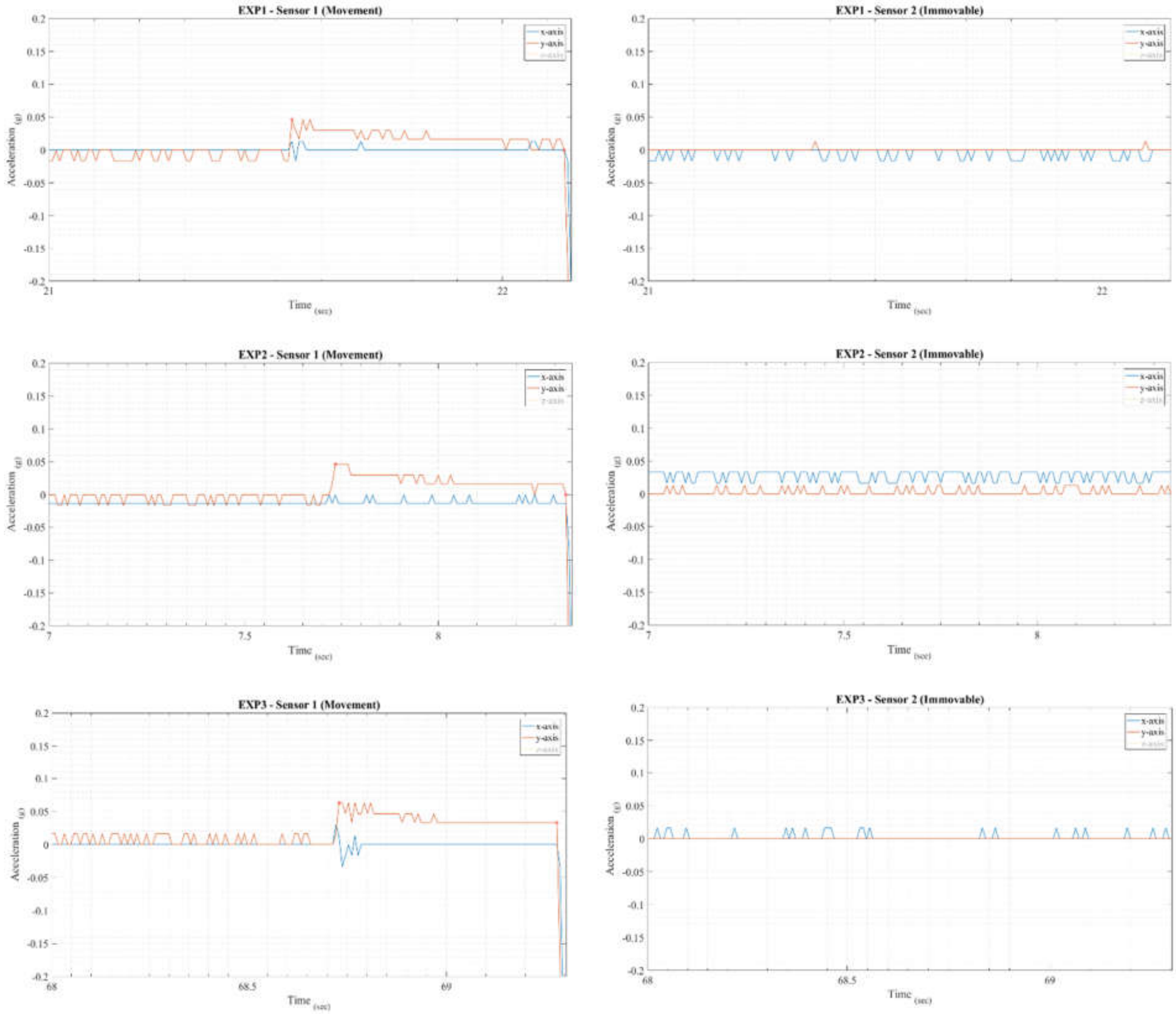

Figure 3. Acceleration over time comparison for sensor 1 (left) against sensor 2 (right)

(up: Experiment 1, middle: Experiment 2, down: Experiment 3

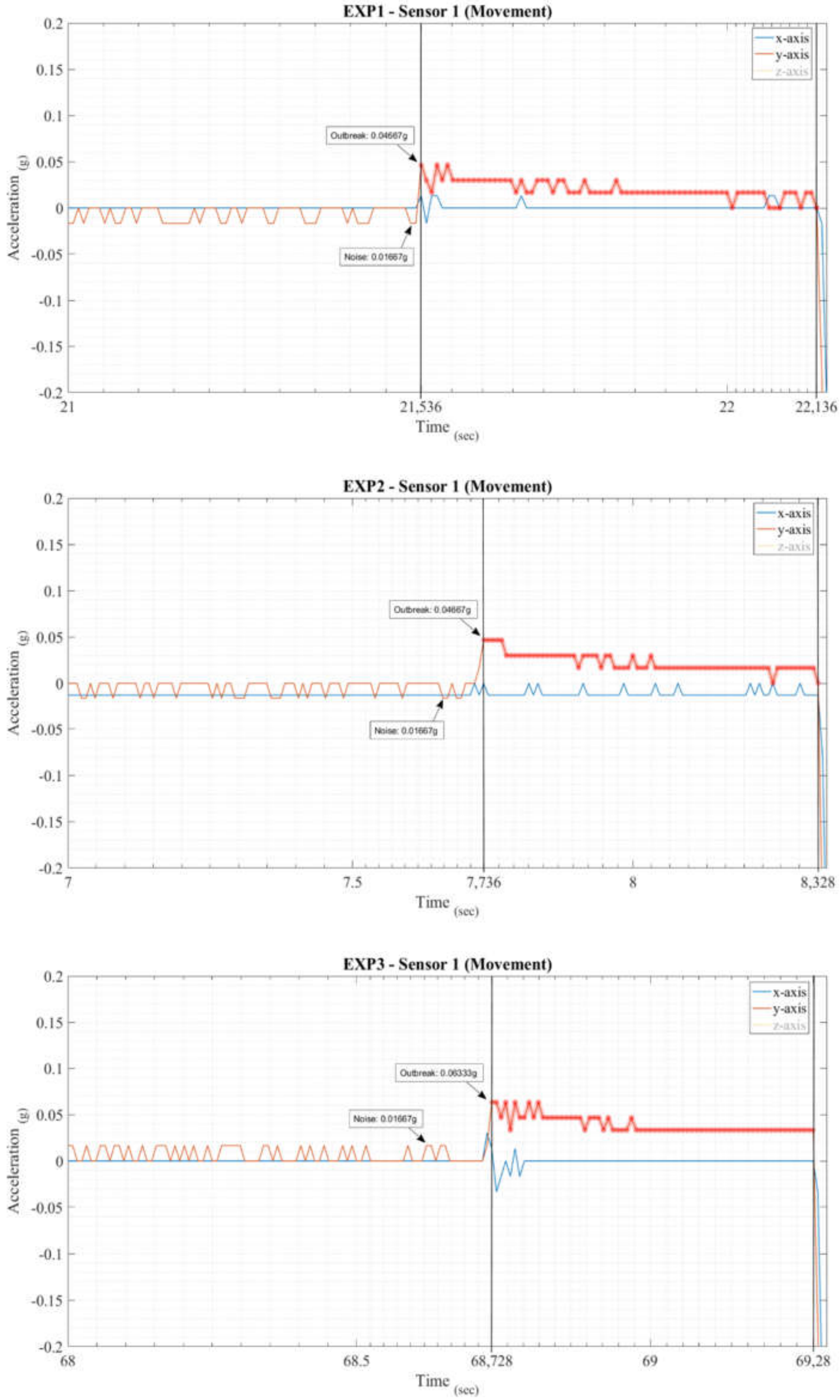

Figure 4. Detailed acceleration over time illustration for sensor 1, showing the outbreak point against noise. (up: Experiment 1, middle: Experiment 2, down: Experiment 3)

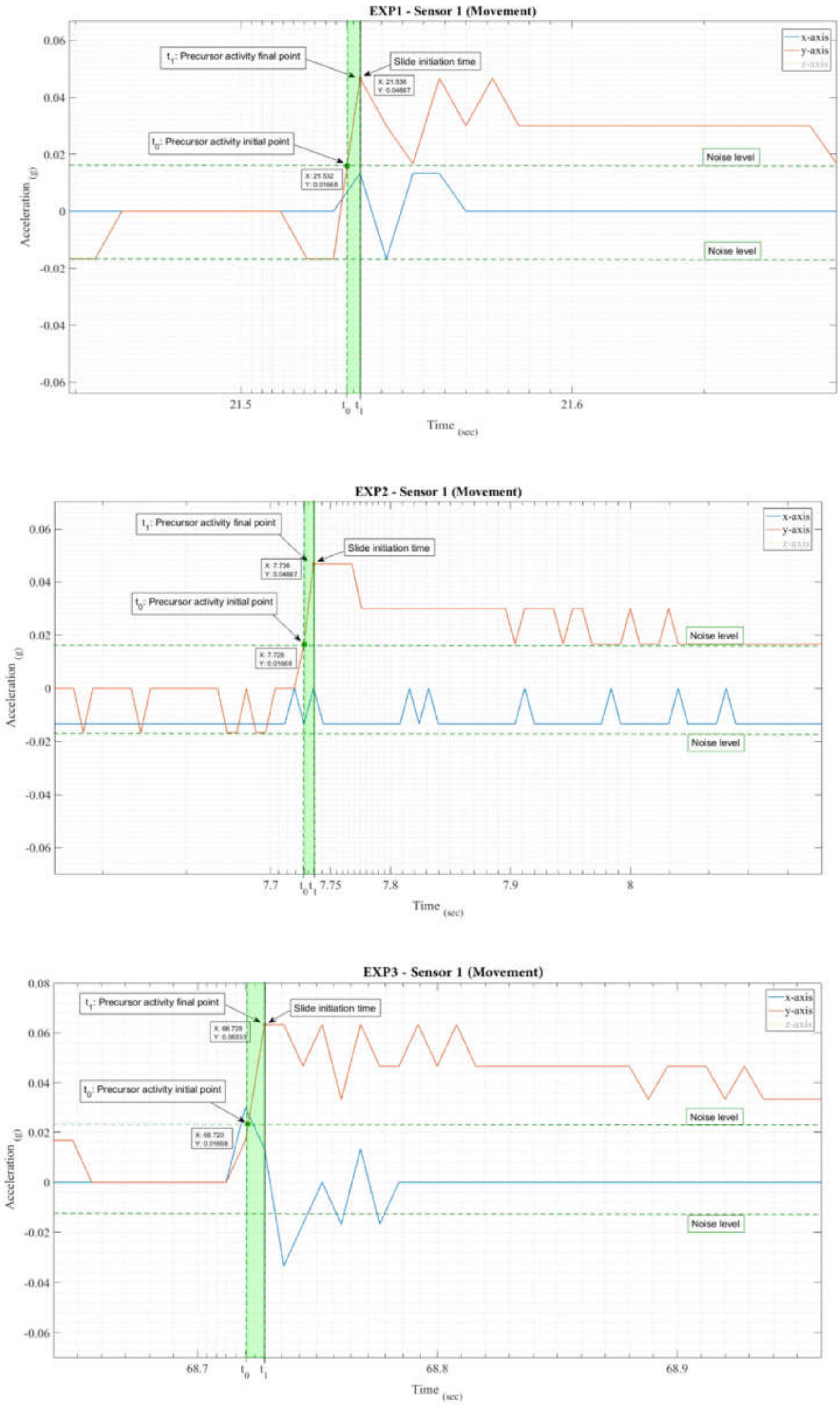

Figure 5. Detailed acceleration over time illustration for sensor 1, showing the precursor activity determination against slide start time (outbreak point) .
(up: Experiment 1, middle: Experiment 2, down: Experiment 3)

	Experiment 1	Experiment 2	Experiment 3
Inclination (degrees)	9°	12°	18°
Outbreak (Y-axis)	0.04667 g	0.04667 g	0.06333g
Peak noise level (Y-axis)	0.01667 g	0.01667 g	0.01667 g
Outbreak-to-noise ratio	2.79964	2.79964	3.79904
Slide start time (from second)	21.536	7.736	68.728
Slide end time (to second)	22.136	8.328	69.28
Slide duration (in seconds)	0.6	0.592	0.552
Precursor activity start time (from second)	21.532	7.728	68.720
Precursor activity end time (to second)	21.536	7.736	68.728
Precursor activity duration (in seconds)	0.004	0.008	0.008
Displacement on Y-axis (cm)	7	7	7
Velocity (cm/sec)	11.67	11.82	12.68

Table 1. Comparative representation for sensor 1 results within Experiments 1,2 and 3

4. Conclusion

To summarize, a low cost system capable of recording and detecting early landslide activity phenomena is presented. Its innovation is based on the very low development cost along with low-cost acceleration sensors usage (MEMS accelerometers). It is not only easily expandable, since velocity sensors (geophones) can simultaneously be used, but also extremely portable with the ability to be easily transferred on the field. Based on an Arduino Uno R3 single board microcontroller is universally open - source code in usage and development. Moreover, it has great configuration features like adding one or additional rain sensors, for later defining the failure causes of the monitored slope, such as an intense and prolonged rainfall. Its advantages can be further improved by adding a lead component battery charged by a solar panel results for almost complete energy autonomy, while usage of a better low cost acceleration sensor aims at even more accurate measurements.

Through a small-scale landslide simulation, our main goal was initially to detect the failure beginning time and then to determine the precise time region between the point with acceleration values larger than the peak noise level and the failure start time. Even though these laboratory findings are extremely short in a region of time (4ms and 8ms), under real field conditions, the precursor activity time region is expected to be more intense and last longer, given that several factors have acted, so as the slope to reach marginal equilibrium state and consequently slide. For all the above mentioned, our next research stage will be the installation of the proposed system on the field, landslide susceptible slopes in a bid to test better the system's behavior under uncontrolled conditions. Since we were able to record and detect this small motion initiated by such an undetectable triggering factor in the laboratory, recording this activity's imprint in real conditions is also anticipated. Besides, slope failure is an event that rarely occurs abruptly, and usually in stages. One cannot ignore that an alarm even a few seconds before failure (e.g. on a beach during summer season) can be proved beneficial, saving many lives and giving us the opportunity to use this in its final form as an early warning system.

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REHABILITATION COST FOR 3 LISTED BUILDINGS IN THESSALONIKI

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Abstract

In Greece, the protection of the listed buildings is a very complex issue, subjecting to a complicated legislative framework, to frequently overlapping competences between different Public Services, to unclear ownership and to the facing of significant financial cost needed for their restoration and reinforcement.

A listed building may not be demolished, extended or altered without special permission from the local planning authority. Detailed technical and economic studies will specify the necessary interventions to be carried out. Several factors must be considered, such as the clarification of the legislative framework, the analysis of the static entity, the identification of the pathology of the building, its usage, the economic incentives and funding, etc.

This research analyzes three listed buildings in Thessaloniki. These were selected in order to satisfy a number of criteria: they are supervised by different Public Services, they are built with different construction techniques and materials, and their pathology was treated differently. According to the data collected, the cost for the restoration of the structural framework of these buildings range from 216.30€/$\mathrm{m}^2$to 973.20€/m^2.

The study presented herein provides only a first-level techno-economic analysis of the interventions in listed buildings in Thessaloniki, as the results are limited to only three. Although, it is essential to estimate the cost of their preservation in order to enhance public safety and “uplift” cultural heritage. Future research based on the analysis of interventions carried out on a larger number of listed buildings will provide more accurate restoration costs.

Key words:

Greek architectural heritage, Legislative Framework for Listed buildings, Reinforcement Techniques for listed buildings, Intervention Cost, Thessaloniki.

1. Introduction

Monument and listed buildings have been considered as part of our cultural heritage. Their reservation and reconstruction is one of the most significant challenges of cultural heritage and must be major objective of town and country planning (Mpouras, 1983).

Constitution of Greece 1975, as revised by the $\mathrm{VIII}^{\mathrm{th}}$ Revisionary Parliament of May 2008 recognize the importance of cultural heritage as refers directly to the Protection of Natural and Cultural Environment (Article 24). Moreover, an extended and strict national legal framework was adopted through Presidential Decrees, Laws (e.g. 3028/2002), Ministerial Orders (e.g. 153/A325/02 “…credit facilities for listed buildings…”) and Joint Ministerial Decisions (e.g. 27124/07 “Finance of urban environment improvement projects”) to develop, exploit and utilize Listed buildings. Moreover, the appropriate legislative framework provides information about Building Permits and approvals, about accepted construction works in historic built environment etc. Apart from its national legislation, Greece, alongside with other nations, Greece has co-signed several International Conventions (e.g Venice Charter, 1964, Granada Convention, 1985, UNESCO Paris Convention, 2003) and EU Directives (e.g European Council Directive 2014/52/EU, Recommendation 880 (1979) of the Parliamentary Assembly of the Council of Europe) that have been ratified by the Hellenic Parliament, as well.

Nevertheless, the regulatory environment for the listed buildings in Greece is quite intricate. The authority for listing and management of listed buildings is granted to two ministries: the Ministry of Culture and Sports and the Ministry of Environment and Energy. The structure of each Ministry defines and establishes the Services and Advisory Bodies that are responsible for the conservation of the architectural heritage. A building can be declared as listed by either one of the above mentioned Ministries or by both the Ministries. Moreover, each Ministry has its own database for listed buildings according to its regulations (Fig.1) and follows different procedures to approve or deny the requests for carrying out any work on the listed buildings they supervise (Fig. 2a, 2b).

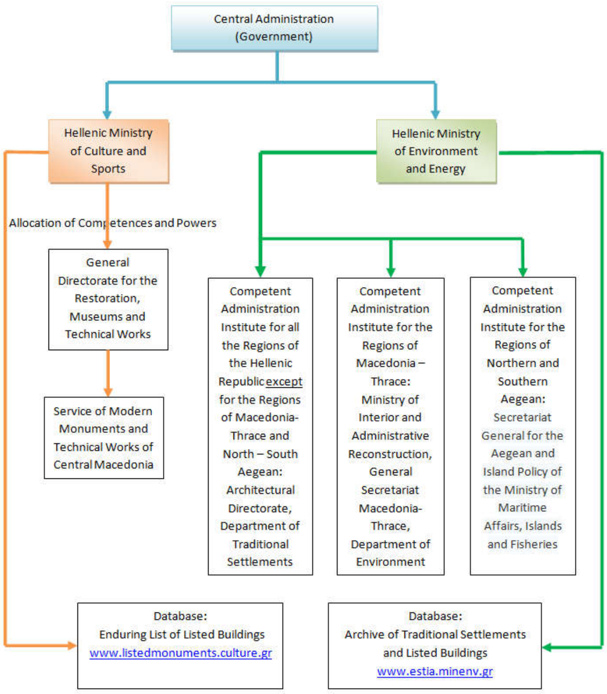
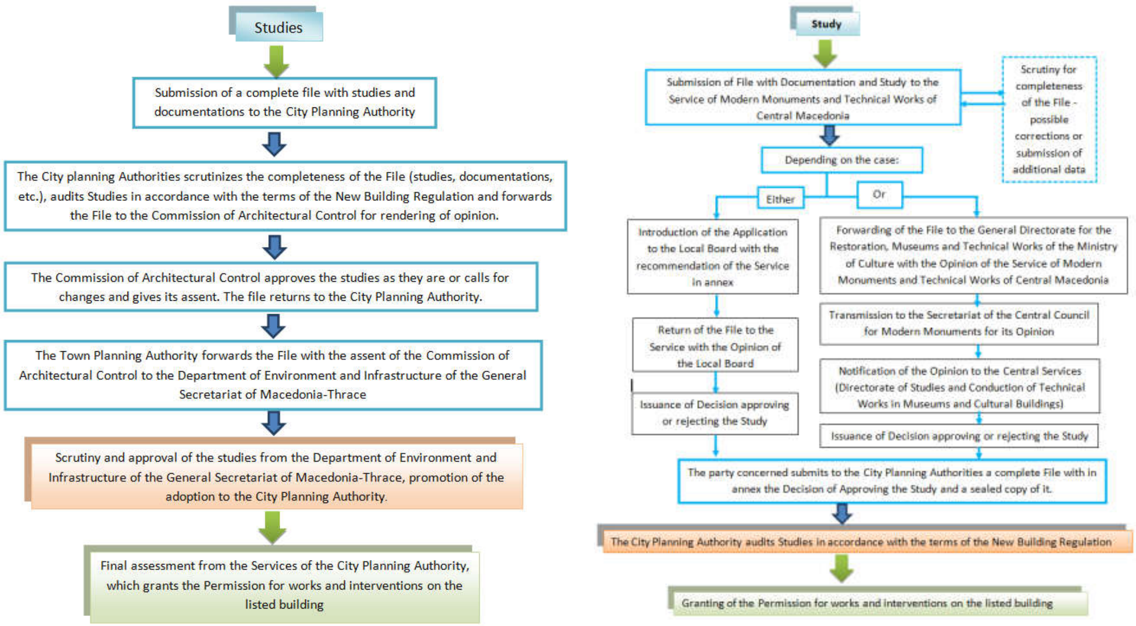


Fig.1 Authorities engaged in listed buildings in Greece.

It should be mentioned that if a building is characterized as listed by both Ministries, then both procedures must be followed. Nevertheless, the procedure under the Ministry of Culture and Sports proceeds of any other approval authority and the provisions of the Law 3028/2002 of the same Ministry prevail over any other legislation (Dousi, Kampouri, 2012).



(a) (b)

Fig.2 (a) Procedure for the approval of interventions on a listed building under the supervision of the:(a) General Secretariat of Macedonia-Thrace (Ministry of Environment and Energy), (b)Ministry of Culture, Service of Modern Monuments and Technical Works of Central Macedonia

This research presented herein analyzes three listed buildings in Thessaloniki and provides a first-level techno-economic analysis of the interventions. Table 1 illustrates the legislation framework relevant to listing buildings in Thessaloniki (Greece).

Table 1.Legislation relevant to listing building in Greece – focus on Thessaloniki.

Hellenic Ministry of Culture and Sports	Law 3028/2002	Protection of the antiquities and of the architectural heritage.
	Presidential Decree 104/2014	Organization and structure of the Hellenic Ministry of Culture and Sports. Departments supervising listed buildings.
	Ministerial Order 19/6/1983	Statutory criteria resulting to listing certain buildings in the commercial centre of Thessaloniki (Agiou Mina and Edessis streets) as works of art (equivalent to Grade I category in UK).
	Law 1337/1983	Implementation Act, Capital Transactions in Land and Money, Urban Fabric Expropriations, and similar provisions.
	Law 358/1986	Transferring competences and powers of acting to public services of the (former) Ministry of Macedonia and Thrace.
	Law 2508/1997	Town Planning and Environmental Council. (Jurisdiction, Organization Chart, etc.)

Hellenic Ministry of Environment And Energy	Law 4067/2012	New Building Regulations. (Last prior: Law 1577/1985, Law 2831/2000).
	Law 4495/2017	Regularization of arbitrary building. (Last prior: Law 3843/2010, Law 4014/2011, Law 4178/2013).
	Presidential Decree 12/3/1979	Presidential Decree for the Upper City of Thessaloniki – criteria, listing, rulings and regulation for reconstructions and building.
	Presidential Decree2/11/1983	Characterization of certain buildings in Thessaloniki as listed.
	Presidential Decree15/4/1988	Reconstruction of demolished listed buildings.
	Presidential Decree 27/7/1999	Encoding of basic urban legislation.
	Ministerial Order 5650/1994	Declaration of 87 buildings in the "Ladadika" area as listed.
	Ministerial Order 3428/2016	Declaration of 199 buildings in Thessaloniki as listed.

Three listed buildings in Thessaloniki were studied and analyzed concerning the interventions for the reinforcement of their structural framework. These buildings were selected as a representative sample as they are governed by different administrative authorities, have different structural frameworks, and are examples of different reinforcement techniques. This diversity of characteristics allows a better technical and economic approach of the rehabilitation cost of the listed buildings. Nevertheless, future research based on the analysis of interventions carried out on a larger number of listed buildings in Thessaloniki will provide more accurate restoration costs.

Except of the complicated legislative framework, the identification of the pathology of a listed building is a very complicated issue that includes several uncertainties such as the identification of its structure system, of the code/ practice/materials used, combined with its poor maintenance, atmospheric pollutants etc (Spanos et al, 2002). Different types of interventions are needed for the restoration of listed buildings, the avoidance of the reappearance of damages in the future or their strengthening due to their usage. Several techniques are used for their preservation (e.g. deep grouting, reconstruction of masonry, grouts application at cracks or stitching, construction of lintels) and/or fortheir reinforcement (e.g. soil reinforcement, slab brackets, underpinning, beams/bars and chainages, reinforced coating, jackets, tieback anchors etc.) (Atmatzidis & Athanasopoulos, 2006; Dimosthenous, 2009; Dritsos, 2005; Milltiadou-Fezans, 2016; Tsonos, 2006).

The final decisions of interventions must satisfy several requirements and standards (Parthenopoulou et al, 2009) In the case of a private property the cost of the interventions and the amortization of the investment are of paramount significance, whereas, in the case of a public property, this is of lesser relevance.

The most important factors affecting the planning of the conservation, restoration or reinforcement except of civil engineers' experience (Kakavas, 2013), are the economical funding (Republic of Cyprus, Ministry of Finance, 2008), the span of life of the interventions, the flexibility in allowing alternative uses and facilities in the building,the cost of the works, the time required for their completion, the capital gains anticipated after the interventions on the building (as a direct result from its condition, location, size, permitted uses, etc.), the economic viability of the investment (amortization period), the low maintenance cost in the future, the estimated life span of the materials, and of the building in general after the interventions, the satisfaction of the installation of well-defined objectives of uses of the building in light of a multifunctional character, the obligation or desire for reversibility of the interventions (which requires the implementation of very costly techniques), the possible constrains or limitations to the materials or techniques may exist, the legislative framework and Public Services limitations.

After the decision for the restoration of a listed building has been taken, the procedure of the interventions for its structural reinforcement methodically follows distinct steps and phases until the completion of works. The interventions for the treatment of the pathology of listed buildings are based on techniques consisting of works and materials aiming to satisfy multiple targets (e.g. reinforcement and reuse).

As a result of the above, most developers still regard re-use of listed buildings to be an unfavorable venture when compared to other types of development; hence, vacancy and dereliction of listed buildings.

2. Analysis and study of three listed buildings in Thessaloniki.

The three selected buildings (Fig. 3) are:

- A multi-story building at 1 Rempelou Street, dating from 1929, with reinforced concrete frame construction, today used as a hotel.
- A two-story residential building at 24 Kleious Street at the Upper City, dating since 1870, with wood supporting framework for brick masonry and
- A two-story building at 5 Edessis Street, Upper Ladadika, dating from 1870, with a composite structure, today housing multi-purpose facilities.

Fig. 3 The location of the three buildings

It must be stressed that the estimated cost of the three buildings refers only to interventions for the reinforcement of the structural frameworks of the buildings and does not take into account other costs of interventions for restoring architectural or morphological characteristics, interior adjustments, re-decoration and, in general, any other intervention that does not affect directly the structural elements of the buildings.

2.1 Building at 1 Rempelou Street.

Figure 4 summarizes the most important characteristics of the building resulting from the study and analysis, focusing on the interventions on its structural system.The total cost refers only to the interventions for the reconstruction and reinforcement works – not for the addition of the two floors.

The calculation is based on measurements on the “as built” drafts and on the unit rates referred at the Official Journal of the Hellenic Republic 320^{A} / 30-12-2011.

1929 2001 2018

Address	1 Rempelou St & Har. Vamvaka, Thessaloniki, Greece.
Land Plot	Plot 5, Block 47, Sector 5 of Burnt Zone, Surface: 164.49m^2
Competent Administrative Authority	Hellenic Ministry of Environment and Energy, General Secretariat of Macedonia-Thrace (1988). Hellenic Ministry of Culture and Sports (1994).
Typology	Multistory Urban Building (Initially: Underground, Ground and two floors)
Construction	1929
Building Permit	595/22-04-1929
Original Use	Commercial (Underground and Ground levels) & Residential (Floors).
Surface Built	Original building 590.92m^2. After the addition of two floors at 2001, the current total surface of the building is 855.35m^2
Structure	Reinforced concrete frame.
Cost	716,784 Drachmae (Value of 1929)
1978 Earthquake	Inspection Report: "Yellow"- Sporadic: disclosure of steel reinforcement, concrete carbonation at basement level.
Pathology	Local failures due to fatigue (material aging and poor maintenance). Limited load-bearing capacity. Absence of seismic design. Low static equilibrium. Inadequatestructuralsafety.
Building Permits for interventions	1447/2001 Permit for "Reconstruction, Reinforcement and Addition of two floors" and 26/2015 Permit for "Change of use" from the City Planning Services of Municipality of Thessaloniki.
Tools and methods of interventions	Concreting new foundation floor ("Radier General"). Perimeter concrete wall at basement. Reinforcement of existing pillars (Emaco, steel frames) and beams (Gunite). Addition of steel pillars and beams, new concrete walls, new steel frames. Reinforcement of concrete floor slabs.
InterventionsCost	Total calculated cost : 185,000.00€
Intervention Cost per m^2	$\frac{\text{Total calculated cost}}{\text{Surface of building where inerventions were carried out}} = \frac{185{,}000.00€}{855.35m^2} = 216.30\,{}^{€}/_{m^2}$
Current use	Hotel *("Caravan Bed-and-Breakfast")*.

Fig. 4 Summarized report of the most important information of the building at 1 Rempelou Street.

2.2 Building at 24 Kleious Street, Upper City of Thessaloniki.

The most important information on this building is summarized at Figure 5. The total cost for the reconstruction and reinforcement works was calculated with data from the "as built" drafts of the Revision of the Permit (2016), using the unit rates referred at the Official Journal of the Hellenic Republic 320A / 30-12-2011.

Late '60s | 2013 | 2018

Address	24 Kleious St., Upper City of Thessaloniki.
Land Plot	Block 43, Surface: 153.29m^2
Competent Administrative Authority	Hellenic Ministry of Environment and Energy, General Secretariat of Macedonia-Thrace, listed building Category I (1999). Decree of Upper City Thessaloniki – Sector II.
Typology	Detached House (Semi-underground, Ground floor, Upper floor)
Construction	1870
Building Permit	(No original Building Permit was issued)
Original Use	Residential
Surface Built	186.62m^2
Structure	Foundation – perimeter walls of basement: Stone Masonry. Superstructure: Brick Masonry – wood supporting framework. Wood supporting framework for floors. Supported timber frame roof. Tiles roofing.
Cost	(There are no records of the cost of the original construction)
1978 Earthquake	Inspection Report: "Severe cracks at courtyard masonry. No subsidence or deviations from the vertical plane were recorded. There is no need for ordering the evacuation of the house".
Pathology	Local failures due to fatigue (material aging and poor maintenance). Low quality materials. Limited load-bearing capacity. Shearing forces. Absence of seismic design. Stress forces. Cracks and deviations from verticality due to forces from later additions to the building. Low static equilibrium. Inadequate structural safety.
Building Permits for interventions	53/2013 Permit for "The Demolition of non-designated additions", 96/2013 Permit for "Reconstruction and Reinforcement", Revised in 2016, the Municipality of Thessaloniki, City Planning Services.
Tools and methods of interventions.	Removal of all additions to the original construction. Gunite and grouts at stone masonry. Usage of steel beams and wooden frames for strengthening. Reinforcement of wooden frame of brick masonry. Restoration of verticality. Replacement of deteriorating bricks. New coatings.
Interventions Cost	Total calculated cost : 181,620.00€
Intervention Cost per m^2	$\frac{Total\ calculated\ cost}{Surface\ of\ building} = \frac{181,620.00€}{186.62m^2} = 973.21\,€/m^2$
Current use	Residential

Fig. 5 Summarized information on the building at 24 Kleious Street.

2.3 Building at 5 Edessis Street.

The most important information on the interventions on the structural framework of the building is summarized at Figure 6. The calculation of the cost of these interventions is based on quantities resulting from the "as built" drafts and the unit rates referred at the Official Journal of the Hellenic Republic 320[A] / 30-12-2011.

Address	5 Edessis St., Upper Ladadika, Thessaloniki, Greece.
Land Plot	Surface: 390.37 m^2
Competent Administrative Authority	Hellenic Ministry of Culture and Sports. 1983: Designated as "work of art", alongside with other buildings of the commercial center of Thessaloniki.
Typology	Two-story building (Ground and Upper floors)
Construction	1868
Building Permit	(There are no records for any Building Permit)
Original Use	Originally: Inn – Later: commercial uses.
Surface Built	728.10 m^2
Structure	Composite structure (Foundations: Stone Masonry. Ground floor: Perimeter Brick Masonry – Steel pillars and beams support the composite roof of slabs made from solid bricks and concrete flooring. Upper floor: Perimeter Brick Masonry Perimeter Brick Masonry, interior brick masonry and interior wooden pillars supporting the roof made from wooden framework, roofing with French tiles.
Cost	(There are no records of the cost of the original structure).
1978 Earthquake	Inspection Report: "Green"- sporadic cracks at the brick masonry of the upper floor.
Pathology	Surface corrosion of steel pillars and beams. Failures of wooden roof trusses. Extensive deterioration of mortar and plaster. Local failures due to fatigue (material aging and poor maintenance). Absence of seismic design. Inadequate structural safety.
Building Permits for interventions	56/2016 Permit for "Reconstruction, Reinforcement and Renovation and Modifications of the Interior from the Municipality of Thessaloniki, City Planning Services.
Tools and methods of interventions.	Basement: partial Radier General, reinforcement of the base of steel pillars with reinforced concrete. Reconstruction of mortars and plasters. Reinforcement by iserting a new double-faced steel beam. Anticorrosion treatment. Sporadic grouting,
Interventions Cost	Total calculated cost : 510,000.00€
Intervention Cost per m^2	$\frac{Total\ calculated\ cost}{Surface\ of\ building} = \frac{510{,}000.00€}{728.10m^2} = 700.00\,€/m^2$
Current use	Multi-purpose facility (Exhibitions, Offices, Café)

Fig. 6 Summarized information on the building at 5 Edessis Street.

3. Conclusions.

The research presented herein proved that each listed building is unique, has different legislative framework, age of construction, pathology and it needs to be studied separately.

The study of the three buildings confirmed that there are plenty of techniques and materials that can be used for interventions as different techniques and materials were used in each case. The cost of the interventions on the selected buildings range between 216.30euro/m2 to 973.21euro/m2 as is direct connected with a chosen technique-method for the intervention (Building 1: 1 Rempelou Street/ Radier General, Emaco, steel frames and gunite in beams, Building 2: 24 Kleious Street/ Gunite and grouts at stone masonry, steel beams and wooden frames, Building 3: 5 Edessis Street/ Partial Radier, reconstruction of mortars, sporadic grouting and steel beam) and depend upon the pathology of the building (Building 1: Local failures due to fatigue limited load – bearing, inadequate structure safety; Building 2: Local failures due to fatigue, low quality materials, limited load-bearing capacity, cracks, inadequate structure safety; Building 3: Surface corrosion, failures of roof, extensive deterioration of mortar and plaster, local failures due to fatigue), the selected the time needed to implement the interventions, the construction type (Building 1: Reinforced concrete frame; Building 2: Stone

Masonry and wood supported framework, Building 3: Composite Structure), the original use (Building 1: Commercial & Residential; Building 2: Residential, Building 3: Inn- later: commercial use) and the experience of the competent engineer. It must be stressed that the estimated cost of the three buildings refers only to interventions for the reinforcement of the structural frameworks of the buildings and does not take into account other costs of interventions for restoring architectural or morphological characteristics.

Future research based on the analysis of interventions carried out on a larger number of listed buildings will provide more accurate restoration costs.

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FOREST FIRES, ONE SIMPLISTIC APPROACH

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Abstract

It is a fact that the occurrence of a forest fire is one of the most frequent incidents in the news agenda, especially during the summer period. The scope of this work is to study the problem of forest fires through literature research. Firstly, we are defining the forest fire; record of the causes of the forest fires and the consequences thereof are made. Secondly, after mentioning the types of forest fires, the factors that affect the start and spread of forest fires as well as the measures required to deal with them are studied. Thirdly, there is a brief description of forest fire prevention and repression measures in Greece. In conclusion, forest fires, with the exception of those due to natural causes and aiming at the regeneration of nature, are almost equally disastrous for both the forest and the human being. Concluding, the forest fires are an issue with enormous consequences for both the structured and the natural environment, so through this work an attempt is made to inform and understand this phenomenon, which sometimes proves to be disastrous.

Keywords: forest fires, problem, nature, natural disaster

1. Introduction

According to the revised Constitution of Greece in Article 24, by forest or forest ecosystem, the organic whole of wild plants with woody trunk on the necessary area of ground is defined, which, together with the flora and fauna co-existing there, constitute, by means of their mutual interdependence and interaction, a particular biocoenosis (forest biocoenosis) and a particular natural environment (forest-derived). A forest expanse exists when the wild woody vegetation, either high or shrubbery, is sparse (The Constitution of Greece, 2008). The forest is one of the most complex ecosystems of nature (Chazdon et al., 2016) and plays an essential and decisive role in preserving the global ecological balance and, by extension, life itself (Messier et al., 2015). Forests are a lively, dynamic ecosystem that uses different ways and means to perpetuate them, one of which is fire. Nasi et al. (2002) report that fire is a vital and natural part of the functioning of numerous forest ecosystems and Hovi et al. (2007) mention that perhaps the most striking forest restoration method is prescribed fire, which creates disturbance regimes where natural succession dynamics prevails. However, although fire plays a key role in the regeneration and existence of forests, it often tends to become the main factor in their destruction and total disappearance, possibly being the most important global hazard (Mitsopoulos & Mallinis, 2017).

2. The definition of forest fire

The main driving factor in the story of human evolution is fire (Wayman, 2012). In 1970 Katsanos (Κατσάνος, 1970) describes the fire as the uncontrolled burning with oxygen, along with the release of large amounts of heat and light, accompanied by destruction of the burned material and can have undesirable effects. In a same way Emmons and Atreya (1982) tried to present a scientific understanding of fire in their study about the science of wood combustion. Those two researchers wrote about the triangle of fire and explain that fire is the natural phenomenon caused by burning, the chemical reaction of various elements with oxygen. The combustion, in order to be carried out, requires the existence of a combustible material and heat supply. These three factors oxygen-combustible matter-heat constitute the famous triangle of fire. Tampakis and Karanikola in 2015 wrote for the triangle of fire that without oxygen nothing can burn; without heat cannot ignite fire and without combustible matter there is nothing to burn (Ταμπάκης & Καρανικόλα, 2015). In addition, the triangle of primary conditions that can affect extreme forest fire behavior consists of topography, fuels, and weather (Trollope et al., 2004). Steeper slopes and generally the presence of hilly reliefs creates windbreaks, speeds up the wind in ravines and increases the impact of topographic thermal winds tending to increase the rate of fire spread. The vegetation constitutes the fuels for the forest fire. The amount and type of vegetation available for combustion is crucial in the way a fire ignites and spreads. Furthermore the behavior of forest fire depends on the quantity of biomass present in the three main vegetation strata (herbaceous, scrubs and trees) as well as on its moisture. Hot, dry, and windy conditions are generally ideal for the rapid growth and spread of forest fires (Dlamini, 2010; Plana et al., 2016).

Forest fire is a term which is used in Europe to designate the unwanted fires burning forests and wild lands and make up a serious problem for Europe. Forest fires are extremely powerful and destructive phenomena which occur with significant frequency and intensity not only in Europe but on many parts of the Earth (Dlamini, 2010). Forest fires, as well as fire in general, are the result of combustion. In each forest area, because of the high concentration of combustible organic matter, there are specific critical conditions, i.e. defined limit values of the triangle which, when overcome, generate ignition and fire starts (Κωνσταντινίδης, 2003). Overall, the result from an uncontrolled spread of fire in a forested area called forest fire (Plana et al., 2016).

Forest fires are part of the ecology of forest ecosystems in Greece and generally in the Mediterranean region and are a complex phenomenon that follows the laws of nature (Pausas and Vallejo, 1999). Forest fires represent an expression of how nature works in a highly flammable, Mediterranean environment and is related in the long run to the natural mechanisms of life cycle recycling and forest regeneration. It is also a devastating phenomenon, which disrupts the balance and natural evolution of natural and man-made ecosystems that depend on the beneficial effects of forests (Athanasiou, 2016).

One of the most important enemies of forest conservation and productivity is forest fires. The rapid and extensive disasters caused to the forest ecosystem are not compared to any other factor. And while they actually look like absolute destruction they are also associated with the regeneration of forests, contributing to their perpetual existence. What is certain, however, is that fires, with their power, create radical changes in forests.

2.1 Causes of forest fires

The causes of forest fires could be classified as follows:

- Natural causes.
  In this category fires are mainly caused by lightning. If they are not extinguished due to rain, they are likely to cause serious damage. Lightning usually falls on slopes and inaccessible locations, which prolongs the approach of fire brigades to start neutralizing them. In the same category fall the fires caused by volcanoes (which are almost non-existent in Europe).
- Negligence.
  Fires caused by “negligence” are very common and are the main cause of fire ignitions in most European countries. Actions such as throwing a cigarette butt or matches, burning garbage and dry grasses, cooking, barbeque, electric cables, engine sparks, military exercises etc. can cause fire. At this point, it is important to note that negligent fires are mainly related to agricultural burnings to remove unwanted biomass and to vegetation management for forestry and pasture purposes (e.g., burning of slash or piles of vegetal waste, and vegetation renovation), because it is a cheap and efficient tool (Leone et al., 2003).
- Deliberate.
  Deliberate fires are linked to different motivations. Setting fire for profit is the most important motivation, mainly related to opening or renovating pasture or for hunting. Interests are also related to setting a fire for monetary (e.g., insurance fraud) or nonmonetary profit (e.g., to set a fire to maintain seasonal employment: Leone et al., 2003; Lovreglio et al., 2010). The irresponsible use of fire assumes a relevant expression and is explained by psychological troubles and mental illnesses and by entertainment or children’s games. Usually the person who ignites fire deliberately selects days or times when the fire will spread rapidly and uncontrollably.
- Unknown causes

These fires cannot reasonably be explained or proved. The unknown causes are explained by the difficulty in determining the ignition point and the cause or by the high number of fires without information or not investigated.

The Hellenic Fire Service in an effort to quantify the causes of forest fires, had publicized the following percentages: Fires by natural causes 3%, by negligence 50%, deliberately 30% and unknown causes 17% (Αρχηγείο Πυροσβεστικού Σώματος, 1990).

2.2 Forest fires and their impact.

It is widely accepted that forest fires are part of the ecological circle of the ecosystems (Athanasiou, 2016) and are an important ecological factor, having a number of effects on the terrestrial and atmospheric environments (Dlamini, 2010). Whether the fire is natural or man-made; it can disturb and strongly change the structures and functional processes of forest ecosystems (Földi and Kuti, 2016). The economy and the environment of the area that burst a fire are directly and indirectly affected.

Forest fires cause significant changes in the microclimate of the area, affecting negatively both fauna and flora. At the same time soil erosion is observed with the inevitable consequence of floods occurring and generally the aesthetic value of the landscape is degraded (Σκρεπετός, 2018). In addition, there are direct and indirect economic consequences of the destruction of forest products (e.g., timber, resin), losses of properties and human lives and a feeling of insecurity for citizens (Τσαγκάρη και άλλοι, 2011)

2.3 Frequency of forest fires.

Fire frequency, differs by region as a function of climate conditions, and the requirement of fuels that are sufficiently dry and abundant to burn (Peterson and Littell, 2012). In Greece, fires started becoming a problem in the 1970s (Athanasiou, 2016). And since then it has been observed that 80% of the most devastating fires occur between June 1 and October 31, while 90% of them occur between 08.00 and 23.00 (Κατσάνος 1970)

2.4 Forest fire types.

Kaulfuß and Hofmann (2011) describe three types of fire: the crown fire, the ground fire and the surface fire. Although Plana et al. (2016) and Földi with Kuti (2016) describe and one more type, the torching fire.

Specifically, those authors describe the fires as:

1. Under ground fire starts in forests, where peat layers can be found beneath and it spreads through the underground organic matter and roots. In most cases under-composed organic material enriched in the upper layers of soil burns without flames. Even though flames are not visible, the fire can stay active for long periods. Usually the spreading speed is slow.
2. Surface fire starts at the lower parts of the trunks and roots above the surface and spreads through the surface fuel strata (herbaceous strata, duff and shrubs). Spread rate depends on air direction and speed.
3. Torching fire occurs when smaller trees and bushes can catch fire. In that case fire spreads from the surface strata and into the crown of a single tree or small parcel of trees. The spreading is faster and the burned area grows radially.
4. Crown fire spreads through tree crowns. This type of fire is not only on the ground, but on trunks, leaves and shrouds of bushes and trees, with the burning of leaves, twigs and bigger arms of the trees.

The latter is characterized by the highest severity and an uncontrolled growth.

2.5 Factors that affect the onset and spread of forest fires.

The way in which the fire will behave, depends on various factors that affect it. These include fuels, weather, and topography.

2.5.1 Fuels

The forest as a whole is considered as a fuel as it consists of flammable materials (Σκρεπετός, 2018). However, the way in which these materials affect the behavior of the fire depends on a number of factors, such as quantity, structure, composition, humidity, temperature and type of vegetation (Fire security, 2013).

The amount of fuel is considered a key factor in combustion and an important parameter for forest fires. The increased biomass in forests combined with its distribution in the site -i.e. the structure of the vegetation- are key elements for the spread, speed and intensity of the fire (Ganteaume and Jappiot, 2013). The density of the fuel is inversely proportional to the ignition capacity. Dead biomass burns very easily due to its low density. Also, fuel anatomy affects burning, in particular wood porosity has greater ease of ignition, as well as rough and uneven surfaces are more easily ignited (Ταμπάκης & Καρανικόλα, 2015)

The temperature of the fuel is another factor in the development of a fire. The temperature of the fuel depends on the temperature of the air and the intensity of the incident solar radiation. Hot fuels ignite more easily and contribute to a more rapid spread of fire (Moreira et al., 2010).

Fuel humidity is another factor to consider. According to Xantopoulos and Wakimoto (1993) the moisture content of the fuel is the amount of water in grams contained in a gram of dry combustible matter. The higher humidity a fuel contains the slower is its ignition. It is worth noting that the change in moisture content of living biomass is influenced by the physiology of the plant and to a lesser extent by environmental conditions. Conversely, the change in moisture content in dead fuel depends exclusively on environmental conditions, since we are talking about dead organisms (Ταμπάκης και Καρανικόλας 2015).

2.5.2 Weather

Weather can affect many aspects of a fire, such as intensity, severity, and fire size (Feng et al. 2015).

Air temperature has a direct effect on the behavior of the fire due to the heat requirements for ignition and the continuation of the combustion process. It has been observed that that large forest fires occur in Greece during hot exhaust gases and when temperatures above 30°C are combined with moderate or strong winds.

Relative humidity is also a regulating factor in the moisture content of the fuel and thus in the ignition and continuation of the combustion process. Relative humidity is the ratio, ie the fraction, of the moisture content in the air to the maximum humidity that the air could hold at the same temperature and pressure, i.e. when the air is saturated. The relative humidity is usually expressed as a percentage. When we have fog in the atmosphere, that is, humidification of water vapor, it means that the relative humidity is 100%. As the air temperature rises, the relative humidity decreases as the air can hold more moisture. Relative humidity affects the behavior of the fire because it affects the moisture content of the fuel. Low relative humidity levels result in faster evaporation of fuel moisture. Therefore, the smaller the amount of moisture we have on a fuel, the less heat energy is needed to come to a flashpoint (Σκρεπετός, 2018)

2.5.3 Wind

The motion of the air caused by the rotation of earth, its anaglyph, but also because of the sun's radiation is called wind (Μακρυγιάννης & Σαχσαμάνογλου, 1994). The wind is a changeable factor that can influence the intensity and magnitude of the fire through its direction and speed and, depending on the topography of the area that breaks out a fire; to make it particularly difficult to extinguish (Mitsopoulos and Mallinis, 2017).

When a fire starts in a region, if no wind blows, then the fire will extend approximately concentrically around its starting point as it burns a homogeneous and uniform layer of forest fuel. If the wind prevails, the fire will extend mainly towards the wind direction and less in the opposite direction, and if the wind suddenly changes its direction, then the fire will expand to the new direction of the wind (Καϊλίδης και Καρανικόλα, 2004). At the same time, through the wind a fire is fed with more oxygen, which speeds up the burning process, while transferring heat through the wind is another negative consequence that results in more intense and faster spread of fire (Weather Elements, 2017). Finally, the wind can become the means of transporting ignited fuel particles (burners) at a distance of tens or hundreds of meters from the front of the fire, contributing to its uninterrupted expansion.

2.5.4 Topography

Areas with intense topography are more likely to experience large fires (Guyette and Dey, 2000). Fire generally spreads faster uphill than downhill because fuels are more efficiently preheated by the uphill spreading flames and heat. Additionally, the steeper the slope, and the more fuel, the faster the fire will burn and spread. Fuels dry earlier in the season on south slopes compared to north slopes. Low areas that lie between two higher ridges, called saddles, also influence fire behavior. Topographic features such as “chimneys,” which are vertical drainages on either side of a hill, can draw fire up very rapidly as the hot air rises, even creating their own winds. As a result, topography can alter the normal heat-transfer process of a fire, modify general weather patterns, and result in microclimates with localized moisture conditions (Leavell et al., 2017).

2.6 Addressing forest fires

It is commonly accepted that forest fires are a global problem and a serious threat to the ecosystem's balance, with particularly negative effects on the environment, society, economy and human life in general (Σκρεπετός, 2018). Their proper handling will therefore minimize them. The key to successfully addressing forest fires lies in prevention rather than repression which runs counter to the policies pursued by mainly Mediterranean countries, since the most serious of the measures they take is repression (San-Miguel-Ayanz, 2013). Nevertheless, almost all countries take a series of preventive measures such as: 1. Analyzing statistics and investigating causes; 2. Raising awareness and informing citizens; 3. Forest policy and appropriate management of forest ecosystems; 4. Legislative measures; 5. Preliminary planning and preparatory works (Σκρεπετός, 2018).

The repression of forest fires is done by terrestrial and aerial firefighting forces. Forest fire suppression is directly related to the intensity of the fire and in particular to the length of the flames. When flame length is lower than 2.5 meters the strategy to extinguish is direct attack. The firefighting forces act directly on the flame by means of hand tools (any piece of hand-held equipment operated manually or with power assistance used to dig, rake, scrape, chop, cut or remove fuel) and water supplies such as water tankers or water bombing aircraft. If the flame length is between 2.5 and 3.5 m. then the firefighting forces use the indirect attack. In that case the suppression methods are implemented away from the fire edge, such as the creation of a control line (a constructed or natural barrier used to control a fire). Finally, when flame length exceeds 3.5m., then the parallel attack is used. This type of strategy involves the construction of a control line approximately parallel to the fire edge and located at some distance from the fire, which is supported by a back fire (a fire set intentionally along the inner edge of a control line to consume the fuel which is in the path of a forest fire in order to create a fuel discontinuity and consequently minimize and the spread of the forest fire) (Plana et al., 2016).

3. Prevention and suppressive measures in Greece.

3.1 Prevention measures.

Forest fires are a phenomenon that falls into the category of natural disasters (Σαπουντζάκη, & Δανδουλάκη, 2016).

The General Secretariat for Civil Protection (GSCP) designs, plans, organizes and coordinates actions regarding risk assessment, prevention, preparedness, information and response to natural, technological or other disasters or emergencies, coordinates rehabilitation operation, monitors the above actions and informs the public on these issues.

Forest fires within the framework of the General Civil Protection Plan under the code "XENOKRATIS" may cause:

- Injuries and loss of human life.
- Direct and indirect economic losses from disasters in the primary sector (forest products, agriculture, livestock farming), to various infrastructures and facilities in the country (electricity networks, telecommunications, etc.) as well as consequences for forest recreation and tourism in general.

- Disruption of ecological balance of natural ecosystems.

For this reason, the preventive measures are determined by the Civil Protection and are as follows: 1. Risk Analysis, 2. Fire and forest fire protection works, 3. Checking the status and proper functioning of the fire hydrant, .4. Preventive cleaning of vegetation to reduce the risk, 5. Preventive cleaning of vegetation along the road network, 6. Measures to avoid fire from the operation of uncontrolled urban waste disposal sites, 7 Measures to avoid the occurrence of fire from the performance of agricultural and other work in open air, 8. Measures for the protection of children's camps, campsites, 9. Issuance of a fire risk prediction chart, 10. Thematic maps of administrative boundaries for municipalities, fire and forest services, 11. Informing the public about self-protection measures against forest fires, 12. Preventive traffic ban (Γενική Γραμματεία Πολιτικής Προστασίας, 2018).

3.2 Suppressive measures.

In Greece, the Hellenic Fire Service is a subdivision and operational arm of the GSCP and is responsible for the operational design of fire and assistance for the rescue of individuals and material goods threatened by them.

The extinguishing measures in the case of a forest fire are primarily the responsibility of the Fire Brigade in cooperation with Civil Protection and are mainly the following: 1. Actions of increased preparedness in view of threatened threat to forestry fire actions 2. Actions for announcing, controlling and suppressing forest fires 3. Supporting the firefighting body to the task of combating forest fires 4. Actions to deal with emergencies and to manage the consequences of forest fires (Γενική Γραμματεία Πολιτικής Προστασίας, 2018).

4. Conclusion

Fire plays a vital role in maintaining many ecosystems and the communities that depend on them. Fire is a natural process that has played a major role in shaping our environment and maintaining biodiversity worldwide. Fire’s benefits and impacts are extensive; the majority of the world’s terrestrial habitats depend on fire for ecological sustainability. Howbeit even that fire is considered as a key ecological process can be a threat to biodiversity and human livelihoods with unwelcome and far reaching consequences (Shlisky et al. 2007).

No other element of nature is so beneficial and at the same time as destructive as fire. Using its power, man has managed to create modern civilization but at the same time the same power of fire, when escaped from man’s control, caused disasters that sometimes were irreparable. The majority of forest fires, with the exception of those due to natural causes and aiming at the regeneration of nature, are equally devastating both for the forest itself and the mankind.

Urban societies have often a limited knowledge and awareness of the real causes of the forest fire problem; so the only way to solve this problem is to understand the reasons which cause it.

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THE PRESENTATION OF THE SEMINAR: "DISASTER MANAGEMENT IN CULTURAL INSTITUTIONS," ATHENS, GREECE / JUNE 2017

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Abstract

Successful disaster management in cultural institutions begins with the awareness of this pressing necessity as the frequency and intensity of disasters notably increases. The seminar, "Disaster Management in Cultural Institutions," was designed to improve the understanding and knowledge of professionals in the cultural sector about the development and implementation of disaster management strategies specific to cultural materials and sites. Creating a common base of knowledge, systematic and aligned response actions are the key in developing crises management specific to protection of Greece's important cultural resources.

The 10-day seminar targeted professional level cultural heritage professionals, including directors, conservators, librarians, archivists, curators, collections managers, archaeologists, stewards of historic churches and house museums, and students. International systems of response, extensive resources, and hands-on experiences introduced seminar participants to the theory and practical tools for disaster management. Lectures and exercises guided students through the necessary progressive steps of risk assessment, analysis, strategic planning, and preventative actions in advance of catastrophes. Students then learned the protocols and goals of response, salvage and recovery after catastrophes occur. The systems adopted in international level for disaster management on cultural institutions can be easily adapted to Greek cultural institutions tailoring requirements of disaster management to each organization. This course, along with ongoing seminars in Greece, is a starting point for establishing a dialogue, mutual understanding, and cooperative support among Greek organizations.

Keywords: catastrophes, disaster management, cultural sector, cultural resources, risk assessment, risk analysis, strategic planning, preventative actions, response, recovery.

1. The Seminar

Lectures introduced the participants the theory and practical applications of disaster assessment, protective actions and systematic disaster incident response for cultural collections and sites. Increased frequency and intensity of worldwide natural and manmade disasters have created awareness, commitment and a growing mobilization to confront the needs of systematic protection and reaction to disasters. The cultural heritage sector has developed tools for addressing the specific needs of managing, protecting, and rescuing collections and historic sites. Lecture content alternated between the theory of disaster management and illustrated examples of actual disaster events experienced by the presenters.

The organizing committee of this seminar included the authors and our colleague, Maria Papadimitriou, MA in Preventive Conservation, Directorate of Conservation of Ancient and Modern Monuments, Greek Ministry of Culture, pap-dim@otenet.gr. The faculty are expert disaster specialists who work internationally as consultants and teachers. The faculty represents several disciplines in museum and library management and work in many different countries.

The seminar targeted professional level cultural heritage professionals, including directors, conservators, librarians, archivists, curators, collections managers, archaeologists, stewards of historic churches and house museums and students. Participants acquired theoretical background and practical skills for managing disasters within their own cultural institutions. Students were encouraged to actively participate, contributing their professional expertise and experience. The intention was for participants to assist their organizations in necessary preparations for protection and recovery from manmade and natural disasters of any scale. Following the seminar, many participants reported working towards disaster management in their institutions. Topics included:

- Team building for pre-disaster assessment and post-disaster response, including incident command systems and required roles and responsibilities of assessors and responders
- Risk assessments of sites, buildings and collections to identify and mitigate vulnerabilities and potential problems
- Disaster planning, including writing a plan, the required resources for disaster response and examples of disaster plans worldwide
- Protective measures for the safety of collections, buildings, sites and people
- Identifying required resources, such as supplies, staff, work and storage locations, money and specific information
- Disaster response actions, including collections salvage, drying, packing and treatment options and the issues of long-term recovery
- Health and safety for staff and volunteers working in disaster situation
- Staff training subjects and goals

Lectures, classroom team exercises, homework, individual written exams and hands-on simulations of fire and flood disaster responses introduced participants to all facets of disaster assessment, protection, response, and recovery (figure 1). Practical classroom discussions and exercises were designed to guide the participants in addressing issues confronting their own institutions. As part of the training, students were directed to cooperate with others as an important component of team building (figure 2). Students were provided extensive bibliographic information for additional training. Hands-on simulations gave practical experience in disaster response to fire and flood disaster. The students applied information provided in the classroom, allowing them to experience and better understand protocols and potential issues in managing a disaster site and staff. Students were required to develop all protocols for a systematic recovery from the simulated disasters, manage the disaster site and staff, and handle water and fire damaged collections.

Admission requirements for the 30 seminar participants included a higher education degree in a cultural heritage-related field and English language proficiency (because of the many available international resources). Participants paid nominal tuition and were awarded with 3 ECTS credits of Lifelong Learning Certificates. Three of the students represented 3 European countries. Two TEI student interns received tuition-free attendance and provided general assistance in running the program.

The seminar was hosted by the Institute of Lifelong Education of the Technological Educational Institute (TEI), Department of Conservation of Antiquities and Works of Art, (Athens, Greece). The seminar was held in September 2017 and continues to be presented throughout Greece.

Additional information about the 2016 seminar was published in the Greek newspaper, Kathimerini: http://www.kathimerini.gr/authors/sakhs-iwannidhs

Figure 1, Classroom lectures: Maria Lyratzi, Maria Papadimitriou, and Susan Duhl introduce theory and practical approaches to disaster assessment, protection and recovery from disasters in cultural institutions

Figure 2, Classroom Exercises: Students work cooperatively to understand the process of assessment, development of disaster planning, and disaster incident response.

1.1 Understanding the History of Disasters:

The seminar began by presenting a survey of catastrophes throughout history. Since before destruction of the Alexandrian Library, many hundreds of libraries, museums, archives, historic buildings, and archeological sites have been damaged or lost as a result of different kinds of disasters. The lecture introduced participants to the cause and effects of disasters, as well as the relative success or failure of disaster recovery programs.

Effective disaster management began in response to the 1966 Florence, Italy flood, when the Arno River overflowed and covered the city in meters of water. Millions of works of art and countless books and documents were affected by floodwater containing contaminates and mud. There were no universally established guidelines at that time and the Florence flood revealed and emphasized the practical needs of disaster management. This catastrophic natural disaster served as an impetus to develop programs for museums and libraries in which disaster planning is a central component. Disaster planning is now considered a core mandate for all collecting institutions and historic sites (ICCROM, 2014). The flood led to experimentation and innovation in treatment protocols, establishing protocols and procedures for coordinated response, recovery, drying and treatment of cultural materials (Waters, 1993).

1.2 Developing Disaster Planning in Cultural Institutions and Sites:

All cultural institutions are expected to have detailed plans addressing the needs of caring for staff, visitors, collections and the site in case of emergency. This seminar lecture outlined the elements of a disaster plan, including how to assess unique conditions and issues, analyze and develop priorities in protective actions and assemble necessary resources.

Disaster Plans include a series of written policies and procedures designed to prevent or minimize damage resulting from manmade or natural disasters. These protocols provide a unified system to guide the post-disaster recovery of a cultural institution.

1.3 Assessment of Risks in Cultural Institutions:

Disaster assessments evaluate the level of preparedness of an institution to guard against and recover from disasters of varying origins and scale. Assessments identify potential external and internal risks posed to institutions and collections and help to estimate the effects when risks become real events. The process assists the institution in anticipating, evaluating and undertaking the needs of disaster preparedness and response specific to their collections, site and organizational management (ICCROM, 2016).

Detailed examples of the causes and results of disasters were shown through slide-illustrated lectures, followed by application of the learned techniques through classroom exercises and homework. Students were provided resources of information about conducting assessments and given samples and templates for writing disaster plans.

Disaster plans are tailored to every institution’s specific circumstances and facilities and covers all relevant threats or risks to the institution, its collection and staff and visitors. A successful disaster plan identifies and predicts potential risks, based on variables of origin, scale and resulting damages. Every institution will be unique in its circumstances, determined by geography, accessibility, building conditions, staff capabilities and availability of funds. Each organization will have differing missions and collections scopes. After disasters, each institution will address unique aftermath, dependent on the extremity of the disaster and the available resources to salvage and recover(NPS,2000).

An assessment is used to analyze risks in terms of probability and effect. Qualitative and quantitative approaches to assessments were introduced in the seminar. In a quantitative approach, mathematical functions denote relationships between variables considered to quantify a hazard. Numerical data is derived to forecast potential events. [Waller, 1994]. In a qualitative approach, scales of extremity, ('high', 'moderate' or 'low',) are observed to identify and assess the risk, potential hazards and mitigating protective actions (Stovel, 1998).

The assessment team gathers information from all members of the staff, including the directors, collections staff, security personnel, buildings and grounds crews and sometimes volunteers or visitors. All staff will have unique observations. The team may expand depending on the size of an institution. The assessment team may also include recovery specialists, such as conservators, historic preservation architects and other cultural institutions who can provide valuable insight, support and training. For example, architects and engineers can identify building issues and develop priorities to address them. Other local institutions may have staff with expertise or experience and institutions with cooperative agreements are often more successful in recovery actions (American Institute for Conservation, 2017).

Civil service is often included in the assessment team, identifying safety issues, making recommendations and providing training. Their visit is also an opportunity to cross-train and sensitize the police and firefighters to the unique needs of cultural sites and collections. A cooperative relationship with civil service agencies is critical, because they are often the first responders to a disaster scene and are in charge of the site and safety of people.

Students were provided examples of disaster plans for different types of institutions, which reflect typical conditions that may be present in various collections and sites. Key issues of disaster assessment were presented:

- The administration: institutional mission, existing and required policies and protocols, collections care requirements, funding, staffing and staff training. The level of an institution's development is an important factor in disaster preparations and avoidance. A well-managed institution with professionally trained staff is more likely to effectively protect against and/or recover from disasters.
- The geography and meteorology: The cause and effects of natural and manmade disasters on cultural heritage materials.
- The location of the institution: the geography, topography, weather, and proximity to civil service. For example, cultural institutions may be in earthquake, fire, and/or flood zones. Urban or rural locations may affect accessibility to recovery services or supplies.
- The building and site: A building may be the first line of defense in a disaster, or it can be the source of disasters. The building site, structural and mechanical systems are key issues in assessing the safety of collections. Building materials, age, construction techniques, maintenance are reviewed. Internal systems, plumbing, electrical and air conditioning systems are assessed. Interior space utilization is reviewed to determine the best locations for collections storage. Safety systems, including security staff and fire detection and suppression are located and reviewed for effectiveness, safety and usability. The building and campus are reviewed for safe access and evacuation.
- Collections care and protection: Storage, exhibition and work areas are reviewed to determine the level of collections care. Space utilization is an important factor, especially in positioning collections storage in the safest building locations. Collections should be stored in locations away from potential hazards, such as affects from extreme weather, extreme interior conditions (like humid basements), leaking pipes, or mechanical equipment. Exhibition techniques are reviewed to determine if collections are securely installed, to protect them against things like vibration from earthquakes, rising flood waters, or human accident or vandalism.

- Team building and collaboration: Cooperative work between departments and outside agencies , such as civil service agencies and collegial organizations are imperative and can significantly contribute to successful recovery from disaster.
- Disaster preparedness: Specific resources are required in advance of disaster. For example, purchasing and keeping supplies specifically for salvage of damaged collections is important.
- Protocols and techniques for salvage: Handling, packing, drying and conservation treatment of vulnerable cultural materials, as well as inventory controls are critical to avoid secondary damages or lost and stolen collections.
- Periodic re-assessment: Disaster plans are updated as circumstances change over time, such as changes in personnel or with expanding collections.

Students undertook assessments of the local buildings, observing existing conditions and potential risks. Students were provided with additional resources of information about risk assessments (figure 3).

Figure 3: Assessment of buildings and sites. The procedures were done by the students, introducing them to critical areas of concern. This exercise provided both the tools, and the means to cooperatively develop disaster plans

1.4 Developing the Plan:

Plans provide information and guidelines detailing the procedures, protocols, goals and resources for response and recovery. An understanding of the intentions, scope and details of a disaster plan ensures both appropriate guidelines and practicable, realistic expectations to achieve goals and objectives of disaster preparation and recovery.

A disaster plan is a written, approved, implemented and periodically tested program to identify, protect, reconstruct or salvage an organization's collections and vital records. A disaster plan and its mandated actions are updated as improvement projects are completed or urgent issues arise, or as the level of funds or staffing changes.

The plan should:

- Protect people, collections, the building and site
- Predict and reduce risks caused by manmade and natural disasters to minimize adverse consequences
- Provide detailed management directives
- Outline logistics and recovery procedures for implementation of disaster recovery
- Provide necessary resources for staff, supplies, work and storage space, money, etc.
- Resume and continue regular daily operations

A disaster plan contains detailed information, including:

- Responder contacts
- Management policies
- Procedural Guidelines
- Floor plans and evacuation routes, including locations of safety equipment
- Template forms and checklists
- Resources of assistance and information

Following assessments, decisions must be made to effectively address concerns within typical constraints of institutional management. Gathered quantitative and qualitative information will assist the team to develop a focused acceptable plan. A successful disaster management program requires an assessment team to collaborate closely and make consensus decisions to balance needs across all departments. The seminar introduced some of the needs and complications of administrative policy making, budgets and the political structure of institutional management (Lyratzi, 2013).

Understanding a common lexicon and agreed use of terminology are invaluable tools in effective communications between responding agencies and individuals.

Disaster planning also includes defining needed roles and the responsibilities of staff in event of a disaster response. This is an opportunity to identify the best people for a salvage team by establishing each individual's capabilities and skill sets. This is very helpful, because disaster situations are stressful and critical decisions will be made during difficult times.

Complex decisions must be made in choosing priority collection items prior to (and again following) disaster. These items will have higher priorities for care and use before a disaster and in recovery in event of a disaster. Decisions about priorities are a thoughtful balance of criteria, including, but not limited to: collection items representing the mission of the institution, curatorial value, financial value, media and structural sensitivity, quantity of damaged/undamaged material and replicability of an item. Vital records and collection items on loan from other institutions are considered high priorities. Available resources are a consideration and are used in developing a strategic plan for identifying priority collections and protective actions.

Protective Actions:

Protective actions are taken to address risks and to avoid, eliminate or reduce those risks considered to be unacceptable. Identifying and completing needed protective actions is considered a very high priority for all collecting institutions and crucial for professional level collections management.

Pre-disaster protective actions and staff training are most significant in guarding against, or limiting the extent of damages. Protective actions are undertaken in a predetermined priority order, recognized by the extremity of need and as money becomes available. Dedicated staff time and funds for supplies are required (Duhl, Frellsen, and Herskovitz, 2016).

The development and continual updating of risk management plans and projects are considered protective actions. Ongoing assessments identify additional or recurring issues and can be used to monitor the effectiveness in implementation of control mechanisms. Vigilance ensures continuing protection of people, buildings and collections as changing circumstances alter risk priorities.

Protective actions include establishing strong programs of:

- Strategic planning and project implementation/completion
- Physical maintenance, repair and improvements of the sites and buildings
- Installation, repair, or replacement of security systems and training in proper use
- Organizing, housing and storing collections in the best possible manner
- Provision of disaster response supplies
- Provision of health and safety equipment

- Staff training, undertaken and updated regularly

Staff training is critical in effective crisis management. Staff training topics include, but are not limited to:

- The purpose and intended use of the disaster plan
- Roles of staff positions, to inform and sensitize everyone to responsibilities and potential disaster-related issues within their area of expertise
- Physical and psychological health issues, such as exposure to pathogens or other contaminants, or emotional response to disasters
- Safety techniques, such as evacuation of visitors and fire extinguisher use
- Assessment of collections and the building for changes in conditions
- Options and techniques for collections protection
- Salvage techniques, such as art handling and systematic disaster recovery

Staff training prior to disaster is imperative. Responders must understand and accept incident command, safety procedures for people and the established system of collections salvage. Students were encouraged to achieve certification from a free web-based training program for Incident Command in emergency situations (Federal Emergency Management Agency, 2018).

Lectures illustrated standard protective actions and students were provided with detailed bibliographic information on protection of buildings, sites, collections and people. An exercise enabled students to discuss their experiences and observations, increasing everyone's understanding of a range of standard and unique circumstances.

1.5 Disaster Response:

Every disaster is different in type, size, resulting damages and needs so the recovery depends on the type and results of the disaster. The seminar introduced the students to the established steps and potential variables of incident response in event of natural or mechanical catastrophes. The resulting damages and salvage options for collections affected by earthquake, fire and/or flood were illustrated in the seminar. Students were introduced to the theory and reality of disaster response using images from real disaster response events.

In response to disasters of any origin or size, many actions must be undertaken at one time. Effective and successful management requires systematic actions to ensure a common set of goals and the implementation of controls to achieve them. It is very important for everyone to understand and conform to common goals and procedures for a successful recovery.

Topics discussed in the seminar included initial and long-term incident management:

- Emergency services (Fire and Police)
- Creation of the disaster response team
- Protection of all responders
- Incident Command Systems
- Assessment and documentation of the incident and collections
- Incident action plans
- Priorities, techniques and goals for collections salvage
- Staff assignments and needed roles and responsibilities
- Supplies and equipment
- Work and storage space
- Money

- Collections salvage

Salvage and stabilization goals and procedures were introduced in the seminar. Understanding the techniques, requirements and goals of moving collections from disaster affected areas is a key issue. Proper protocols will limit the potential for secondary problems, such as secondary damages or lost inventory. This is especially important as collections are physically moved through stages and different locations.

Incident Command is a system designed in the United States by the Federal Emergency Management Agency (FEMA) and adapted for use in cultural institutions (Federal Emergency Management, 2019). In disaster response, incident command is responsible for:

- Understanding the situation
- Establishing incident objectives
- Developing the Incident Action Plan (coordinating activities and priorities)
- Confirming available financial and human resources
- Preparing and disseminate the incident action recovery plan
- Executing, evaluating and revising the plan
- Developing language for the public and media

The Incident Command System (ICS) defines the chain of command and identifies roles and responsibilities needed in disaster recovery. ICS is used to manage staffing and actions to create a coordinated, collaborative, strategic and effective salvage and recovery of cultural collections. ICS provides chain of command and unity of command to ensure a clear structure for developing and implementing successful disaster response. Assigned team roles ensure a common understanding of individual assignments and responsibilities and the steps needed to complete the incident recovery objectives. The modular organization of ICS allows the response structure to expand or contract depending on incident complexity and scale, available resources and changing needs as recovery progresses.

The successful system of the American Institute for Conservation National Heritage Responders was used a basis for training because it is easily adapted to Greek circumstances and needs(American Institute for Conservation, 2019).

1.6 Long-Term Recovery:

Pre-disaster assessment anticipates and balances the needs of disaster preparedness and response and predicts long-term needs of recovery for cultural institutions.

Recovery from disaster can be a long process. Immediately after a disaster, institutions will need to maintain daily operations but will also have the added burden of rehabilitation. Additional staff time will be needed to treat, repair, de-accession, or replace items to rebuild collections. Damaged collections may require isolated storage, designated workspace and regular re-assessment of conditions over time. An important example of this is isolating and monitoring mold-contaminated collections to ensure there is no additional outbreak, even after treatment.

A disaster of any size is likely to alter existing strategic management plans and divert or delay implementation of other projects. The need for additional funds is inevitable. Additionally, disaster affected materials are more susceptible to secondary problems (such as mold growth after a flood) and vigilant ongoing assessments are required.

Students were provided with theoretical and realistic examples of disaster response through slide-illustrations of actual events.

Thorough pre- and post-disaster assessments will help develop strategic planning and actions that are both practical and realistic for the institution.

Students were provided with extensive resources of information on disaster salvage and options for collections handling, drying, packing, storage and conservation treatments.

1.7 Hands-On Workshops:

Students actively participated in 3 hands-on workshops:

- Fire safety was presented by a representative from the local fire brigade (figure 4). A slide-illustrated lecture introduced the students to the causes and effects of fire and the roles and responsibilities of the fire brigade. Students were taught the proper use of fire extinguishers.
- Salvage of fire-damaged collections was introduced using fire damaged facsimile collections. Students were encouraged to examine and handle damaged facsimiles to better understand the type and extent of damages. Recovery and cleaning techniques for soot, ash, and charred materials was presented.
- Salvage of water-damaged collections was experienced using a simulation of flood damages (figure 5). A scenario was created using wet and dirty facsimile collections. Students were required to develop ICS, secure supplies and develop and implement salvage and drying operations.

Figure 4, fire safety workshop: The workshop followed a lecture on fire safety and the importance of working cooperative with civil service agencies, like the local fire brigade.

Figure 5, Collections recovery workshop: Workshop with simulated scenario of flood. Using information learned in the seminar, students were responsible for all aspects of incident command, gathering supplies, salvage, and packing water damaged collections.

The seminar, “Disaster Management in Cultural Institutions” has since been presented in various locations throughout Greece. The seminar is adapted to local communities, the specific interests of the audience, and available time. Specialists are included to contribute additional expertise. Professional level training creates a common base of knowledge and will significantly contribute to aligned and consistent crises management for the protection of Greece’s important cultural resources.

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PROGRAM TO ADDRESS NATURAL DISASTERS

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Abstract

The problem that motivated the project is the forest fires that afflict Greece, especially during the summer period. The purpose of the study is to create a database that will indicate how to approach by means an area, terrestrially or aerially, taking into account parameters such as geographical, climatic and geo-environmental conditions. The method use Matlab software to indicate if an overhead force is needed to deal with an emergency, taking into account factors such as: altitude, proximity to a residential area, humidity, temperature, wind, tilt. The program is at a pilot stage, as the user manually completes the fields of the factors influencing the result. The first results show that geographic, climatic conditions and factors such as the proximity of residential area and the density of vegetation, can influence the decision about terrestrial or aerial approach. The importance of this project is to create a tool that compares aerial or terrestrial operation to combat an emergency, by suggesting the most effective, efficient, fast and safe way to approach the area. However, this program can also be used in other rescue or even military operations. The innovative part is the creation of an integrated database with continuous and then in real-time updates of geographical and environmental changes, that are key parameters for approaching an area in emergency. Finally, depending in parameterizations, the program could be used as an emergency, preparedness and coordination tool, to face humanitarian and environmental crises in Global level.

Key-words: Fire extinguish of a forest fire, Aerial intervention, Innovation, Emergency situation, Matlab, Sustainable development

1. Introduction

In the future, climate change will significantly undermine efforts for sustainable growth because it will exacerbate the risks of natural disasters, such as forest fires, which in turn will adversely affect sustainable development. This is because after a forest fire, due to the lack of vegetation that retains both water and soil catastrophic floods will follow. Eventually erosion and desertification phenomenon will appear.

The impact of these disasters will be rapid, and they will have a direct impact on the economic and social life of a country. Nowadays, the amount of money which is spent on fire fighting and the restoration of the damages that follow, counts on hundreds of millions of euros.

However, caution is not given to the prevention of fires, the cost of which may be much lower than that of repression and the results much more substantial. That is why the protection of the forest ecosystem is "the foundation stone on which sustainable development must be built".

It is also important to consider the new facts. The ecosystems of Greece will be particularly affected as they are in the sensitive Mediterranean Zone. The creation of an appropriate infrastructure system will therefore play a key role in both prevention and repression. Moreover, interdisciplinary and international cooperation is also a priority of paramount importance for the country.

There are 3 main axes for infrastructure building that the project is based on.

- Protection of the forest ecosystem and restoration of burnt areas.

- Forest sustainable development
- Use of technology and innovative tools to support the infrastructures.

Protection of the forest ecosystem and restoration of burnt areas.

- Designing appropriate forest fire prevention and repression works with innovative and environmentally friendly methods, especially before it is spread (forest roads, firefighting dispersion, observation sites, types of firefighting vehicles, number of vehicles and personnel required).
- Post-fire rehabilitation (original wood harvesting methods, anti-corrosion dams, etc.).
- Forest maps development, arbitrary control as a measure to prevent forest fires, land use maps for prevention and development.

Sustainable forest development projects in 3 directions:

- Timber (harvesting methods).
- Alternative tourism (sports areas, paths, bridges, waste, biological cleaning, etc.).
- Alternative energy sources (bioenergy, wind turbines), bio-feed (livestock farming).

Use new technologies and innovative tools to support the above-mentioned infrastructure.

- Developing candidate researchers' skills in research support tools and techniques.
- AutoCAD, GIS, GPS-HEPOS Seminars in forest conditions at postgraduate students and PhD candidates.
- Support for postdoctoral and doctoral research.
- Calling foreign researchers to transfer experiences.
- Improve guide studies.

In the international interdisciplinary context cooperation is valuable for exchanging experiences on the issues of adapting development to new climate change circumstances. Scientists from the advanced forestry countries will be called for cooperation.

So, we believe that the future generations we will:

- Reduce the risks of natural disasters
- Reduce regional unemployment
- Create sustainable development infrastructures
- Train new scientists to new competitive technological and research knowledge
- Enhance the international cooperation to improve the convergence.

In Greece, only 15 % of forest fires occur at altitudes over 500 m altitude (Dimitrakopoulos, 1998), mainly in oak and black pine plantations. The arrival time of initial extinguishing fire crew to the highlands is very slow and takes about 60 minutes (Dimitrakopoulos, 2001).

According to researchers the growth rate in infrastructure costs should be accompanied by a corresponding reduction in costs and damages (Figure 1). In Greece however, the damages caused by fire (suppression costs and loss of forest) are independent of the infrastructure costs to strengthen fire fighting forces and efforts.

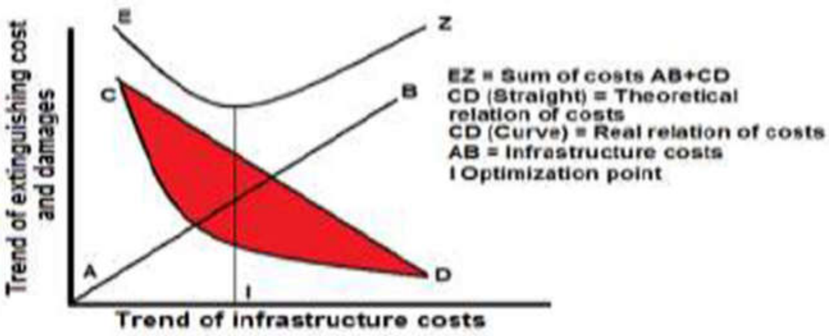

Fig.1. Correlation between infrastructure expenditure and expenditure for extinguishing and damages.

The rate of reduction of costs is not directly (DC) proportional to suppression costs and damages but is associated with DC curve and the right branch of the curve EZ has smoother slope on the left side (Dimitrakopoulos and Skourtos, 1991). This is due to poor organization, the misplaced breakdown of costs and the overall institutional framework.

Therefore, new firefighting model is required to optimize the efficiency, independent of the excessive cost of expenditure. This is also result of the socio-economic conditions prevailing in the country that is expected to worsen the situation.

In Mediterranean ecosystems the climate change causes temperature rising, therefore the risk of forest fires is increased. In Greece, during the 2007 – 2009 summer periods, 71 people died, many houses and approximately 300,000 ha of forest were burned. (Drosos et al., 2015a, b)

The consequences of the torrential phenomena that occur on the urban environment are even greater because of the foliage loss. A definite cause of fires is the lack of inventory of forests, woodlands and grasslands, as well as the disputed recording of property rights for the creation of forest cadastre, forest maps and land use maps. (Drosos, 2014)

Although this project has started in 1976 while the team continued working on forest maps, in 1997 the creation of forest maps for the 5.85% of the territory had been successfully covered, unfortunately still no one has ratified it as definite.

During the past years and after the turnouts of dramatic significance for humanity which occurred due to the reckless and catastrophic for the environment linear economical “developmental” activity, the perception that development is either complete, namely economic, social, technical/technological, political, and cultural, in harmonious interaction and respect of the natural and cultural environment, whose part is also humankind, or nothing, is becoming more popular, directly or indirectly (Rokos, 1998, 1999).

Development has been the flag of every country in the world. But what development is meant? It meant the residential development or the qualitative one or by the way the touristic development or sustainable one? To achieve the suitable development, necessary land planning use and forest cadastre (forest maps) are needed, meaning the essential foundation for development and instrument of land policy exercise (Drosos, 2011). Infrastructure creation and, more specific, spatial planning of land use and innovative ideas for sustainable development are necessary. Plato predicted centuries ago that the deforestation of the mountain slopes means reducing their ability to help people and animals live comfortably, or in other words, the salvation of the cities is on the mountain and we should initially concentrate there (Doukas, Drosos, 2013).

Development of mountainous areas is linked to the development of anthropogenic impacts, which, like any form of economic development, is usually accompanied by negative environmental impacts. The specificity lies in the fact that this anthropogenic action often degrades the natural and structured environment, which is, at the same time, the raw material for its development (Doukas, 2004, Drosos et al., 2014).

For this reason, the development of a forest area should aim to maintain compatibility with the environment. In an age of rapid developments in the process of knowledge / technology share, where knowledge is fast growing and needing to become new, the importance of lifelong learning for the renewal of knowledge and skills.

The purpose of the paper is to create a program-based database to indicate how to approach a location, as well as early warning and sending of aerial or terrestrial means as an adaptation to the new realities of climate change. As expected, climate change will significantly undermine efforts for sustainable development because it will exacerbate the risks of natural disasters, such as forest fires.

Hence, a new firefighting model is required to optimize efficiency, irrespective of the excessive cost of expenditure. This is also due to the socio-economic conditions prevailing in the country, which are expected to exacerbate the situation.

In Mediterranean ecosystems the climate change causes temperature rising, therefore the risk of forest fires is increased. In Greece, during the 2007 – 2009 summer periods, 71 people died, many houses and approximately 300,000 ha of forest were burned (Drosos et al., 2015a, b)

On July 23, 2018, two major fires broke out in Attica, the first in Kinetta and the second near Daou Pentelis. In the second case, the fire spread and passed through the settlements of Neos Voutzas and Mati, resulting in the loss of 102 people and injuring dozens of others. Of the two fires, completely destroyed, or damaged thousands of homes while tens thousands of acres of forest were burned.

The fire in Neos Voutzas and Mati is the most lethal in the history of the modern Greek state and the second deadliest fire worldwide in the 21st century, following the fires in Australia on February 7, 2009, that had killed 180 people.

The consequences of the torrential phenomena that occur on the urban environment are even greater because of the foliage loss due to the forest fires. A definite cause of fires is the lack of inventory of forests, woodlands and grasslands, as well as the disputed recording of property rights for the creation of Forest Cadastre, forest maps and land use maps (Drosos, 2014).

Forest Cadastre has started in 1976, while continued in the form of forest maps, in 1997 the creation of forest maps for the 5.85% of the territory had been successfully covered, unfortunately still no one has been ratified as definite.

Forest maps are a useful tool both at the stage of responding to natural disasters (for guiding fire-fighting vehicles, etc.), as well as at the stage of rehabilitation and restoration of the area to the status quo of sustainable development. Over the past few years and after events that are of dramatic significance for mankind which occurred due to the reckless and catastrophic for the environment linear economical “developmental” activity, it became common consciousness, the notion that development should occur in harmony with the natural and cultural environment. This applies equally to economic, social, technological and cultural developments (Rokos, 1998, 1999). To achieve the sustainable development, suitable land use planning and Forest Cadastre (forest maps) are needed, meaning the essential foundations for development and means of land policy exercise (Drosos, 2011). Infrastructure creation and, more specific, spatial planning of land use and innovative ideas for sustainable development are necessary. Plato predicted centuries ago that the deforestation of the mountain slopes means reducing their ability to help people and animals live comfortably, or in other words, the salvation of the cities is on the mountain and we should initially concentrate there (Doukas and Drosos, 2013).

Development of a region either mountainous or semi mountainous or lowlands is inextricably linked to the human activity and can either exacerbate the risks (humanitarian and environmental crises) or mitigate the effects. This human activity often degrades the natural and structured environment, which is, at the same time, the raw material for its development (Lazaris, Drosos, 2018, Drosos et al., 2014).

The purpose of the work is to create a database taking into account factors such as altitude, proximity to a residential area, humidity, temperature, wind and slope. These data are going to enter to a special software to indicate how to approach the region concerned, in which a natural disaster has occurred (forest fire), with terrestrial or aerial means, considering geographical, climatic and geo-environmental conditions.

2. Material and Methods

A program using the MATLAB software and Excel as well was created. The purpose of the program is to indicate if an overhead force is needed to deal with an emergency, using the climatic (Humidity, Temperature, Wind) and Geoenvironmental Conditions (Density and species of vegetation) and geographic parameters (Altitude Proximity to a residential area, slope).

Some of the program parameters are changing slowly, steadily and gradually over time, while others are changing unpredictably and rapidly. More specifically, the altitude, the slope, the proximity to a residential area and the density of the vegetation vary gradually over time with relative slow rates.

On the other hand, humidity, temperature and wind are parameters that are changing rapidly. Based on the fixed parameters, it is possible to determine the degree of difficulty of approaching an area with terrestrial means. However, it is the immeasurable and rapidly changing parameters that essentially determine whether airborne entanglement is imperative, recommended or even prohibitive.

1.1 Slowly changing parameters

- Altitude is a parameter that has a catalytic effect on the way of intervention in an emergency area. The higher the altitude the more necessary is airborne intervention.

- The proximity to a residential area affects the way to respond in an emergency, because of the closer the fire can find to a residential area, the greater the chance of hasty human life. Efficacy and immediate intervention in such cases must be intensified as the negative impacts left behind by the fire will be even more noticeable in society.
- Slope also affects how to respond in an emergency because a high or steep terrain makes the terrestrial operation more difficult.

- Finally, the density of vegetation plays a major role on the decision of aerial or terrestrial approach to an area as denser vegetation in an area leads to greater and faster the spread of the forest fire.

Future scope is to add one more parameter, the type of vegetation. Some vegetation types inhibit fire creation and fast spread (in combination with the climatic conditions prevailing at the time such as the temperature, humidity, etc.). Such as herbaceous vegetation, plumage, shrubs as well as various coniferous and broad-leaved trees are flammable materials.

1.2 Fast Changing Parameters

- Wind is a parameter that cannot be controlled and accurately predicted. The wind has more weight than the other parameters, because when it is at a maximum value, aerial intervention becomes extremely difficult or even impossible, since the wind affects the airborne flights. Also, wind affects the spread of a fire. This, sometimes leaves only one option, the terrestrial intervention.

- Moisture is another parameter that affects the evolution of a fire. Higher rates of moisture, reduce the spread of the fire.

- Temperature also plays a catalytic role in the development of a fire. Higher temperatures create suitable conditions for forest fire to start and spread.

Table 1 shows the weight of the inputs that affect the output. The program runs for all possible combinations that may occur.

Table 1: Indicatively weights of the inputs and how they affect the output

Altitude	Proximity to a residential area	Moisture	Temperature	Wind	Slope	Vegetation Density	Priority of aerial intervention
High							High
				High			Low
	High						Low
		High					Low
	High			Medium			Low
Low	Medium	Medium	High	Medium		Medium	High

The values that determine whether a value is low, medium or high are shown below:

Low, Medium, High

Altitude 0-300, 301-700, 701-2000 meters

Proximity to a residential area 20000-50000, 5000-20001,0-4999 meters

Humidity 0-50, 51-69, 70-80 %

Temperature 0-20, 21-30, 31-42 Celsius degrees

Wind 0-3, 4-6, 7-12 Beaufort

Slope 0-5, 6-25, 26-100 %

Density of vegetation 0-25, 26-49, 50-100 %

The program at this stage requires the parameters that affect the result setting manually by the user. It is advisable after the extinguishment of the fire to record the burned area (in acres or hectares) and the time it took to extinguish it, as shown in Table 2.

Table 2: Recording of the burned area in acres or hectares as well as the time taken for the extinguishment of the fire.

FORESTRY DIRECTORATE	FORESTRY	BURNED LANDSCAPE (ACRES)	TIME OF INTERVENTION
KAVALAS	KAVALAS	606	13.75
KAVALAS	THASOU	20	93
DRAMAS	DRAMAS	632	25
DRAMAS	NEVROKOPOIOU	50	0
KSANTHIS	KSANTHIS	793	53
KSANTHIS	STAVROUPOLIS	62	15
RODOPI	RODOPI	153	36
EVROU	ALEKS/POLIS	378	20

After collecting data on the altitude, the slope, the proximity and the density of vegetation for 100 areas in Greece, a first database was developed to improve user experience.

Particularly the parameters that are slow changing and could be considered stable are automatically completed, thus facilitating the user's process of completing the program fields. At this stage of the program parameters that change rapidly such as humidity, temperature and wind speed should be completed by the user (Table 3).

Data can be collected from online - meteorological sources (meteorological page).

Table 3: Parameter values which auto filled in and those which are to be filled in by the user

Altitude	Moisture	Temperature	Speed of wind	Slope	Proximity to a residential area	Vegetation density
227				2	5	20
281				2	10	36
472				3	11	58
520				1	12	70
571				3	13	79
550				3	14	73
214				2	15	58
185				2	16	19

3. Conclusions and Discussion

The first results show that geographic, climatic conditions as well as factors such as the proximity of the situation in a residential area and the density of the vegetation in the area can influence the decision on aerial or terrestrial force.

In the future, this program will automatically work for all regions of Greece without mandatory user interaction. Essential prerequisites are the creation of vegetation and land use maps as well as digital elevation model (DEM) and slopes maps for Greece. Real time climatic condition data will be available for every possible location.

The next step in the development of the program is the continuous and time-based automatic updating of the parameters. This concerns both the parameters that change rapidly and unpredictable over time and the parameters that change slowly and staidly.

The goals of the program are:

The creation of innovative projects for:

a. Protection of forest ecosystems from fires in the prevention and suppression phase

b. Early restoration of fire areas

c. Sustainable development of forest areas

d. Development of the new research skills

e. More efficient international co-operation resulting in our most convenient / effective convergence.

The core purpose of this project is to improve the way of facing a natural disaster. Specifically, the program suggests aerial intervention, based on geographical and climatic parameters. That is why the aerial intervention is faster and more effective. The nature of the project is to prevent the worst scenarios of a disaster. In this way the use of this program will protect the forest ecosystem and reduce the risk of an extensive destruction.

A database with information will be created which can be integrated all the necessary data after a disaster occurs. Specifically, depending on the size and the nature of the disaster the relative researchers will suggest solutions for restoration of the areas and their development. Moreover, this program is dynamic and as the technology involved this tool, will evolve and be even more innovative to create new and support the already existing infrastructures.

Finally, if the program has recorded the values of the parameters mentioned above, such as slope, altitude, vegetation density and proximity to a residential area then it should be updated at regular intervals because some values, although theoretically are stable, can be changed. For example, after a fire or other natural disaster or a cutting of trees, vegetation density will change. Additionally, the creation of a new settlement can affect the proximity to inhabited areas. So, it is necessary for the program to be updated with new data over time.

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THE IMPACT OF NATURAL AND MAN-MADE DISASTERS ON PUBLIC HEALTH

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Abstract

Public health emergencies can be defined as those situations which have an adverse effect on the public health system and / or protective infrastructures and related services (such as water or sanitation, food, shelters, fuels and health) that lead to both direct and indirect effects on the health of the population and occur when these protective infrastructures are absent, damaged, under-exploited or unavailable to the population. Urgent public health emergencies following a disaster are more common in developing countries where basic public health and care services are already deficient or absent. However, all countries are at risk, especially where the population density in urban-prone areas is increased, urban or suburban infrastructure is outdated or inconsistent with the rapid urbanization of the population and therefore increases its vulnerability or finally, where extensive ecological and environmental degradation has limited the ecosystem's ability to absorb the shock.

This paper presents the direct and indirect impacts of natural and man-made disasters on public health, and refers to ways of dealing with natural disasters and presenting interventions across the spectrum and public health sectors -safe drinking water, control of rodents and insects, housing, feeding, control of communicable diseases, immunization of the affected population, management of corpses, mental health services, and public health surveillance mechanisms needed to mitigate the consequences of the disaster and support the victims.

Keywords: public health, morbidity, water supply and sanitation, communicable diseases.

1. Introduction

Global population growth, poverty, land scarcity and urbanization in many countries have increased the number of people living in areas prone to natural disasters and multiplied the impact of public health. In recent decades, the prevalence and importance of natural disasters has increased, causing millions of people to be affected and killed and major economic losses (Aljunid 2012).

The main factors that promote, accelerate, or induce a catastrophic event to turn into a public health crisis with regard to the possibility of injuries and illnesses are the following:

- Developing countries, where public health infrastructure and systems have failed or are absent
- Deficiency and / or inefficiency of existing infrastructure capacity and / or public health system to respond to crises
- If the capacity and efficiency of public health services in general has been affected (destroyed, degraded, questioned, maintained ineffective, or if there is still a refusal to provide services to the population) as a consequence of the disaster
- Geographically extensive destruction
- Population size, distribution and density
- Prolonged time / report of the disaster
- Existing environmental and ecological decline or an environment that is adversely affected by the disaster (Burkle 2008).

2. Direct effects of a natural disaster on public health

Short-term losses fall into three categories, which have both direct and indirect effects:

- Disease, disability and death
- Direct losses of infrastructure
- Loss or interruption in the provision of medical and health care (Burkle 2008).

2.1 Death following a natural disaster

For obvious reasons, there is a lack of information on the number of deaths in the first minutes or hours after a disaster. Researches conducted among rescuers about the use of drugs and equipment have shown that very little is known about survival after a disaster. However, the relatively small number of serious injuries observed after most natural disasters- excluding earthquakes- show that people either die or survive relatively without injuries. This figure suggests that the seriously injured may die before they can survive and take urgent care.

In this respect, sociologists have conducted a series of studies that shed new light on how communities and individuals react to disasters. These studies show that within the first 30 minutes of a major catastrophe, more than 75% of survivors will be involved in rescue operations. These remarks are particularly useful for preparing for disasters and increasing the efficiency and acceptance of relief operations. So, in order to reduce the number of deaths after disasters, the most effective measure would be to educate the local population on rescue techniques. Such training can include the entire community, or groups of volunteers, or organized professional groups, to increase the self-confidence of communities that are exposed to possible disasters. In some areas, it may be possible to train primary health officials in rescue and relief techniques after a disaster (Lechat 1997).

2.2 Morbidity after a natural disaster

Apart from earthquakes, the number of people injured who require medical care is usually low compared to the number of deaths. In floods, the proportion of people in need of medical care has been reported to range between 0.2% and 2%, with most injuries involving minor injuries such as abrasions and ulcerations. It has even been argued that the general health level of the survivors of a disaster may be better than the rest of the non-affected population in the region.

Generally low morbidity rates as well as the ratio of the number of injuries to the number of deaths are important indicators for planning the amount of supplies and staff needed to relieve the people affected. The experience of recent disasters has shown many examples of excessive reactions: mobile hospitals of all kinds, teams of specialized surgeons as well as unprepared volunteers, and tons of scrappy supplies that have been hurried in the area at the same time as other types of medical and non-material would be more appropriate for the circumstance (Lechat 1997). The direct burden on health depends on the nature of the risk. The day after a great disaster, authorities must meet extreme demands with means that can not meet the basic medical needs and are often exhausted.

Disasters related to natural phenomena may affect the transmission of pre-existing communicable diseases, but the objective risk of their large explosion after natural disasters is often excessive. In the short term, an increase in visits to hospitals due to diarrhoeal diseases, acute respiratory infections, dermatoses, and other diseases should be expected after a disaster. In the middle stage of crisis, heavy rainfall can affect the transmission of host-related diseases- such as insects and rodents- such as, for example, standing water that may contribute to an explosive mosquito growth.

Earthquakes can cause a large number of injuries. While most of them are not life-threatening, the injured will still seek immediate medical help from health structures, which are often unprepared, carry serious damaged or are completely destroyed. Authorities must provide services to displaced populations, restore health structures, repair services, and strengthen health surveillance in communicable diseases. It also has to deal with permanent disabilities, mental health problems and a possible increase in heart an chronic diseases rates.

Tsunamis are disastrous tidal waves from earthquakes on the seabed. These waves can travel for several hundred kilometers an hour and reach a height of up to 10 meters as they approach the coast. Coastal disasters may be extensive, and usually the number of deaths far exceeds that of survivors with severe injuries.

Volcanoes, while causing serious problems, are usually underestimated due to their long-term inactivity. Explosions follow a period of volcanic activity, giving people time for scientific monitoring, warning and preparation. Some aspects of the phenomenon, such as the fall of volcanic ash and rocks, lethal gas, lava flow, although they are a factor of concern, are of little relevance to health. Volcanic ash affects transport, communications, water sources, plants and stocks. Volcanic ash and gasses may irritate eye conjunctivitis and the upper respiratory tract and also aggravate chronic lung diseases, but usually cause little morbidity in the general population. The most significant danger is caused by the pyroclastic flow (hot gases, ash, and rocks that travel at a particularly high velocity from the crater) or gasses, ashes, rocks, and / or mud flows mixed with water, caused by the rapid melting of snow at the peaks of the volcano or by intense rainfall in unstable mass of ash-the so-called lahars. Historically, pyroclastic explosions or lahars have caused around 90% of volcanic eruption injuries Other concerns include the possible contamination of water reserves with heavy metals as a result of the ash, the movement of a large population for an indefinite period of time, and the associated problems of hygiene and mental health.

Drought develops slowly over a period of months and years and is caused by a lower than the average precipitation in a certain area over an extended period of time, leading to a decrease in water reserves. Approximately 15% of global natural disasters are caused by droughts and the associated deaths reach 59% of the mortality from extreme natural phenomena worldwide.

Water is necessary for food production. To produce a calorie feed, at least one liter of water is required, while a calorie of meat or dairy product requires about ten liters of water. So, drought often leads to a reduction in food production. Serious droughts can eventually lead to plague as has happened repeatedly in Ethiopia. It can also cause significant population shifts. Children are especially at risk due to adverse effects, especially when droughts lead to plague and malnutrition. The elderly are also susceptible to the adverse health effects of drought. In addition, droughts cause adverse effects on air quality due to prolonged molecular airway inhibition, which in turn can adversely affect the health of people with lung disease. Fires in wild vegetation are more common in drought areas and the smoke of these fires also contributes to lung function disorder (McCann 2011).

The flood waters can behave like a trigger, releasing chemicals that are already stored in the environment. The health impacts associated with exposure to chemicals are therefore greater in populations living near flood-damaged industrial or rural areas. However, the causal relationship between floods, contamination and related outbreaks of diseases in affected populations remains scientifically proven. For example, in a review of a series of data on UK-flooded chemical pollution incidents, the relationship between these incidents and the mortality and morbidity of the population remains unreliable. In the past, flood waters and soil have been contaminated with carbon monoxide, insecticides, agricultural chemicals, dioxins and a number of heavy metals. Exposure to these substances is known to be associated with cancer, cardiovascular, gastrointestinal, renal, hepatic and neurological diseases.

Increased soil toxicity not attributable to floods was responsible for increasing the concentration in arsenic and lead soil after Hurricane Katrina and Rita. In the weeks following the disaster, the basic change in toxic exposure was associated with the lack of energy sources, which resulted in a sevenfold increase in carbon monoxide and gasoline and thirteen times in exposure to lamp oil. Incorrect use of portable generators during the Katrina was responsible for the majority of cases of carbon monoxide poisoning in the affected areas (Alderman 2012)

Climate disasters include seasonal floods, hurricanes and cyclones. Seasonal floods can cause an increase in the prevalence of diarrhoeal diseases, respiratory infections, dermatitis and snakebites. Exposure to the risk of water reserves depends on the previous state of community water. Salt water contamination is a serious consequence of the high waves of the sea (blister sea) and the tsunami. Prolonged flooding jeopardizes local crops and sometimes large-scale provision of food to the affected population is required. Primary healthcare concerns the survival in conditions of great density, poor conditions of hygiene and provision of safe water in temporary camps or other areas where services are under operated or destroyed. Strong winds, heavy rainfall, and storm waves caused by hurricanes and cyclones can also lead to illness and death. Survivors of such disasters require psychosocial support.

2.3 Acute diseases

Unlike infectious diseases, in disasters there is the possibility of short-term effects on the health of the population. In some disasters there is the possibility of causing direct or indirect acute illnesses in the exposed population. Earthquakes, for example, can release various microorganisms from the soil, such as the coccidioides immitis fungus that causes coccidioidomycosis. This disease occurred after the 1994 earthquake in Northeast, California, creating an explosion in a settlement in the area. (Southern Ventura County). Other natural hazards that can cause diseases include volcanoes and fires in the countryside, which can cause respiratory and ocular problems due to ash, smoke and toxic gases.

Extreme weather events can also cause direct or indirect health problems. In the United States in the recent past there has been an increase in mortality and morbidity as a direct result of the heat waves that hit the country. In Chicago, in the summer of 1995, 465 people died of diseases related to the 8-day heatwave. Those who were at the highest risk were the elderly, who either did not have, or did not use the Air Condition of their home.

Extreme hypothermia, on the other hand, is only a possibility of causing acute health problems associated with a particular cold. It is usually accompanied by two other secondary risks, which have their own adverse effects. Extreme cold, especially what tends to turn into a frozen storm, leads to power failure. This usually leads residents to use candles for lighting, kerosene heaters and fireplaces for heating. The use of these materials has been associated with domestic fires and mortality from them. Lack of energy also results in residents using oil or kerosene generators. Incorrect use of these in poorly ventilated areas is associated with an increase in carbon monoxide poisoning (Shoaf 2000).

2.4 Chronic illnesses

The consequences of a disaster on the health of the population are not limited to acute conditions such as injuries and acute illnesses. For a long time, there has been a suspicion that disasters lead to an increase in the adverse effects on chronic diseases, such as heart disease. Unprecedented disaster calculations often include reports of increased cardiac arrest deaths, especially in sudden and instantaneous (earthquake) catastrophes. Of course it is customary to include deaths by arresting the official numbers of the victims from a disaster. However, it appears that in a direct catastrophe such as earthquake, it may accelerate death by cardiac arrest, but there is no mention of a generally significant increase in lethal cardiac arrest.

While disasters can not be related to a large increase in fatal coronary events, they seem to lead to more morbidity in chronic disease, such as cardiovascular, hypertension and diabetes. Research in Japan showed that blood sugar control had become weakened after the Kobe earthquake. Therefore, conditions in which anxiety is a risk factor and for which the continuation of medical care is necessary, appear to be affected by disasters (Shoaf 2000).

3. Long-term effects of a natural disaster on public health

3.1 Loss of primary health care.

The health sector carries a significant share of the long-term financial burden of a disaster. The value of direct and indirect losses gives the total cost of the disaster. Direct damages refer to the material losses occurring immediately after the disaster: loss of nursing beds, damaged equipment and drugs, damaged or affected health structures, damaged water and drainage ducts. Indirect losses refer to the production of goods and services lost as a result of the disaster and the resulting loss of income. Damage of the healthcare system can have a serious impact on the health of the population in the affected area. In addition to the need for urgent medical care as a result of the disaster, there are also basic needs that must continue to be met and that have nothing to do with the crisis. There are primary health care needs, which if not satisfied will adversely affect the health of the population. Vaccinations, prenatal care, management of chronic medical conditions such as hypertension, diabetes and cardiovascular diseases, as well as other primary medical services, which should be restored and available to the affected population (Control Priorities Project 2007).

3.2 Loss of normal lifestyle

Disasters can affect both the community and the people themselves. Those who depend exclusively on external aid may find that the recovery process is longer and harder. In addition, members of the community who are marginalized due to their economic profile, linguistic insufficiency, age, sex, disability or minority status may have difficulty in accessing the necessary rehabilitation services. Meanwhile, those who have not received such help often live under bad conditions, without basic sanitation (Shoaf 2000).

4. CRITICAL PUBLIC HEALTH OPERATIONS

For displaced people, damages of health, hygiene and water supply structures, buildings and crops can lead to a rapid increase in malnutrition and infectious diseases. Fortunately, supplying adequate clean water and ensuring basic hygiene conditions, timely vaccination against measles, simple treatment of dehydration resulting from diarrhea, supplementation of trace elements in undernourished patients and the creation of an appropriate health surveillance system, can lead to a significant reduction in health risks associated with the harsh environment of refugee camps.

4.1 Water supply and sanitation

Damage of water and sanitation systems can have serious health effects. In severe floods, the sudden interruption of these services coincides with the direct effect on the transmission of host-related and water-related diseases. In the case of earthquakes, the number of people adversely affected by water scarcity may well exceed the number of injured or those who have lost material goods. As in the case of health structures, the restoration of public water supply systems is just as slow (Control Priorities Project 2007).

Appropriate sources of drinking water, cleanliness and hygiene (collection, disposal and handling of sewage and other liquid and solid waste and refuse) must be accessible in an equal way to all residents of the camp. This can be achieved by creating a sufficient number of appropriately located waste disposal facilities (toilets, lavatories, waste disposal sites and sewage collection), water distribution points, access to soap and bath and washroom facilities and effective health education and enlightenment.
The UN High Commissioner for Refugees recommends, that each refugee receives at least 15-20 liters of clean water per day to cover his domestic needs. A sufficient amount of relatively clean water is preferable to small quantities of high quality water. Delivering to each family special caps of water that have been chlorinated shortly before dispensing and which are chlorinated before each filling can be a very effective preventive measure directly applicable to the very first stages of an emergency.

The construction of lavatories should begin early in the acute phase of the disaster, but the primary sanitary measures in a camp can be nothing more than from the definition of an area as a waste site that will be isolated from water sources. It is recommended to create a toilet for every 20 people (Noji 2005).

4.2. Insect and rodent control.

The control of disease carriers (insects or rodents, carriers of communicable diseases) such as mosquitoes, flies, fleas or rats is a critical health measure (Noji 2005).

4.3.Housing
The World Health Organization recommends that each person has 30 m² of living space- plus the space required for the development of its social activities, crops and the area of growth of domestic animals, when designing refugee camps. From this area, 3.5 m² is the absolute required space per person in emergency camps (Noji 2005).

4.4 Control of communicable diseases and management of epidemics.

Many believe that the primary role of public health in disasters is to control possible outbreaks of transmissible diseases after the disaster. While it is true that the possibility of such outbreaks or even epidemics of infectious diseases occurs after any natural disaster, the actual occurrence of such explosions is rare. In order for the risk to exist, the disease should be pre-existing in the population before the disaster (Shoaf 2000). Malnutrition, diarrhea diseases, measles, acute respiratory infections and malaria are consistently responsible for 60-95% of the reported deaths among refugees and displaced populations. The protection of displaced populations from high mortality resulting from epidemics of communicable diseases is mainly due to the immediate provision of adequate quantities of water, ensuring basic hygiene conditions, access to the community as well as effective management of all disease incidents which consists of both provision of the necessary medicines and health surveillance to identify new incidents and to take appropriate control measures. Proper management of diarrhea diseases with relatively simple, low-tech measures can reduce fatalities even in cholera epidemics- below 1% (Noji 2005).

As has already been said, epidemics are not directly linked to natural disasters. Several factors including the massive population displacement and changes in the environment and living conditions of the affected population, as well as its vulnerability to existing pathogens, must be exacerbated and intensified as a result of the impact of the disaster. Outbreaks / epidemics of communicable diseases are almost absent during the initial phase of the disaster. It may occur several days, weeks or months after the disaster. However, it is common for the international community, NGOs, volunteers, experts and the media to leave an affected area usually after 3 months, when in fact basic hygiene and access to hygiene facilities may not be available or are worsening due to the financial burden of the disaster.

Factors that affect the transmission of diseases after disasters.

- Pre-existing illness (such as cholera, measles, typhoid).
- Proportion of vaccinations.
- Concentration / population density.
- Damage of public utilities and infrastructure, water or food contamination.
- Increased transmission of diseases from hosts- their reproduction areas, lack of personal hygiene, interruption of control programs (Noji 2005).

4.5 Vaccination and vaccination programs

Health authorities are often under intense social and political pressure to launch mass vaccination programs, usually against typhoid, cholera and tetanus. This pressure can be increased by exaggerated and excessive reports of the risk of such diseases in the local and international press and the "offering" of such vaccines from abroad (Pan American Health Organization 2000).

4.6. Controlling the spread of HIV / AIDS

The major threat of HIV infection and related sexually transmitted diseases, such as syphilis, swells during civil conflicts and disasters. HIV infection is spreading faster during the period of emergency, when extreme conditions such as poverty, social instability, weakness and violence against women prevail. Moreover, during complex contingencies, the control of these conditions, whether involving interventions by national states or national or international organizations, tends to be subdued, if not totally absent. Education, health, poverty, human rights, forced migration and refugee, security, military and violence against women are only a few of the factors related to HIV transmission and must be taken into account (Noji 2005).

4.7 The management of the dead.

One of the most common disasters-related myths is that corpses are a serious threat to epidemics. This claim is used to justify the widespread and inappropriate mass burial or burning of the victims.1 There is no evidence that corpses constitute a significant risk for the transmission and spread of infectious diseases, especially when they take place immediately after the disaster. Therefore, the source of acute infections is more likely to be survivors than decay bodies (Noji 2005).

It should be noted that this practice leads to a serious violation of the principle of human dignity, depriving families of the right to receive information about their missing persons. It is imperative to stop the dissemination of such views and to reach a global consensus on the proper management of the bodies after a disaster (Kouadio 2012).

4.8 Nutrition-Feeding

Malnutrition increases mortality from measles, diarrhea and other infectious diseases. The lack of vitamins A and C has been associated with increased child mortality in non-refugee populations. Given that, malnutrition contributes to a large extent to the overall mortality and mortality of refugees, dietary rehabilitation and maintenance of a satisfactory nutritional level are among the most effective interventions (along with vaccination against measles) to reduce mortality, especially for those vulnerable groups such as pregnant women, nursing mothers, young children, the disabled and the elderly. However, the most urgent nutritional priority in refugee camps is the timely delivery of 2100 kcal (8.8 Mj) of food per person a day, containing enough protein, fats and micro-elements (Noji 2005).

4.9 Parental and child health (including reproductive health)

It has been seen that maternal deaths contribute significantly to the increase in mortality among women of childbearing age. Parental and child health programs may include health education and access to it in the fields of prenatal, postpartum and postnatal care, nutritional supplements, breastfeeding, family planning and prevention of proliferation sexually transmitted diseases and HIV, vaccination and follow-up of baby weight. By giving women who are the head of the family the responsibility for distributing humanitarian aid, especially food, ensures a more equal distribution of this aid (Noji 2005).

4.10 Health services.

Experience shows that medical care in emergencies should be based on simple, standardized protocols. Comfortable accessible primary health clinics should be established during the initial emergency phase. WHO and other organizations such as Doctors Without Borders have developed basically field-tested protocols to manage common clinical cases that can be easily adopted in emergency situations. These protocols include lists of basic medicines and basic equipment (Pan American Health Organization 2000).

4.11 Supervision of Public Health.

Emergency medical information systems are set up to monitor the health of populations affected by complex humanitarian crises. Heavy mortality is the most critical indicator of improving or worsening health of the population and is also the indicator on which donors and carers are chosen to be involved or not in aid. It not only indicates the general health status of a population at the present time but also provides a basis for measuring the effectiveness of relief programs. During the critical phase of a relief operation, mortality should be expressed as the ratio of deaths per 10,000 population per day, so that sudden changes can be detected. In general, health professionals should be particularly worried when they find that the mortality rate of displaced populations exceeds one death per 10,000 per day or when children under 5 years of age exceed four deaths per 10,000 per day (WHO 2011).

4.12. Psychological reactions to destruction

Contrary to what is usually depicted in the media and cinema, the uncontrollable panic of the population after a disaster is not the prevailing behavior. Whilst some cases of looting and violence have been observed after disasters, they are the exception and not the rule. Very often people show remarkable self-determination and will to help others. Another important behavior during and immediately after the disaster is the restoration of community communication networks. It appears that the symptoms that occur one to two days after the disaster are: hyperactivity, insomnia, tiredness, headaches, paleness, cold feeling, sweating, hand and body tremor, gastrointestinal problems, anorexia, vomiting and diarrhea * Palmer 2009). These natural symptoms are explained as general reflexes that occur after stress, and usually disappear within a few days. Apart from these physical symptoms there is a variety of psychological symptoms. These include a continuation of anxiety often associated with depression. A common reaction among the victims is to tell their story several times with the obvious intention of reducing their personal anxiety. This can also happen through nightmares. This list of long-term disorders also includes lamentation / mourning for loss of life and property, psychosomatic disorders and a number of other clinical symptoms (Shrubsole 1999).

5. Conclusions

It would be useful to sum up the crucial measures that should be applied in emergency situations:

- Quickly assess the health level of the affected population.
- Establishment of a health surveillance and information system on health issues.
- Vaccination of all children from 6 months to 5 years old against measles and supply of vitamin A to malnourished children.

- Implementing diarrhea control programs.
- Provision of elementary hygiene and clean water.
- Provision of adequate accommodation, clothing and blankets.
- Ensure at least 1900 calories per person per day.
- Establishment of health services with defined treatment protocols based on a list of essential medicines that provide basic coverage throughout the community.
- Organization of human resources to ensure at least one doctor for every 1000 people.
- Coordination of activities and actions of local authorities, national and international organizations and non-governmental organizations (NGOs) ((Noji 2005).

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VULNERABILITY OF TRANSMISSION PIPELINE. THE CASE OF FLORINA

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Abstract

This study concerns Florina district and its water transmission pipe. The area under investigation is a mountainous terrain with heavy snowy winters and high rain precipitation combined with gneisses and schists which are the primary reasons for the slope failures. Florina water transmission pipeline is constructed mainly of cast iron, with a length about 20km, dated back to 1960, with diameters till 300mm that supplies the city with water.

The purpose of this research is to assess the vulnerability of Florina water transmission pipeline taking into account earthquakes, changes in watertables and rapid snowfalls or rainfalls. Different scenarios are produced as the prediction of the exact time, location or magnitude of landslide is not feasible because of the complex synergy of geologic, geomorphology, tectonic, hydrologic conditions and soil formations.
A probabilistic seismic hazard analyses is implemented taking into account the geology, the geotechnical characterization and the seismicity of the area. Three seismic scenarios with different earthquake recurrence period (50, 100, 475years) are produced. Peak Ground Acceleration (PGA) and Peak Ground Velocity (PGV) are estimated according to Ambrasey's et al (1996) and Skarlatoudis et al (2003) attenuation relation, relatively. Permanent Ground Displacements (PGD) as result of landslide's hazard is calculated using HAZUS methodology for 3 seismic scenarios and for "dry" and "wet" conditions. Appropriate empirical vulnerability relations for pipelines are applied, to estimate the number and the type of the expected failures. GIS capabilities are used to identify the areas with the more "vulnerable" parts of water transmission pipe.

Concluding, this study can be used by Florina Water Company to minimize the consequences and possible losses for Florina citizens and enhance water transmission pipe reliability.

Key words:

Seismic Hazard, Florina, Landslides, Transmission Pipeline, Vulnerability, Seismic Risk, Pipeline reliability.

1. Introduction

The aim of this paper is to perform a vulnerability analysis of Florina's water transmission pipe as result of wave propagation and permanent deformation. Florina city needs 2100 m^3 of water daily. The Bas-Tsair springs provide 400 m^3/day and Isvoros- Drosopigi springs through the pipeline under investigation, 1700 m^3/day. Since there are three villages (Drosopigi, Idrousa, Tropaiouhos) located along the pipeline the discharge rate of the Isvoros-Drosopigi is 22 l/sec (Florina: 20 l/sec, Drosopigi: 0.5 l/sec, Idrousa: 0.5 l/sec, Tropaiouhos: 1 l/sec).

Although some inventory data are missing and the estimation of the location of possible water pipe damages enhance large uncertainties, reliable assumptions are made using three different fragility relations for wave propagation and one for permanent deformation. At first, a detailed inventory of water transmission pipe was accomplished. Afterwards, based on the available geological data and seismicity of the area, probabilistic seismic hazard evaluation is performed using CRISIS 2007 software. As a result, the magnitude and the spatial distribution of strong ground motion parameters (PGA and PGV values) are computed.

The mountainous, seismically active terrain with the heavy snowy winters (rich snow that lasts 3-4 months) and high rain precipitation in spring and autumn lead to several slope failures (rockfalls and debris flow) in the study area. Permanent Ground Deformations herein are estimated as result of landslide hazard for the selected scenarios. All data are digitized and analyzed through GIS environment.

Finally, appropriate fragility curves for wave propagation and permanent deformation are used for the estimation of the vulnerability of the water transmission pipeline. Comparisons between the spatial distributions of estimated damages and of absolute numbers are presented in GIS maps and in Tables. Issues such as transmission water pipe reliability and serviceability of Florina citizens are also addressed.

2. Methodology (Pipe Seismic Risk)

The seismic risk assessment methodology used in this study includes: a) extensive inventory (e.g. geometry, diameter material, age, etc) and typology of transmission water pipeline, b) estimation of the seismic loads (wave propagation, permanent displacements) that pose threats on transmission water pipe, c) selection of the appropriate fragility curves and d) calculation of the damages in absolute numbers and in spatial distribution.

The spatial distribution of ground motion that serves as seismic load transmission pipe took into account site-effects, and geological conditions. The ground shaking is described in terms of peak ground acceleration (PGA) and peak ground velocity (PGV) after seismic hazard study. Deformations are calculated using the approach originally developed by Newmark (1965). Downslope deformations as result of landslides occur when the induced peak ground acceleration within the slide mass a_{is} (assumed to be a rigid block) exceed the critical acceleration a_c. HAZUS methodology is used, herein to estimate permanent ground deformations (PGDs) for different scenarios.

Especially, for pipelines the seismic loading for wave propagation is described in terms of peak ground velocity (PGV) because it is directly proportional to the ground strain. The fragility relations used to estimate water pipeline vulnerability as result of wave propagation are: O'Rourke & Ayala (1993)- Eq. 1 used in HAZUS 2004 (NIBS, 2004), Eidinger J. & Avila E. (1999)- Eq.2 and ALA (2001)- Eq.3. These relations are empirical and are based on data collected from actual pipeline damages observed from USA and Mexican earthquakes. The predicted damages are given in terms of Repair Rate/ km (R.R/km) and are correlated with PGV (cm/sec) as follows:

$$R.R/Km \cong K1*0.0001*(PGV)^{2.25} \quad (Eq.1)$$

where: PGV- peak ground velocity (cm/sec), K1- coefficient depending on the type of pipeline (brittle, ductile).

$$R.R/Km \cong K1*1.512*(PGV)^{1.98} \quad (Eq.2)$$

where: PGV (m/sec) the peak ground velocity, K1: coefficient depending on the pipe material, diameter, soil & connection type

$$R.R/Km \cong K1*0.241*(PGV) \quad (Eq.3)$$

where: PGV (m/sec) the peak ground velocity, K1: coefficient depending on the pipe material, diameter, soil & connection type

The fragility relations used in this paper to estimate water pipeline vulnerability as result of permanent deformation is ALA (2001)- Eq.4. It is also an empirical relation based on data collected from actual pipeline damages observed from earthquakes and can be used also for PGDs derived from landslides. The predicted damages are given in terms of Repair Rate/ km (R.R/km) and are correlated with the expected PGD (m) as follows:

$$R.R/Km \cong K2*11.221*PGD^{0.319} \quad (Eq.4)$$

where: PGD (m)- permanent ground displacement, K2: coefficient depending on pipe material, diameter, soil & connection type

Two damage states for pipelines are considered, leak and break. In case of wave propagation, is assumed that 80% of damages are leaks and the rest 20% are breaks. For permanent ground deformation, is assumed that 20% of damages are leaks and the rest 80% are breaks.

Consequently, the vulnerability of the system is stemmed from the combination of the seismic ground motion and the fragility curves. The evaluation of transmission pipeline damage is then, defined in terms of pipe failures via GIS.

3. Study area- Transmission Water Pipe

The area under investigation is located in the South-East of Europe and in the North-West end of Greece especially in the area of Florina to Drosopigi district (Fig. 1). It is mountainous, about 360km^2, with heavy snowy winters and high rain precipitation in spring and autumn.

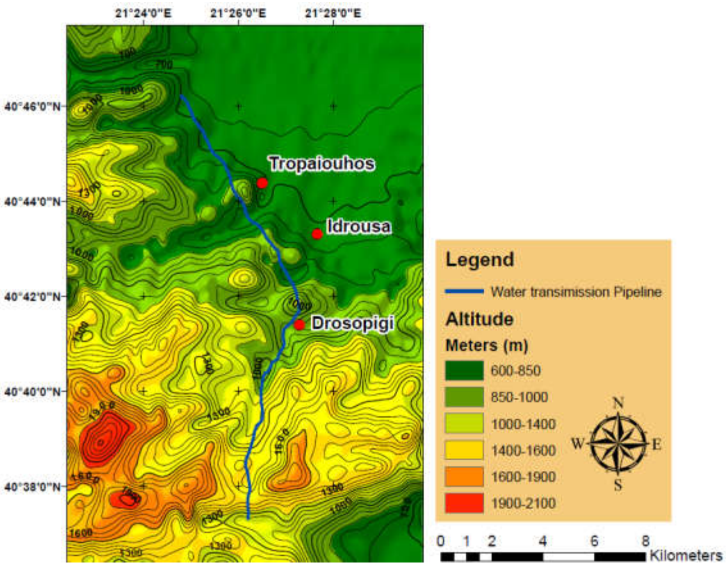

Fig.1 Topography of the study area via Water Transmission Pipeline under investigation

3.1 Geology/ Seismicity/ Soil Characterization/ Hydrological conditions

According to the geotectonic manifestation of the Internal Hellenides zones in Northern Greece the region belongs to Pelagonian (Pl) zone (Mountrakis, 1983). Pelagonian zone consists mainly of crystalline schistoid (slate, gneisses, amphibolite) semi metamorphic (volcanic rocks), carbonic (limestone, marbles), ophiolite and sedimentary rocks. The petrography of the study area consists mainly of Gneisses, with small appearances of Granite, Mesozoic quaternary sedimentary and volcanic-sedimentary rocks.

The combination of the structurally adverse discontinuities in the weathered front of gneiss, the rugged topography with steep slopes with gradient varied from 40^0- 60^0, are responsible for slope instability problems.

The total annual value of rainfalls for Florina region (Period 1961- 2000) according to National Meteorological data is between 500-700mm and the rainfall intensity ranges between 51- 58 mm/day (January – May), with peak hourly rainfall 83,7mm and 102,0mm (24h) in winter months. The annual rainfalls in the area was 1080,4mm during 2010. Heavy snowfalls have been observed in the area in the period 2013- 2015 while in 2014 the annual average rainfall in the area was 652,5mm with a minimum temperature falling down to -15^{0}C (winter 2014-2015). According to the hydrological classification, the hydrographic network is dense with a dendritic drainage pattern and numerous streams in the toe that are responsible for subsurface flows and inner erosion of the bedrock formations. The study area has a small drainage basin and the water from the springs and from the rain precipitations supply lakes Petron and Keli.

Six large shallow earthquakes (Kozani, 1695, M=6.5, VII; Kastoria, 1709, M=6.0, VII; Kastoria, 1812, M=6.5, VIII; Siatista, 1894, M=6.1, VII; Albania, 1960, M=6.5, VIII+; Grevena, 1995, M=6.6, IX+) occurred in the broader territory in the last 300 years with the two of them (1709 & 1812 events) close to Drosopigi village. Moreover, according to Greek Aseismic Code and seismotectonic zonation of Greece, the area is located in Zone I, with maximum value of PGA, 0.16g.

3.2 Seismic Hazard

Probabilistic Seismic Hazard Analysis (PSHA) for the area is conducted using CRISIS 2007, a code developed by Professor M. Ordaz and co-workers of the “Institudo de Ingenieria de la U.N.A.M”, Mexico City. In CRISIS 2007, the sources are modelled as area sources (Seismic Source Zones or SSZs) and fault sources. The present application is performed based on area geometry modelling for sources. The seismotectonic zonation of Greece and consequently of the region is developed by Papazachos & Papazachou, 1997; Papaioannou & Papazachos, 2000 and Vamvakaris et al, 2016. One seismic zone affects mainly the study area (N-E11). The seismic parameters of that zone are derived from data of previous earthquakes after completeness analysis (Papaioannou & Papazachos, 2000; Vamvakaris et al, 2016). Poisson earthquake model and Ambrassey’s (1996) & Skarlatoudis et al (2003) attenuation relations are used for the evaluation of PGA (gal) and PGV (cm/sec) accordingly. Soil is characterized according to Ambrasey’s (1996) classification.

The obtained results in terms of peak ground acceleration for the first two scenarios (50, 100 years) fluctuated among 0.12g and 0.16g for the first scenario and 0.20g and 0.30g for the second, quite close with the values suggested by Greek Aseismic Code (0.16g for 50 years’ earthquake return period and for rock sites). The results of the third scenario (475 years) fluctuate among 0.50g to 1.50g (Fig.2). The PGV values resulted from Skarlatoudis (2003) relationship fluctuate between 9 and 16 cm/sec for 50 years return period, 11 and 17 for 100years return period and 17 and 25 for 475 years return period.

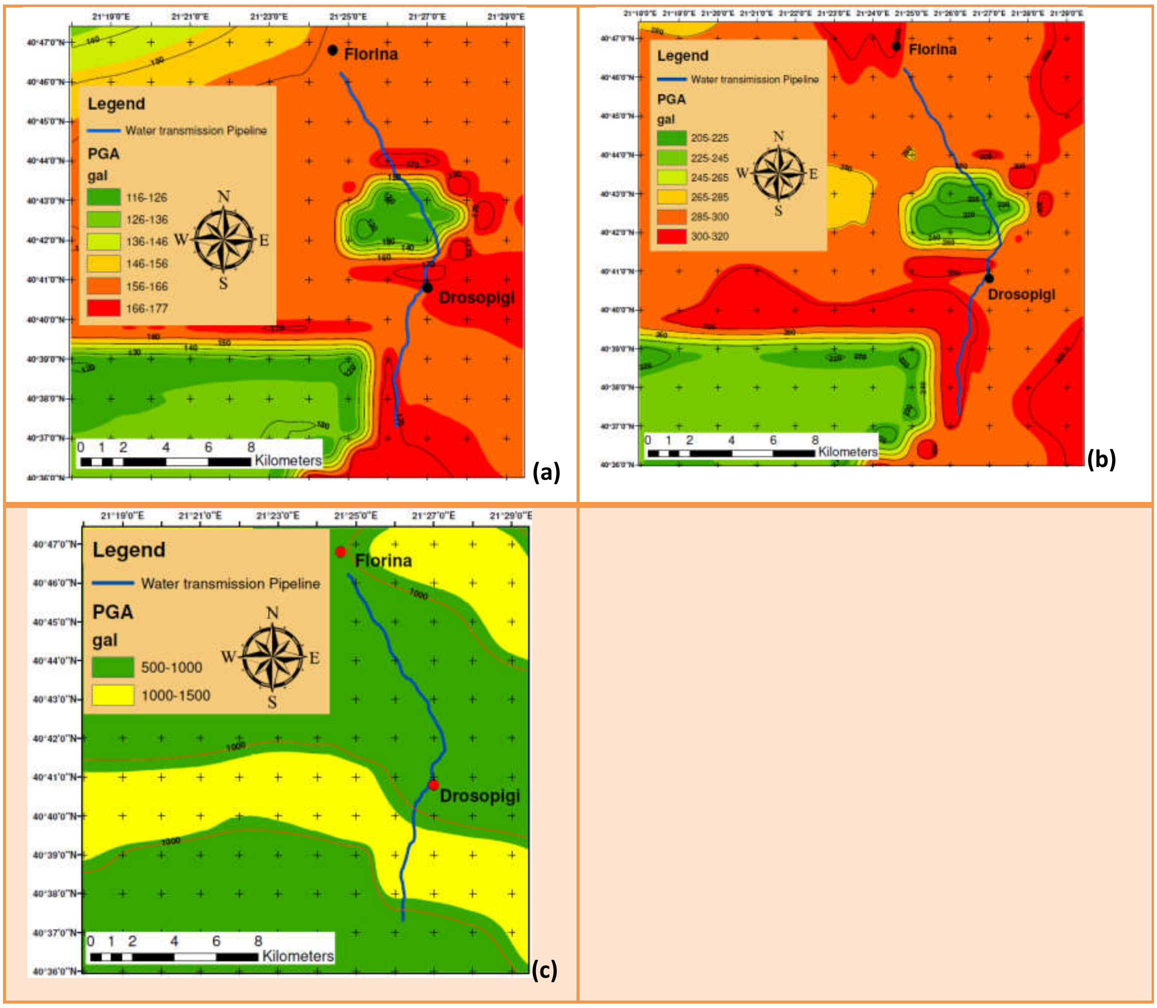

Fig. 2 Spatial distribution of PGA (ArcMap 10.2). Method: Probabilistic. Attenuation relations: Ambrassey, 1996, Earthquake return period: (a) 50 years, (b) 100 years, (c) 475 years

3.3 Inventory (Transmission Pipeline)

Florina's transmission pipeline length is 20km and is installed in 1960, in depths between 2-5m. Transmission pipeline is constructed mainly from cast iron (material) with diameters of 50mm (wall thickness: 9.3mm), 80mm (wall thickness: 10mm), 125mm (wall thickness: 11.1mm), 150mm (wall thickness: 11.7mm), 200mm (wall thickness: 12.8mm) and 300mm (wall thickness: 15.2mm). Only a small part is steel with diameter of 125mm (wall thickness: 5mm). Water pressure in water transmission pipe ranged between 16- 20atm.

3.4 Landslide Hazard Assessment

The landslide hazard evaluation required the characterization of landslide susceptibility of the soil/geologic conditions of a region. HAZUS methodology uses the relationship proposed by Wilson and Keefer (1985). The site condition is identified using three geologic groups (A: Strongly Cemented Rocks, B: Weakly Cemented Rocks and Soils, C: Argillaceous Rocks) and six slope angles (0-10^0, 10^0-15^0, 15^0-20^0, 20^0-30^0, 30^0-40^0, >40 degree). Groundwater condition is divided into dry condition (groundwater below level of the sliding) or wet condition (groundwater level at ground surface). Landslide Susceptibility is then estimated according to geologic group, slope angle and groundwater level. Critical acceleration is estimated for the respective landslide category. The permanent ground displacements are determined using the following expression:

$$E[PGD] = E[d / a_{is}] \cdot a_{is} \cdot n \qquad \text{(Eq.5)}$$

where: $E[d / a_{is}]$: expected displacement factor, a_{is}: induced acceleration within the slide mass (in decimal fraction of g's), n: number of cycles.

Seed and Idriss (1982) relationship is used to correlate number of cycles and earthquake moment magnitude (M).

For relatively shallow and laterally small slides, a_{is} is not significantly different from the induced peak ground surface acceleration (PGA) as predicted by seismic hazard assessment.

A relationship derived from the results of Makdisi and Seed (1978) is used to calculate the displacement factor d/a_{is} as a function of the ratio a_c/a_{is}. It is assumed that there is a uniform probability distribution of displacement factors between the upper and lower bounds.

After the application of HAZUS methodology, PGDs were estimated for two different seismic scenarios (Seismic Scenario: 100 & 475y earthquake return period), for two different conditions (Dry/ Wet) and for two different bounds (Upper/ Lower). For dry conditions and upper bounds, PGDs ranged from 12 to 35cm (Case: 100y earthquake return period) and from 40 to 164cm (Case: 475y earthquake return period) – Fig. 3a & b. For the same conditions and scenarios cases and for lower bounds, PGDs ranged from 8 to 23cm (Case: 100y earthquake return period) and from 27 to 110cm (Case: 475y earthquake return period) – Fig. 3c & d. For wet conditions and upper bounds, PGDs ranged from 31 to 53cm (Case: 100y earthquake return period) and from 70 to 192cm (Case: 475y earthquake return period). For the same conditions and scenarios cases and for lower bounds, PGDs ranged from 20 to 35cm (Case: 100y earthquake return period) and from 47 to 129cm (Case: 475y earthquake return period).

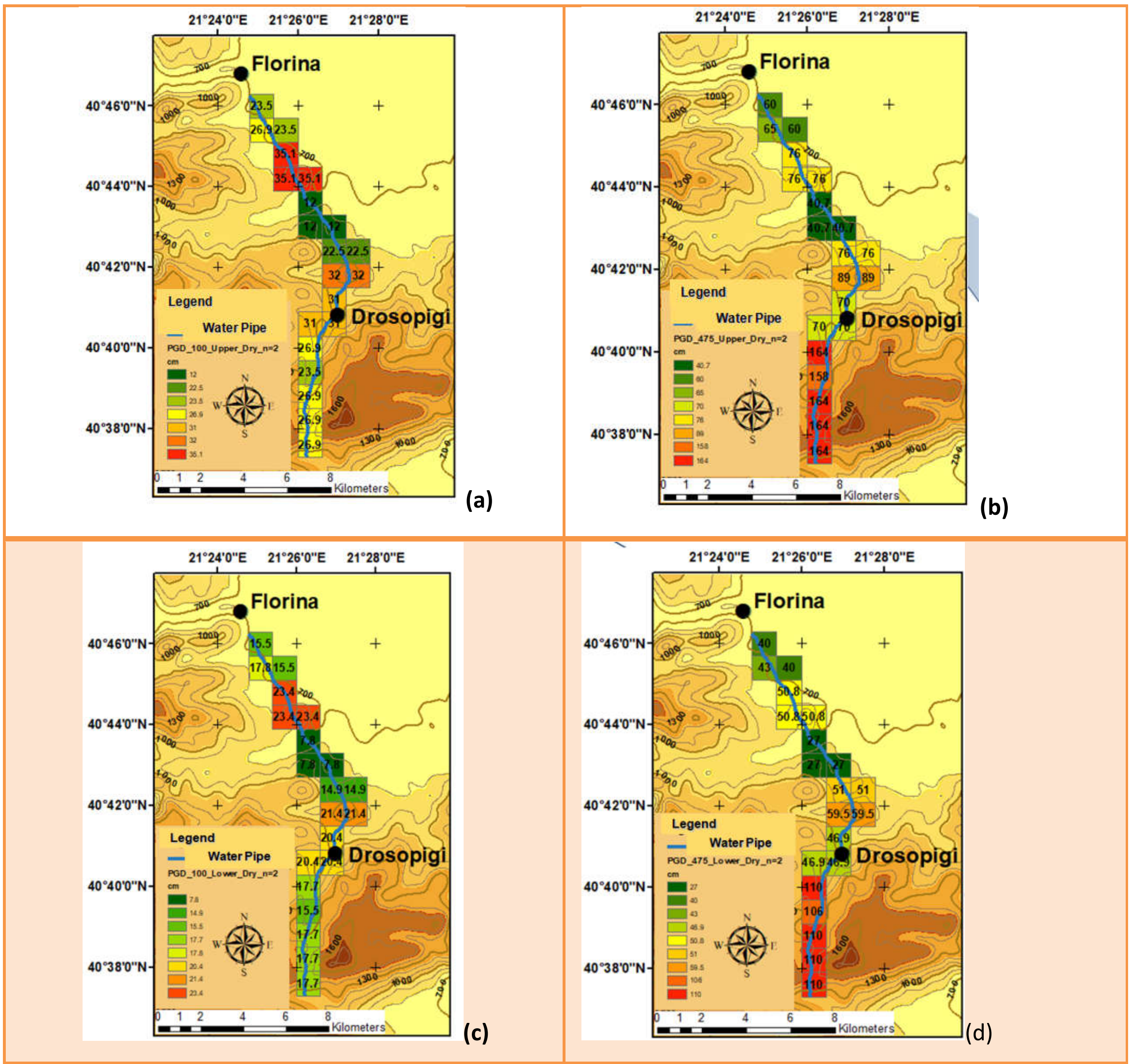

Fig. 3 PGD (cm)– HAZUS Methodology, Dry Conditions (a) Seismic Scenario: 100y, Upper Bounds, (b) Seismic Scenario: 475y, Upper Bounds, (c) Seismic Scenario: 100y, Lower Bounds, (d) Seismic Scenario: 475y, Lower Bounds.

4. Pipeline Vulnerability

Applying O' Rourke & Ayala (1993) and Eidinger J & Avila E (1999) fragility relations a total number of 0 damages for seismic scenarios 50y and 100y earthquake return period is estimated as result of ground shaking. O' Rourke & Ayala (1993), Eidinger J & Avila E (1999) and ALA (2001) estimate 1 leak in case of 475years earthquake return period (Table 1).

Table 1 Estimated damages of water transmission pipe (wave propagation)

Vulnerability Curves	O' Rourke & Ayala (1993)			Eidinger J & Avila E (1999)			ALA (2001)		
Earthquake Return Period	50y	100y	475y	50y	100y	475y	50y	100y	475y
PGV (cm/sec)	9 to 16	11 to 17	17 to 25	9 to 16	11 to 17	17 to 25	9 to 16	11 to 17	17 to 25
N.b of failures	0	0	1	0	0	1	0	1	1
Breaks	0	0	0	0	0	0	0	0	0
Leaks	0	0	1	0	0	1	0	1	1

The spatial distribution of pipeline damages in the case of permanent ground deformation is illustrated in Fig. 4 for the two seismic scenarios (100y, 475y) and for dry/ wet conditions (lower bounds) after the application of ALA (2001) vulnerability relation. No damages are expected for 50y earthquake return period scenario.

Moreover, the expected failures are illustrated in Table 2 & Table 3 for the scenarios (100, 475y earthquake return period) for the calculated PGDs.

Table 2 Number of Pipeline failures (Vulnerability relation: ALA, 2001; Soil Conditions: Dry)

Vulnerability	ALA (2001)			
N.b of cycles	n=2			
Soil Conditions	Dry			
Earthq.Ret.Period	100y		475y	
Bounds of PGD	Upper	Lower	Upper	Lower
Number of failures	10	9	14	13
Breaks	8	7	11	10
Leaks	2	2	3	3

Table 3 Number of Pipeline failures (Vulnerability relation: ALA, 2001; Soil Conditions: Wet)

Vulnerability relation	ALA (2001)			
N.b of cycles	n=2			
Soil Condition	Wet			
Earthq.Ret.Period	100y		475y	
Bounds of PGD values	Upper	Lower	Upper	Lower
Number of failures	36	32	48	43
Breaks	29	26	38	34
Leaks	7	6	10	9

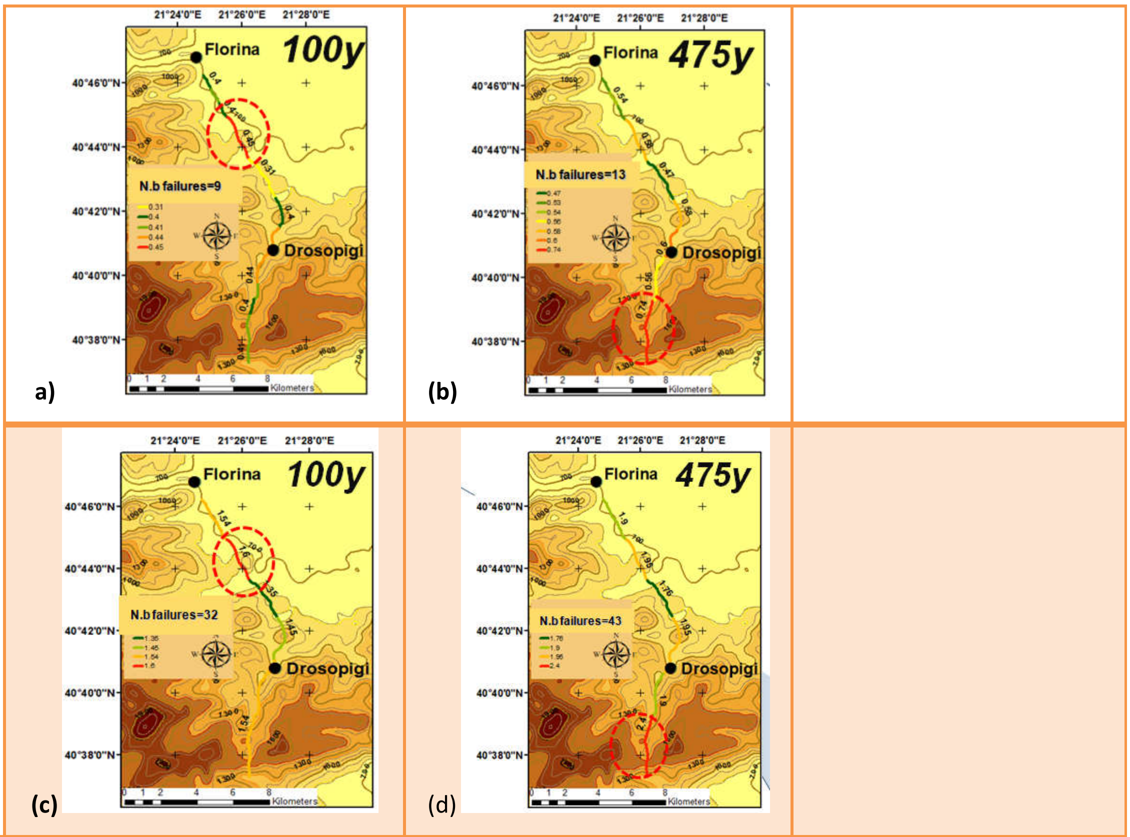

Fig. 4 Pipeline Vulnerability (Case: Permanent Deformation) (a) Seismic Scenario: 100y; Condition: Dry; Lower Bounds; Fragility curve: ALA (2001), (b) Seismic Scenario: 475y; Condition: Dry; Lower Bounds; Fragility curve: ALA (2001), (c) Seismic Scenario: 100y; Condition: Wet; Lower Bounds; Fragility curve: ALA (2001), (d) Seismic Scenario: 475y; Condition: Dry; Lower Bounds; Fragility curve: ALA (2001)

5. Conclusions

The vulnerability assessment of Florina transmission pipeline is an important (initial) step for global risk management for the city. It can be accounted for pre-earthquake retrofitting and post-earthquake actions, for the estimation of restoration time and for the preparation of mitigation strategies. Moreover, it can be use to predict the possible consequences in terms of economical cost, personnel, equipment and materials needed to minimize the necessary restoration time. Special attention should be given to landslides as it is direct connected with pipeline loss of serviceability. The expected failures as results of landslides in term of breaks (total loss of serviceability for the citizens) for dry conditions and seismic scenarios 100y and 475y return period ranged between 7- 8 breaks and 10- 11 breaks respectively. Moreover, the expected breaks for wet conditions and seismic scenarios 100y and 475y return period, ranged between 26- 29 breaks and 34- 38 breaks respectively.

The obtain results, showed that several measures should be taken in account for slopes stabilization to enhance water transmission pipeline reliability and ensure water serviceability for all the affected population.

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ROAD ACCIDENTS BLACK SPOTS ASSESSMENT WITH A RECENTLY DEVELOPED GIS BASED METHODOLOGY

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Abstract

In the scope of this paper, a recently developed GIS based methodology for the road accidents black spots assessment is described, which was developed by the Technical Chamber of Greece/Department of Western Macedonia (TCG/DWM) and was included in the Best Practices Guide of the Interreg Europe Project "Interregional Learning towards Sustainable Mobility in Europe: the REGIO-MOB Experience", in which the Region of Western Macedonia is a partner and the TCG/DWM is a stakeholder.

The aim of the methodology was the assessment of 700 km of the national road network of the Region of Western Macedonia with regard to road safety. The study included: identification of the dangerous road locations (black spots) based both on the data provided by the Traffic Police and on on-site inspections. With regard to the on-site inspections, 183 black spots were identified with their geographical coordinates, photographic documentation and an outline of the problem described. Thus they were all recorded digitally with the use of ArcGIS software.

The methodology presented and the GIS application produced can become a very useful tool for public authorities responsible for road safety, by adding black spots or maintenance updates of the existing ones and targeting measures ensuring road safety of the users. The application could be upgraded by its integration into vehicle safety systems in order to provide real time information to the road user. The added value of the application presented is high with regard to the relatively low overall cost and the immediate and future benefits in the health, socio-economic and environmental sectors, since the methodology can be easily adapted and adjusted by other regions.

Keywords: road safety, road accidents, black spots, regional mobility, GIS, ArcGIS

1. Introduction

Road safety is considered as a significant topic world-widely, both at national and international level. The consequences of road accidents are significant for the social, economic and political level of a city, a region or a country. The efforts to address the problem, more or less systematically, aim to reduce the number of road accidents and the severity of their impact. An important step in this direction is to investigate the causes of accidents and to identify possible differences according to the location of an accident.

The methodology presented in this paper was recently developed by the Technical Chamber of Greece / Department of Western Macedonia (TCG/DWM) and was included in the Best Practices Guide of the Interreg Europe Project "Interregional Learning towards Sustainable Mobility in Europe: the REGIO-MOB Experience" (Christopoulou P., 2017), in which the Region of Western Macedonia is a partner and the TCG/DWM is a stakeholder.

The Technical Chamber of Greece (TCG) is the official advisor of the State on all technical matters. It was established in 1923 and is a public legal entity, with an elected administration. Its headquarters are in Athens and has 17 branches (among them in the Region of Western Macedonia). All qualified licensed engineers in

Greece are registered members of TCG and according to official data in January 2016, TCG had more than 100.000 active members. TCG aims at developing Science and Technology in sectors related to the economic, social, and cultural development of the country, in accordance with the principles of sustainability and environmental protection. (www.tee.gr)

The Technical Chamber of Greece / Department of Western Macedonia (TCG/DWM) was established in 1965. It covers all four regional units of the Region of Western Macedonia (Grevena, Kastoria, Kozani, Florina) and its headquarters are in Kozani. According to official data it has more than 2.000 registered members, who are qualified licensed engineers that either live or have their business address in Western Macedonia. (www.tdm.tee.gr)

The methodology for the assessment of road accident data using GIS technologies was developed by a working group of six (6) engineers, all members of TCG/ DWM (Karadimou M. et al, 2012). It aims to assess road accident data in Western Macedonia Region, in order to support the decision making process in the field of road safety. In general, road accident data usage in Greece is limited to serve statistical purposes only, while its contribution in decision-making process is narrowed.

2. Description of the methodology presented

With regard to road safety data in Greece, in 2014 Greece had a mortality rate of 7,3 road deaths per 100.000 inhabitants, which is less than 40% of the rate of 2000, but still above the European Union (EU) average of 5,1. The regional data of Western Macedonia shows that in 2014 the mortality rate was 6,3 road deaths per 100.000 inhabitants, which is less than the mortality rate of Greece as a whole but also above the EU average. In 2014, 50% of fatal crashes occurred in urban areas (mainly due to the increased motorcycle and pedestrian traffic), 43% on rural roads and 7% on motorways. Since 2000, there has been a 74% decrease in road deaths on the rural network, as almost 1.200 km of the national interurban network were upgraded to motorways. (www.statistics.gr)

Taking these facts into consideration, road inspections of identified by statistical data black spots were accounted as a proper tool to manage the road accident data and support the decision making process in the field of Road Safety. In order to implement the methodology, the whole Region of Western Macedonia was chosen as a study area.

More specifically, the study area of the on-site inspections concerns the entire national road network of the Region of Western Macedonia (secondary, tertiary) with a total length of 700 km throughout the regional units of Grevena, Kastoria, Kozani and Florina. The central axis and the vertical axes of the Egnatia Odos Motorway (primary network), which are operated under the company's (Egnatia Odos S.A.) responsibility, were not studied. Thus the methodology aims to assess the road safety of the national road network of the Region of Western Macedonia and consists of the following general parts:

- Identification of the black spots (hazardous road locations) of the National Road Network of Western Macedonia based on the provided data of the Statistic Service of the Traffic Police and the National Statistic Service. At this point it must be mentioned that only road accidents where damages (death and injuries) occur are registered by the Statistic Service of the Traffic Police.
- Identification of black spots by on-site inspections. During the on-site inspections the black spots were identified based on the statistical data and on the expert opinion of the working group. Particular attention was given to the network with increased traffic volume.
- Analysis of the black spots. The black spots were then defined using a portable GPS device (with ArcPad software) and a high definition camera. The total black spots (183 points) with geographical coordinates, corresponding photographic documentation and brief description of each inspection were recorded on a digital map of the Region of Western Macedonia using ArcGIS software (version 9.3.1).

3. GIS Application and examples

The GIS application produced could be a useful tool/proposal to all public authorities and entities that have responsibility for road safety and in case they were not using GIS software, the total black spots (183 points) were also recorded in a table consisting of the following fields:

- Black spot number (a/a)
- Road code
- X,Y Coordinates
- Regional Unit
- Municipality
- Corresponding photographs
- Brief description of the problem.

The following Image 1 shows the map of the Region of Western Macedonia with the regional units and the black spots, as it was produced by ArcGIS Software.

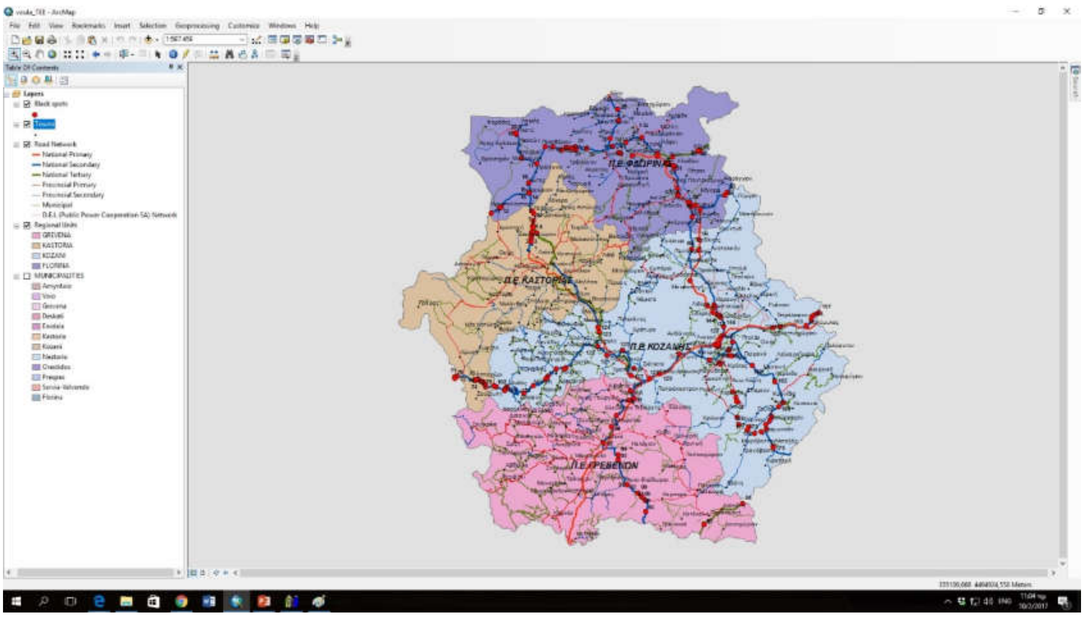

Image 1: Screen shot of ArcGIS software (Region of Western Macedonia map with regional units and black spots) (Christopoulou P., 2017)

The following Image 2 shows a screenshot of the attribute table produced by ArcGIS software.

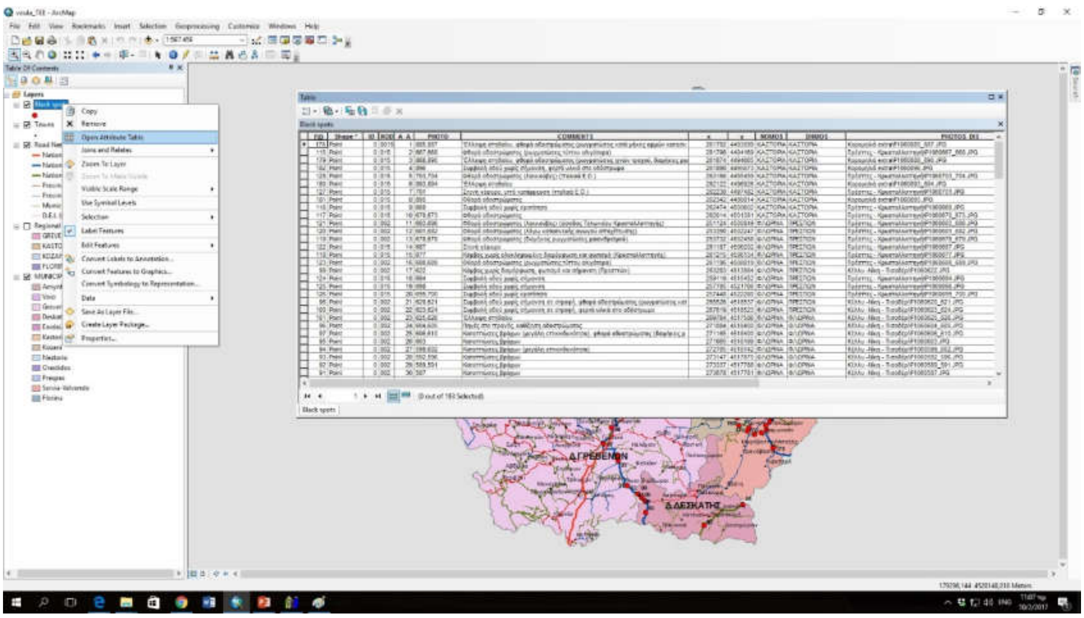

Image 2: Screen shot of the attribute table produced by ArcGIS software (Christopoulou P., 2017)

The following Image 3 shows an example of the final identification with available photographs, coordinates and description of a black spot (both identify and hyperlink tool).

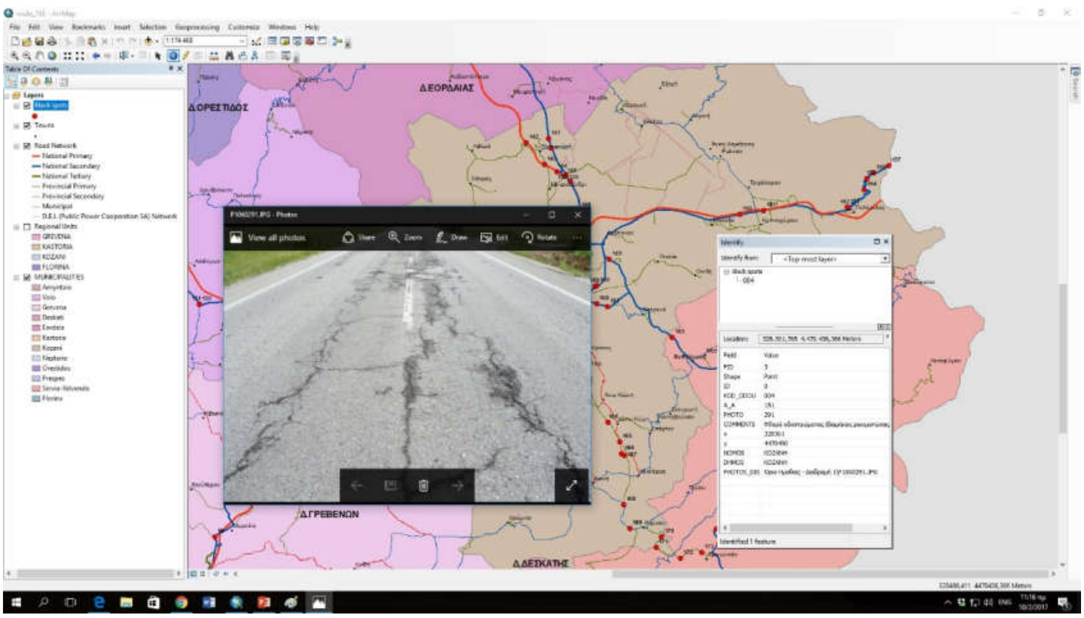

Image 3: Identification of a black spot using identify and hyperlink tool (Christopoulou P., 2017)

The GIS application can also provide printable digital maps of the region, the regional units and the municipalities of Western Macedonia, with the black spots, in case a public authority is not using GIS software. An example of a digital map can be seen in Image 4.

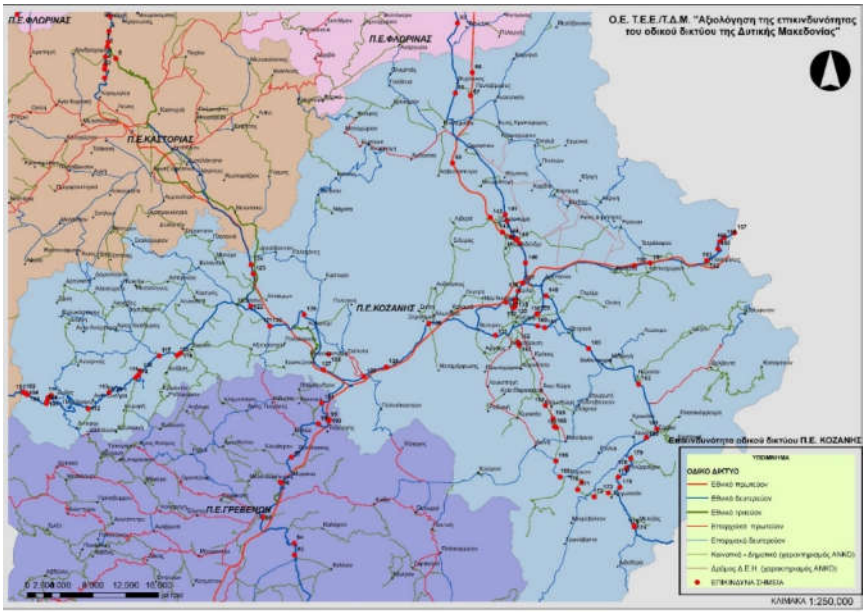

Image 4: Digital Map of the Municipality of Kozani with black spots (Karadimou M. et al, 2012)

In order to provide an example of the identification of black spots without the use of GIS software, the table provided by the methodology is necessary (Table 1).

ΣΗΜΕΙΑ	ΚΩΔΙΚΟΣ ΟΔΟΥ	X	Y	ΝΟΜΟΣ	ΔΗΜΟΣ	ΑΡ. ΦΩΤΟΓΡΑΦΙΩΝ	ΠΑΡΑΤΗΡΗΣΕΙΣ
60	003	305700	4502808	Φλώρινας	Αμυνταίου	-	Κόμβος χωρίς διαμόρφωση (Λακιάς)
61	003	306909	4501676	Φλώρινας	Αμυνταίου	432	Φθορά οδοστρώματος (λακκούβες)
62	003b	304585	4502435	Φλώρινας	Αμυνταίου	421, 422	Απόκρυψη πινακίδας λόγω βλάστησης
63	003b	304843	4499789	Φλώρινας	Αμυνταίου	416, 417	Επικίνδυνη στροφή και έλλειψη ορατότητας λόγω μηκοτομής
64	002	313563	4505576	Φλώρινας	Αμυνταίου	427 , 428	Καταπτώσεις βράχων
65	002	314051	4506304	Φλώρινας	Αμυνταίου	430, 431	Καταπτώσεις βράχων
66	003	306671	4493739	Κοζάνης	Εορδαίας	434 , 435	Συμβολή οδού χωρίς σήμανση
67	003	306464	4490927	Κοζάνης	Εορδαίας	438 , 439	Έλλειψη ορατότητας λόγω μηκοτομής, φθορά οδοστρώματος (διαμήκεις ρωγματώσεις μαιανδρισμού)
68	003b	304594	4491242	Κοζάνης	Εορδαίας	413, 414	Συμβολή οδού χωρίς σήμανση, φθορά οδοστρώματος (ρωγματώσεις καταμήκος ιχνών τροχού, λακκούβες)
69	003	304256	4482689	Κοζάνης	Εορδαίας	451, 452	Φθορά οδοστρώματος λόγω ανάβλυσης υδάτων
70	020	241245	4456678	Καστοριάς	Νεστορίου	793, 794	Καταπτώσεις βράχων
71	020	241374	4457115	Καστοριάς	Νεστορίου	790, 792	Κατολίσθηση πρανούς, καταστροφή οδοστρώματος μέχρι τον άξονα
72	020	241915	4457206	Καστοριάς	Νεστορίου	786, 788	Καταπτώσεις βράχων
73	020	246823	4456408	Καστοριάς	Νεστορίου	785	Καταπτώσεις βράχων (μεγάλη επικινδυνότητα)
74	020	246740	4456044	Καστοριάς	Νεστορίου	780	Καταπτώσεις βράχων
75	020	247133	4456345	Καστοριάς	Νεστορίου	781, 782	Καταπτώσεις βράχων (μεγάλη επικινδυνότητα)

photographs
description

Table 1: Example of the methodology’s table for the identification of black spots (Karadimou M. et al, 2012)

The table provides information about the regional unit and the municipality of the black spot and a brief description of the black spot. Using the maps and the available photos the black spot is then identified (Image 5).

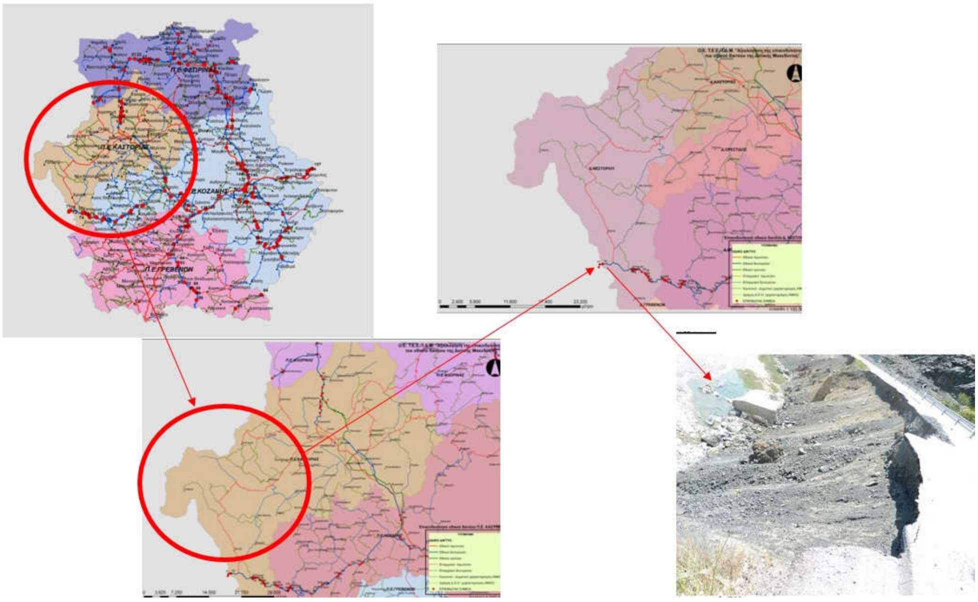

Image 5: Using the methodology's maps and corresponding photos for the black spot identification (Christopoulou P., 2017)

4. Results and benefits of the implementation of the methodology

There were several difficulties encountered during the implementation of the methodology but the most important one was the coverage of the entire road network of the Region of Western Macedonia. In order to cover the entire road network (secondary, tertiary) of the Region of Western Macedonia, the project team had to contact several on-site inspections (total coverage of 700 km).

The results of the project, with regard to the identification of the causes of increased rates of accidents, were very important and the following were identified as main causes (Image 6):

- Conjunction with other roads
- Direct access of adjacent commercial entities
- National road (primary) passing through residential areas
- Geometrical characteristics of road (marginal road width, inclination etc.)
- Environmental characteristics (e.g. rockfalls)
- Poor condition of road surface
- Poor road maintenance (fixing potholes and cleaning drainage facilities, replacing missing traffic signs, guard-rails, road markings and other safety features essential to create a safe road network). (Karadimou M. et al, 2012)

Image 6: Examples of poor road maintenance as a cause of increased rate of accidents in the Region of Western Macedonia (Karadimou M. et al, 2012)

With regard to the benefits of the methodology described, they were categorized in immediate and future benefits and are the following ones:

4.1. Immediate benefits

The methodology introduced by the Technical Chamber of Greece/Department of Western Macedonia can become a very useful tool for both policy makers, in order to target measures which will ensure the road safety of the users as well as for the users themselves who in the meanwhile will avoid black spots due to the information provided.

The Region of Western Macedonia gained:

- Environmental and health benefits (less injuries and fatalities because of less crashes, collisions and casualties, less damages in road network).
- Mitigation of the impact on socio-economic aspects of road accidents (fatalities, cost of injuries etc.).

4.2. Future benefits

The cost of car crashes in Greece is estimated up to 2% of the GDP, which is a very high percentage of the country’s economy. With regard to road safety, the proposed methodology can promote “anticipation instead of treatment”. (Karadimou M. et al, 2012)

It can be a very useful tool for public authorities in order to add more black spots or add information about the maintenance of the existing ones and therefore introduce this new technology in the way maintenance of the road network is confronted in Greece by public authorities.

The methodology introduced could be upgraded by:

- Being integrated into the vehicle safety systems (real time information etc).
- Providing information to the user of the road (improvement of driving culture and behaviour). (Christopoulou P., 2017)

Overall, this methodology proved that with a relatively low cost, immediate and future benefits can be achieved for the Region of Western Macedonia. In order for another region to apply the methodology, the basic equipment and human resources needed are as follows:

- A computer with GIS software
- Portable GPS devices with compatible GIS software
- Digital maps of the road network of the region
- A high definition camera
- A car
- People / engineers / experts with GIS software knowledge to update the database, upload the new entries and identify, describe and record the black spots on-site.

The strategy is common, but it is clear that each country or region adapts and refines the above mentioned, based on the local characteristics, culture and needs. (Christopoulou P., 2017)

5. Conclusions

Road Safety is considered as a significant topic world-widely, both at national and international level. It is the mirror of life quality and development of a country. The consequences of road traffic accidents are significant for the social, economic and political level of a city, a region or a country.

The efforts so far to confront the problem in a more systematic way, mainly aim to reduce the number of road accidents and mitigate the severity of their impact. Thus the main issue encountered is the investigation of the causes of the road accidents depending on the differences between the location of the accidents.

The methodology introduced by the Technical Chamber of Greece/Department of Western Macedonia is an appropriate analytical tool towards this direction. It introduces the use of GIS technologies by creating a dynamic database, in a field that can lead to immediate benefits for the road users and facilitate the road network maintenance, a difficult task to run by public authorities.

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www.statistics.gr

www.tdm.tee.gr

www.tee.gr

ATMOSPHERIC DISPERSION OF HAZARDOUS SUBSTANCES

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Abstract

Computational tools for simulating the atmospheric dispersion of hazardous substances (e.g., toxic, radioactive) in complex built-up environments (e.g., urban areas) or in larger spatial scales are presented. Hazardous substances may be released due to accidents, natural phenomena or intentional / malevolent actions. The complex flow patterns within urban areas necessitate the usage of mass-consistent diagnostic flow models or computational fluid dynamics codes. In larger spatial scales (e.g., regional) prognostic meteorological data from numerical weather prediction models are combined with Eulerian or Lagrangian dispersion models. Such modelling tools are often integrated within comprehensive decision support systems and are connected to modules that calculate exposure or dosages, depending on the substance type (e.g., gamma radiation doses due to the radioactive cloud and the material deposited on the ground). Dispersion models can be used either for forward-in-time or for backward / inverse computations. The latter are employed when a hazardous substance has been detected but its origin is unknown at the time of detection. These might be cases of un-announced technological accidents or covert malevolent releases. In such cases the results of inverse dispersion modelling simulations are combined with the existing measurements through statistical methods to estimate the location of the release and the quantity of the released material. The paper shows application examples of different computational tools demonstrating their exploitation potential and suggests approaches for their operational applicability in emergency response and recovery situations.

Keywords: atmospheric dispersion modelling, decision support, emergency preparedness and response

1. Introduction

The purpose of this paper is to present computational systems or tools that are or can be used in cases of accidents or malevolent actions that result in atmospheric releases of hazardous substances (radioactive, toxic, etc.) to prognose or diagnose the dispersion of these substances, to estimate the dosages to the population and to support the decision making process for application of countermeasures for mitigation of the consequences and restoration to normal situation. Typical examples are direct releases of toxic or otherwise harmful substances due to industrial accidents in chemical processing plants or accidents during the transportation of such substances or fires that result in the formation and dispersion of hazardous material.
In particular for radioactive substances, some conceivable scenarios of nuclear or radiological events that could result in the exposure of the population to radioactivity are the following:

- Accidents in nuclear installations, such as nuclear power plants, nuclear research reactors, nuclear fuel-processing installations or radioactive waste repositories;
- Transport accidents with radioactive material involved;
- Accidents in military installations or during military operations;
- Lost radioactive sources (e.g., from hospitals);
- Satellite return;
- Other events involving the uncontrolled exposure or spread of radioactivity

Besides the above mentioned accidental releases, scenarios of intentional / terrorist radiological acts are studied by the competent authorities:

- Improvised nuclear weapon devices
- Radiological Dispersal Devices RDD
  - eRDD: explosive RDD (dirty bomb)
  - neRDD: a non-explosive RDD (a liquid or powder is dispersed by a sprayer system or added to the food chain)
- Radiological Exposure Devices RED
  - sealed source to expose an individual or group
  - non-sealed source (largely equivalent with a neRDD)
- Sabotage of a nuclear installation

Natural events could also result in the atmospheric releases of substances that could cause damage or harm to human health or general activities, such as volcanic eruptions with the emission of ash.

2. Atmospheric dispersion modelling

In all the above circumstances models can be used to simulate and predict the atmospheric dispersion of the emitted material. Atmospheric dispersion models are mathematical descriptions of the physical processes that take place in the atmosphere, such as the transport, the diffusion, the deposition (dry and wet) on the ground and the chemical or physical transformations of the pollutant(s). In Figure 1 these processes are depicted in the case of dispersion of a radioactive material.

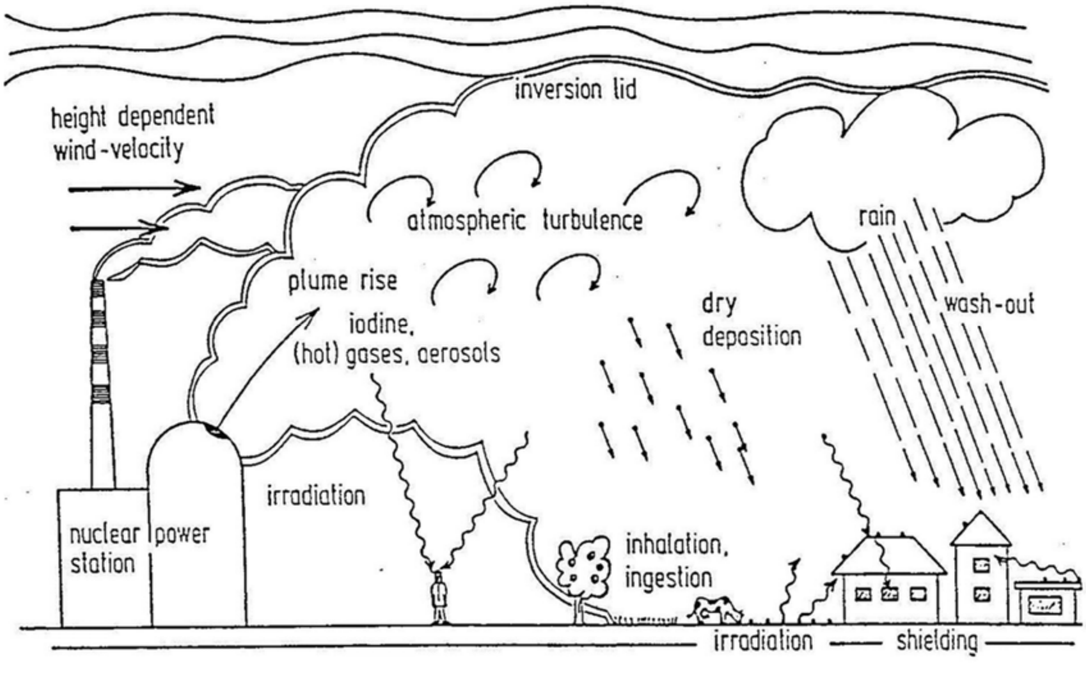


Figure 1: Natural mechanisms occurring during the atmospheric dispersion of a radioactive pollutant and radioactivity exposure pathways

Following the emission and possibly the plume rise (due to initial higher-than-air temperature and/or vertical velocity) the radioactive plume is transported by the wind velocity, it is diluted by the atmospheric turbulence inside the atmospheric boundary layer and it is deposited on the ground through dry deposition and/or wash-out due to rain (depending on the physical properties of the pollutant). The radioactive cloud irradiates the people during its passage (externally but also internally due to inhalation) while the radionuclides that have been deposited on the ground or other surfaces continue to irradiate after the plume passage and possibly they also enter the foodchain and cause irradiation due to ingestion. The atmospheric dispersion models attempt to account for all these processes to a higher or lower detail depending on their type and complexity.

In the following, two characteristic examples of atmospheric dispersion modelling applications in NCSR Demokritos are shown. In Figure 2 the results of a computational simulation of the dispersion of the radioactive cloud emitted from the accident in the Fukushima nuclear power plant in March 2011 (Wakeford, 2011) is depicted. The computations have been performed in the Environmental Research Laboratory of NCSR Demokritos using the HYSPLIT model (Draxler and Hess 1997). This is a planetary-scale application of a dispersion model and it is apparent that after some days the plume has reached Europe. It is worth noting that indeed the presence of radionuclides from the Fukushima nuclear accident has indeed been detected in Europe, of course at levels below the background concentrations, nevertheless at times that agree well with the model-predicted plume movement.

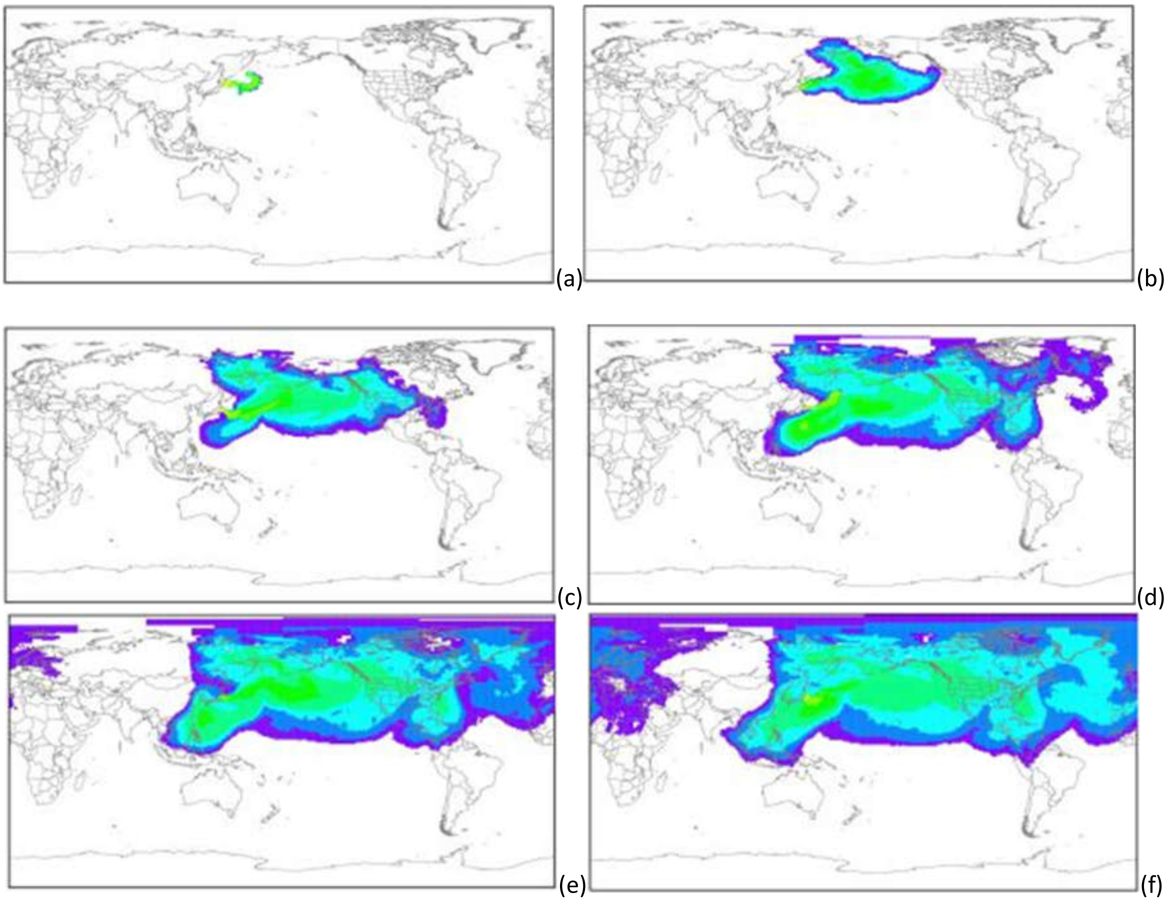


Figure 2: Example of global-scale dispersion modelling: the plume from the Fukushima nuclear accident 2, 4, 6, 8, 10 and 12 days (a, b, c, d, e and f respectively) after the start of the release on March 11th 2011, simulated by the HYSPLIT model in NCSR Demokritos

In Figure 3, the application of atmospheric dispersion modelling in regional case is presented. The specific example concerns a natural event and is the simulation of the dispersion of ash that was emitted from the eruption of the Eyjafjallajökull volcano in Iceland in April 2010. The volcanic ash had caused severe problems in aerial transportations in Europe and indeed the plume eventually covered a large part of the continent as it is apparent in Figure 3. The shown computations have been performed with the model DIPCOT (DIsPersion over COmplex Terrain) which has been entirely developed in the Environmental Research Laboratory of NCSR Demokritos.

In relation emergency response to accidental or intentional / malevolent releases of hazardous substances, the atmospheric dispersion modelling systems can be used in different phases. In the prevention and preparedness phase, i.e., before anything happens, the models can be used for studying scenarios taken from an inventory of threats and for creating databases of results that can subsequently be used for planning and performance of exercises and training of personnel or for design and optimization of monitoring / detection systems. In an actual emergency phase ready-to-use and fast computational tools can be applied to prognose the evolvement of the event or– through assimilation of monitoring data– for the determination / identification of an unknown emission source. The models can support the decision making for application of countermeasures for reducing the population exposure to the hazardous substance and the resulting dosage. In the recovery phase after the emergency situation measurement data start playing an increasing role. Combined use of all existing measurement data with model-results can assist to reconstruct the evolution of the event and in planning depollution and recovery actions. Based on the lessons learned models can be applied for a potential re-design of systems and processes and planning of response to another potential event.

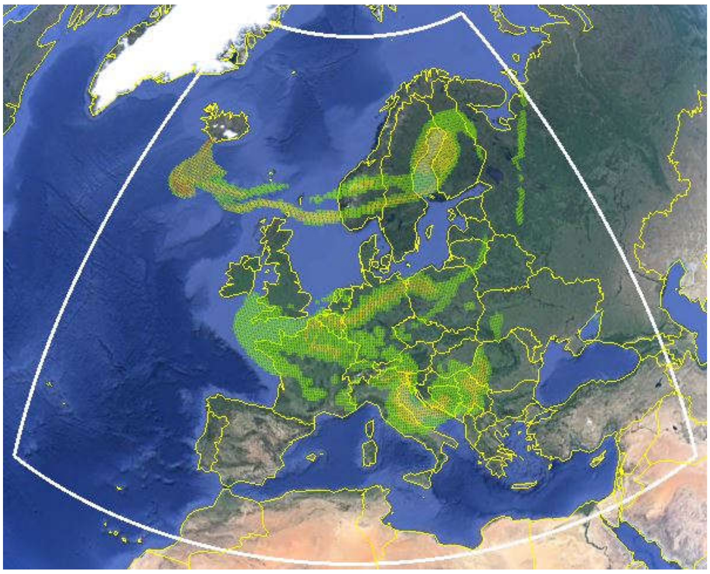


Figure 3: Example of regional-scale dispersion modelling: simulation of dispersion of ash from the eruption of the Eyjafjallajökull volcano in Iceland in April 2010

3. Computational systems

3.1 JRODOS

JRODOS (Java-based Real-time On-line DecisiOn Support - https://resy5.iket.kit.edu/JRODOS/) is a comprehensive decision-support system that has been developed – and continues to be expanded – by a large European consortium of institutions involved in nuclear-safety research with funding from the European Commission through EURATOM research framework programmes. JRODOS is designed to estimate the radiation doses to the population through different pathways as consequence of nuclear or radiological accidents or incidents in medium to large spatial ranges from the point(s) of release of radionuclides. Currently JRODOS is installed and functions operationally in several organisations that are responsible for the radiation protection. Figure 4 presents the modular structure of a comprehensive computational decision-support system such as JRODOS.

The system requires input data, mainly prognostic meteorological data, radionuclides emission data (spatial coordinates of the release, emitted quantities – that can be variable in time, and conditions during the release) and topography and land-cover data for the area under consideration. Based on the above data, a dispersion model calculates the radionuclides concentration in air and their deposition on the ground. Models that calculate radiation doses to the population (from different pathways, both internal and external) come into play next. Finally, the system proposes the appropriate countermeasures to reduce the doses and to recover towards the previous situation.

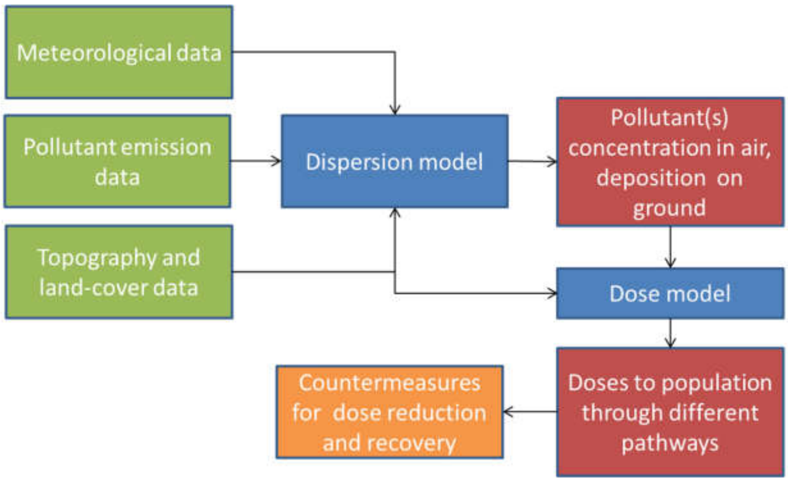


Figure 4: Databases, models, results and flow of information in a computational decision-support system such as JRODOS

The NCSR "Demokritos" and the University of Western Macedonia have contributed in the development of JRODOS by developing and integrating the meteorological data processing module of the system (Andronopoulos and Bartzis 2009) and the atmospheric dispersion model for complex topographies DIPCOT (Andronopoulos et al. 2009). Recently NCSR Demokritos has been actively involved in the development of an inverse-modelling algorithm to estimate the unknown emitted quantities of radionuclides based on the available measurements of radiation and results of the dispersion model.
In Figures 5, 6 and 7 some indicative examples of JRODOS results are presented for the case of a hypothetical nuclear accident in central Europe with real meteorological data.

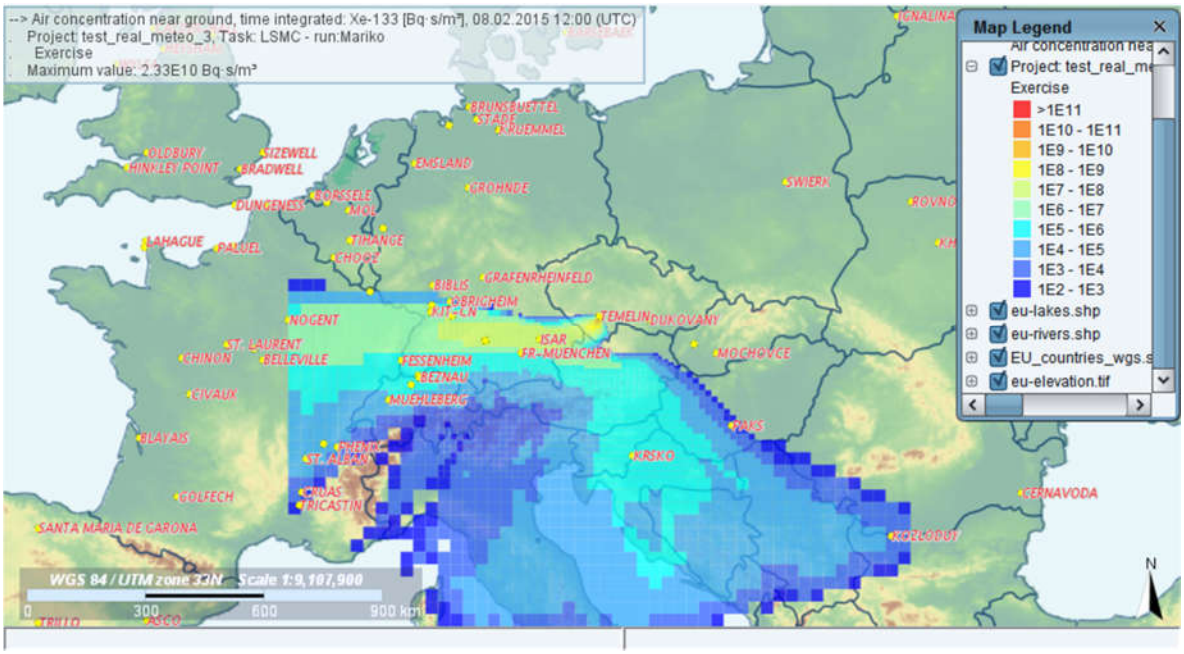


Figure 5: Example of JRODOS results for a hypothetical accident in a nuclear power plant in central Europe: time-integrated activity concentration in air of the radionuclide Xenon-133, 48 hours after the start of the release

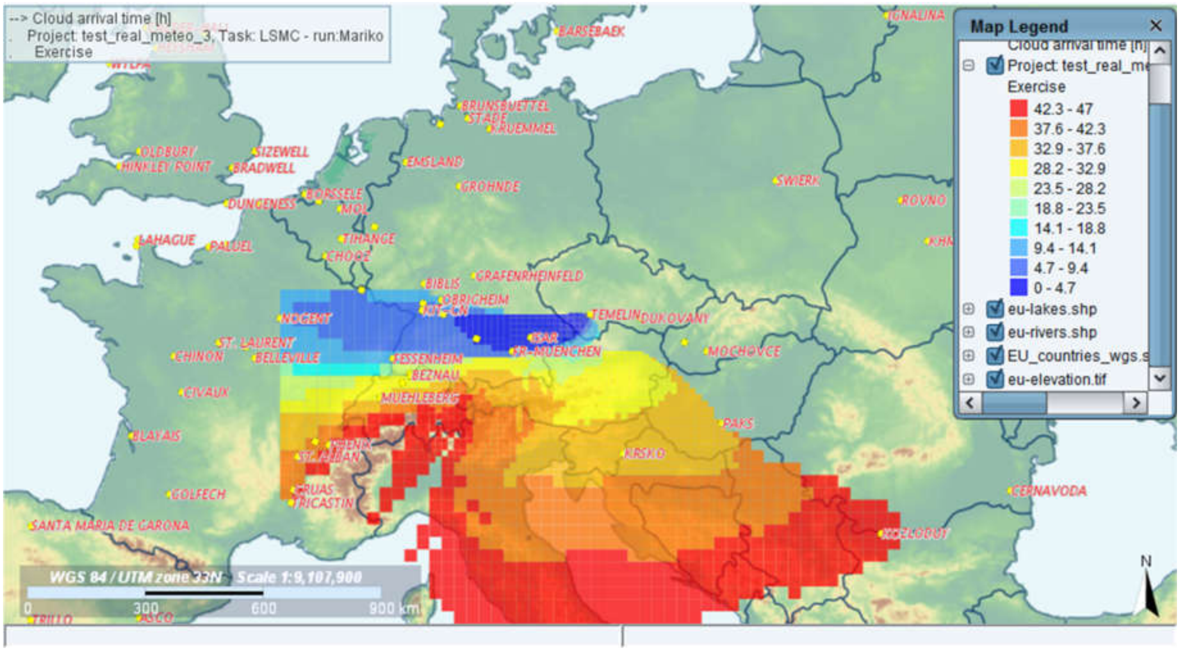


Figure 6: Example of JRODOS results for a hypothetical accident in a nuclear power plant in central Europe: cloud arrival time (h) at different distances from the release location

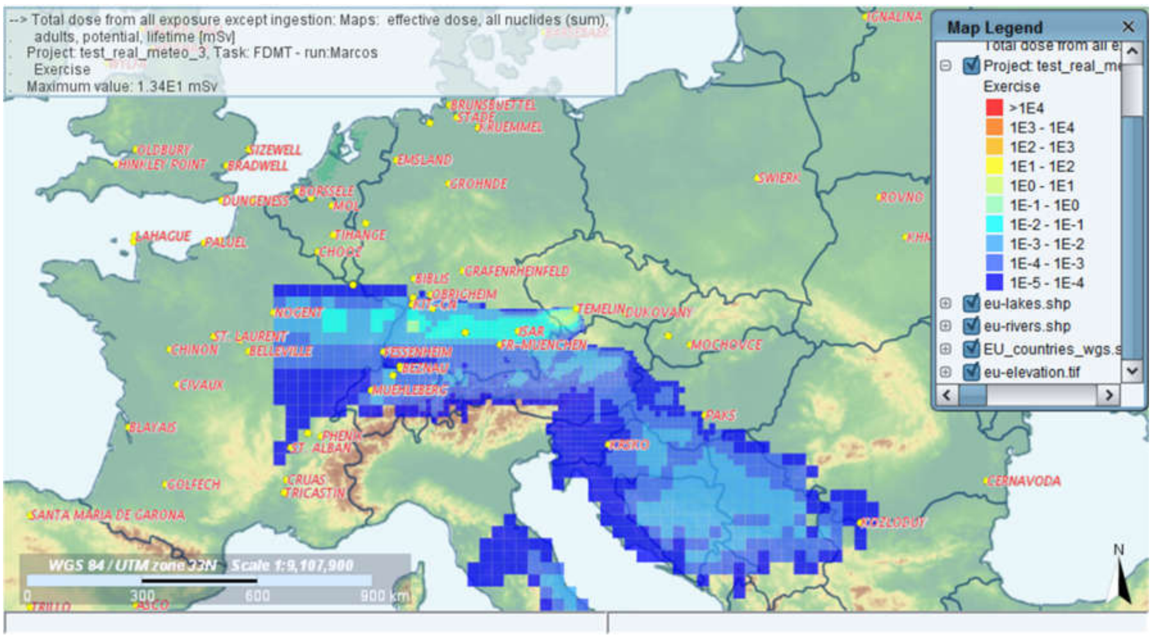
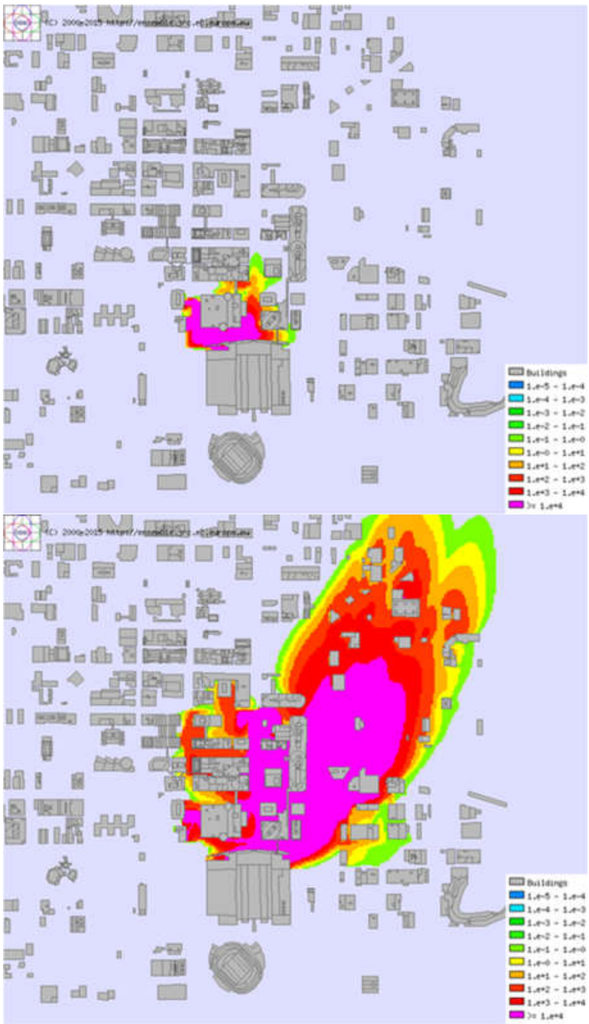


Figure 7: Example of JRODOS results for a hypothetical accident in a nuclear power plant in central Europe: effective dose (mSv) from all nuclides and form all pathways (except ingestion) for adults and for life-time period

3.2 ADREA-HF
ADREA-HF is a computational fluid dynamics (CFD) model developed in Environmental Research Laboratory of NCSR Demokritos and Environmental Technology Laboratory of University of Western Macedonia (Bartzis 1991; Andronopoulos et al. 1994, 2002; Venetsanos et al. 2010). It is especially designed to calculate the flow and dispersion in complicated geometries (out- and in-doors). ADREA-HF is an Eulerian model for solving the unsteady Reynolds-averaged Navier-Stokes (RANS) equations, with a recently-implemented Lagrangian

particle-dispersion model. Several turbulence closure and numerical solution schemes are implemented in the code and can be selected by the user.
As example of an ADREA-HF application, in Figure 8 the results of the model are presented from a simulation of dispersion of an instantaneous release of a passive gas inside a real urban area. It is the computational simulation of a real-scale experiment that was performed in the city of Oklahoma in the USA in July 2003 (Allwine et al. 2004). The experiment that has been calculated by ADREA-HF concerned the instantaneous release of a "passive" tracer (i.e., a gas of density equal to the air) intending to simulate the explosion of an RDD. In the case shown here the wind was blowing from south-west. Figure 8 depicts the model-calculated near-ground concentration of the tracer gas (pptv) between the city buildings at 1, 5, 10 and 20 min after the instantaneous release.



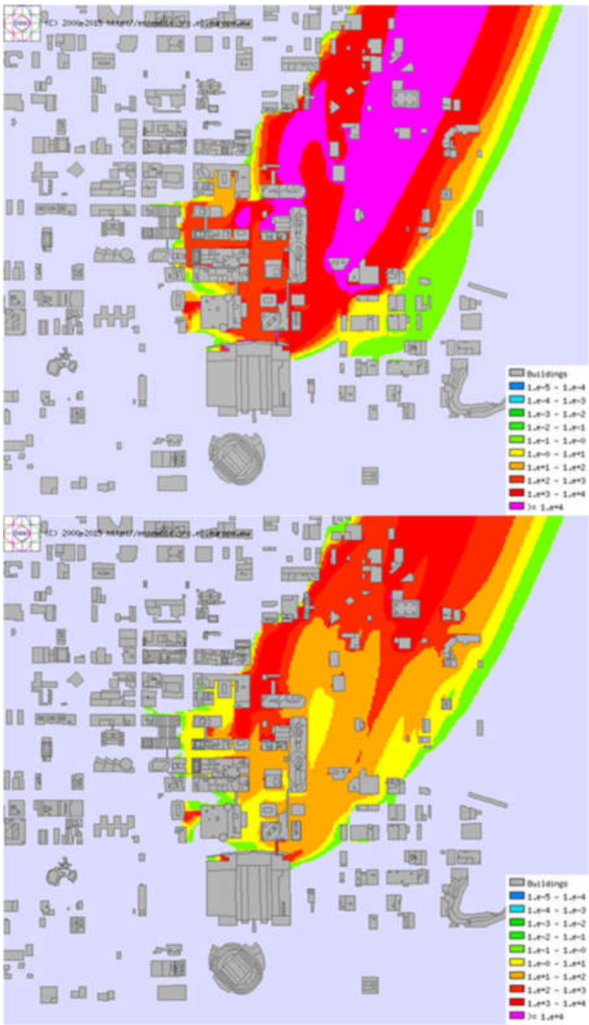


Figure 8: ADREA-HF-calculated near-ground concentration of the tracer gas (pptv) released instantaneously between the Oklahoma-city buildings at 1, 5, 10 and 20 min after the release. The wind blows from south-west.

3.3 QUIC

QUIC is an atmospheric dispersion modelling system developed at the Los Alamos National Laboratory (USA) (https://www.lanl.gov/projects/quic/). QUIC has been designed to calculate the wind flow and pollutant dispersion in a small spatial scale and in particular between buildings inside urban areas. The modelling system comprises two flow models (an empirical / diagnostic mass conserving model and a simplified CFD model), and a Lagrangian-type dispersion model. It includes user interfaces for easy input of buildings geometry, of meteorological data, selection of release scenario from an available list and a database of hazardous substances with corresponding physical properties.

As example of QUIC application, Figures 9, 10 and 11 present results of QUIC of calculations performed in NCSR Demokritos for a hypothetical RDD explosion in the centre of Athens (Papathanassiou et al. 2014). The computations were performed in the framework of a European-Commission-funded research programme ("Implementation of an RN emergency system in Eastern Mediterranean - IMAGES"). The simulated scenario concerns the explosion of RDD in Athens centre and the subsequent dispersion of 3.7×10^{13} Bq of radioactive Cobalt-60 in particulate form. The wind speed and direction are time-varying. Time-integrated concentrations in air, deposition on ground and dosage due to inhalation are presented in Figures 9, 10 and 11.

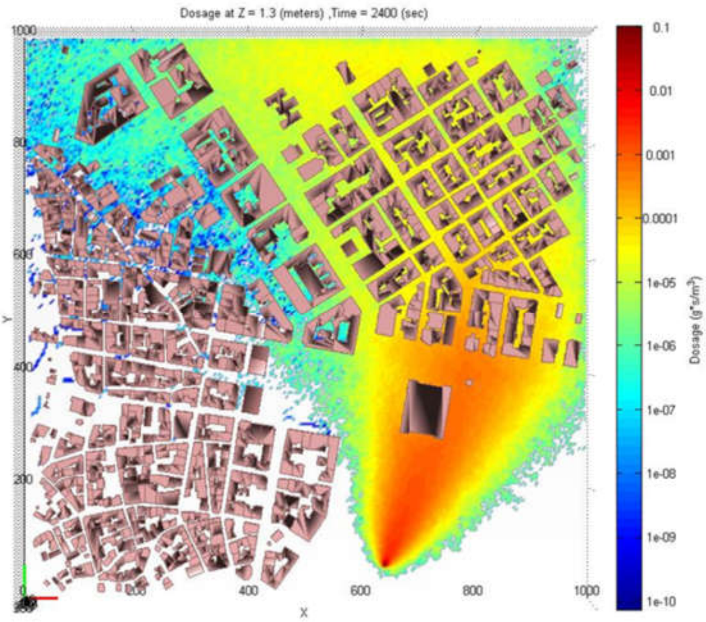


Figure 9: Time-integrated concentration in air (g.s/m^3) of Co-60 calculated by QUIC for a hypothetical scenario of an RDD explosion in the centre of Athens

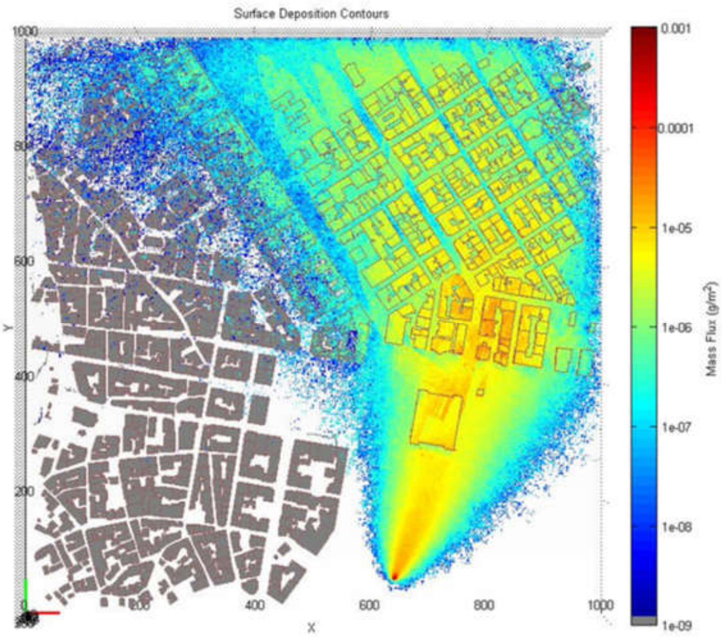


Figure 10: Deposition on ground (g/m^2) of Co-60 calculated by QUIC for a hypothetical scenario of an RDD explosion in the centre of Athens

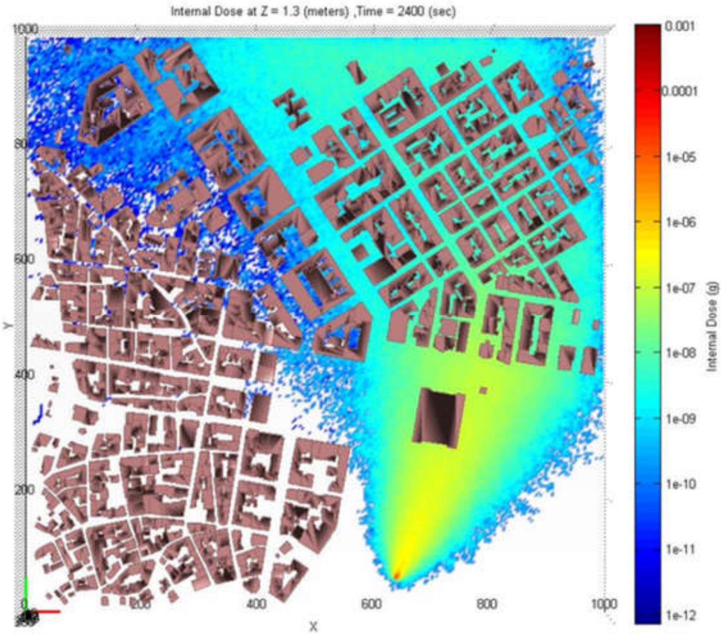


Figure 11: Dosage due to inhalation (g) of Co-60 calculated by QUIC for a hypothetical scenario of an RDD explosion in the centre of Athens

4. Modelling uncertainties

In the framework of the topic of this paper, by modelling uncertainties we mean the deviations that occur between the model results and the reality as observed through measurements. It is common to distinguish the following sources of uncertainties in the model results: (a) uncertainties in input data (e.g., meteorology, release), (b) "Internal" model uncertainty (due to modelling assumptions, simplifications, etc.) and (c) the stochastic nature of the atmosphere (turbulence). The first two sources of uncertainties can in principle be reduced while the third one not. Assessment of modelling uncertainties is usually performed through comparison of the model results with experimental data or with other models results and through sensitivity studies (how much do the model-results vary in response to variations in the model input data). It is noted that the user of a model must be aware of the particular model level of uncertainties for the specific type of application and should pay attention to the model specifications and the model suitability in relation to the intended application. It is also noted that in relation to uncertainties in the model input data for emergency cases, the worst case scenario is not always the best option as the resulting countermeasures may be unfeasible or negative consequences of excessive countermeasures are possible to occur.

5. Inverse modelling

There may be cases where the source of a hazardous substance release is unknown. Such cases could be un-announced technological accidents (as for example the Chernobyl accident that was announced by the Soviet Union several days after its occurrence, while radionuclides had already been detected in Sweden and elsewhere) but also terrorist/ malevolent actions that most probably would be covert.
In such cases the available information would consist of the measurements that have detected the pollutant at different places and times. Also known would be the past and present meteorological conditions. The scientific community has developed in the recent years several mathematical techniques that combine dispersion model results with measurements (through a process known as "data assimilation") in order to identify the position of the unknown source and to assess its "strength", i.e., the quantities of the released substance. The uncertainty of these methods depends on many factors, among which the number of measurements, the quality of the dispersion model results, etc.

6. Conclusions

Several different computational tools are currently available to simulate the atmospheric dispersion of hazardous substances from accidental or even intentional (malevolent) releases and to support the decision-making process for application of countermeasures to reduce the doses to the population and to recover to the previous situation. Different tools are suitable for cases of atmospheric dispersion in medium to long ranges (some kilometres to thousands of kilometres) and for dispersion in the near-range in complicated built-up (urban or industrial) areas (tens to hundreds of metres). The model complexity and the subsequent requirements for computational time and resources in general is a crucial factor for the selection the appropriate model to use, considering also the complexity of the intended application and the time that is available for obtaining the results. In any case the uncertainty in the model results must be known and taken into consideration. Recently inverse modelling techniques have been developed that allow for the assessment of the location and strength of an unknown source emitting a hazardous pollutant.

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FIRES IN SOLAR POWER SYSTEMS AND FIREFIGHTER SAFETY

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Abstract

The vast development of solar power applications in last decades has led nowadays into an increasing number of buildings incorporating photovoltaics which produce electricity, contributing to the electrical power supply. It is a fact, however, that many solar power units installed lots of years ago are now aging, and many of the installed applications could lead to fire development, due to their potentially improper installation, and lack of maintenance. On the other hand, until recently little was known about the dangers imposed in fires involving photovoltaic systems, with firefighters worldwide having a scarce knowledge of proper ways to manage such fire safely and effectively. To this purpose, a number of guidelines both in Greece and other countries have been developed aiming at the protection of firefighters from the risks associated with fires in solar power units, and also at the actions taken for their successful fire suppression. This paper focuses on the analysis of these guidelines, under a literature review methodology, highlighting the most common causes of fires in photovoltaics, and the dangers regarding the firefighters' operational safety. The purpose of this study is to review the risks imposed at firefighters' health when engaged on incidents of fires in solar power systems, and the suggested firefighting methods according to international standards and guidelines. The study's results can be a useful resource tool aimed at enriching emergency responders' knowledge, both in fire suppression techniques, as well as in safety concerns about the health hazards linked to such fires.

Keywords: photovoltaics, firefighters, electric shock, accident prevention, safety, fire risk

1. Introduction

Photovoltaic (PV) applications are a relatively new power generation technology that has been widely developed in recent years, especially in the developed countries like the EU Member States (EEA 2017). The benefits of PV systems is one of the main reasons for its rapid development, since the sunlight is a readily available, inexhaustible, and environmentally friendly natural resource (Markvart & Castaner 2003). Moreover, the owners of PV systems have considerable monetary benefits, since they can have an autonomous domestic electricity production system, being able either to use its electrical energy as autonomous power consumers, or to sell the excess energy they produce by supplying with electricity the local grid. These advantages, combined with public incentives for the promotion of use of PV systems in many countries, such as Italy, Greece and Germany, has resulted to an increasing number of solar power systems installations in the EU (EEA 2017). This is also the case in other continents: in California, for example, between 2001 and 2009 there were about 50,000 residential and commercial solar projects in total (CAL FIRE 2010), and also in Australia with 1.5 million plants producing approximately 5,000 MW per hour per year (Chiaramonte et al 2016).

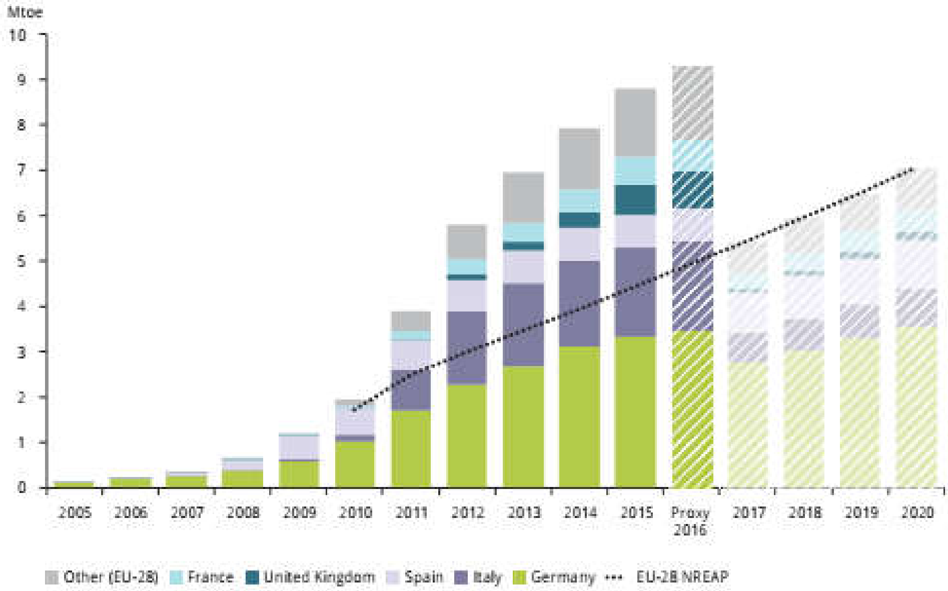

Figure 1. Solar PV Electricity Production between 2005-2016 (EEA 2017)

As the number of installed PV units increases every year, and also since the older solar applications begin to deteriorate in terms of material performance, there are certain cases of fire incidents caused or involving solar panels in many countries around the world (Ju et al 2017). In detail, during recent years there have been reports of a number of fires on domestic roofs, schools and other public buildings, with the PV system or associated equipment often reported as the cause. For example, in Australia during the past five years, the Victoria's Metropolitan Fire Brigade has responded to more than 40 fires involving solar panels (Laukamp, Grab & Schmidt 2012). Fires involving solar panels may be infrequent, but when they do occur, they present additional challenges to the fire fighters, since the hazards that exist in fires involving PV systems are identical to the fire risks associated with electrical equipment. It is, therefore, extremely important that these risks need to be addressed and carefully considered, in order for firefighters in all countries to familiarize with their potential causes and the procedures to be followed in such fire incidents, including preventive and corrective measures, always with respect to their health safety.

Firefighting guidelines are, therefore, necessary to be provided, since fires in solar power systems involve many combined risks, such as electric shock, toxic fumes emissions, explosions, and rooftop collapse (Hellenic Fire Brigade 2015). For this reason, the purpose of the work is the analysis of the PV systems working principles, so as for fire brigade officers to identify and recognize the markings and components of a solar power system, and the review of the firefighting tactics and protection measures to be applied in PV system fires, with respect to the associated dangers of these incidents to the health of a firefighter.

2. How photovoltaics work

A PV system exploits energy in the form of light from the sun, transforming it into electricity for use either on-site or on the local grid network. It generates direct electrical current which is then transformed into alternating current for domestic and grid power supply. PV systems are divided into 2 types: the interconnected and the standalone applications (Markvart & Castaner 2003). The first is directly connected to the local power grid, where part of solar energy is converted into electricity to meet building needs, and the excess electricity is supplied to the grid. At times when electricity is not favored enough to meet the house's energy needs, as during the night for example, electricity is reversely supplied from the local power grid to the building. As for the second type, it is independent of the local power grid; standalone PV systems are purposed only for domestic power use by their owners. The electricity supplied by the PV unit in these applications is solely used to meet the energy needs of the building and batteries are used for the storage of the surplus electricity they generate, which can be used as a back-up power supply unit when electrical power from PV units is not sufficient or not produced at all, such as during the night or a cloudy day (Giraud & Salameh 1999).

2.1 Components of a photovoltaic system

A typical solar PV system typically consists of the following units:

2.1.1 Modules:

A module's composition includes a number of typically around 50-72 square- or circular-shaped PV cells of sufficient durability, since they are protected by anti-reflective glass and a plastic cover. Electricity is generated through them when exposed to sunlight. The connection that exists between modules allows the electrons to move into the system. A group of cells is called a module, a group of modules in series is called a string, and a string group forms an array, as shown in the Figure 2 below. A PV module weights approximately 12.6 kg/m^2 (Battisti & Corrado 2005).

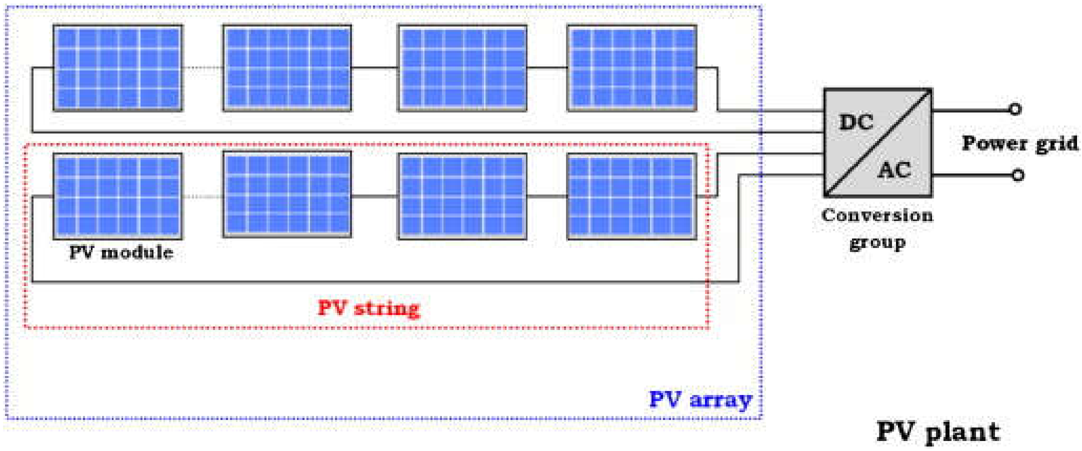

Figure 2: Configuration of PV systems (La Manna et al 2014)

2.1.2 Inverter

Its purpose is to convert the DC produced in the PV array into AC, which can be used by the consumer or be supplied to the power grid, as shown n Figure 2. Depending on the purpose they serve, there are several inverter types available in different sizes, such as the microprocessors and the system inverters. The microprocessors convert the DC of each unit into AC. That's why their location is usually next to or embedded in each individual PV module. Instead, the system inverters receive power from multiple arrays and are located close to the device or inside the building in an auxiliary room (CAL Fire 2010).

Figure 3: Inverters with their disconnect switches used in PV units (Hellenic Fire Brigade 2015)

2.1.3 DC isolation switch

For safety reasons, electric systems must be equipped with a manual disconnection device. This is normally used to protect technical personnel from electric shock during system maintenance. In addition, a manual disconnection switch allows any user to interrupt the circuit if there is an emergency. Since solar power systems convert energy from the sun into electricity, a Direct Current (DC) generation in PV arrays is continuous during daylight hours. To this purpose, the DC isolation switch (or DC Isolator) is one of the most important parts of a solar power system regarding safety. Its role is to isolate the part of a photovoltaic system which flows through DC current (Chiaramonte et al 2016). It is installed between a DC array and the unit's inverter. Positioned adjacent to the inverter, the DC isolator switch provides a choice of manually isolating the PV array during system installation, in case of emergency or any subsequent maintenance. Germany, the Netherlands and some other European countries require inverter manufacturers to configure with built-in DC Isolators, while countries like the UK, India, and Australia require that the PV systems must be installed with external DC Isolators. In PV systems there is also an Alternating Current (AC) disconnect switch installed after the system inverter.

Figure 4: Solar PV system with a rooftop installed DC isolator switch (Chiaramonte et al 2016)

2.1.4 Alternating Current (AC) cables

They allow the AC to be transferred from the inverter to the main power supply grid. There is also installed a power meter for recording the electrical energy produced by the PV module, and there is also installed an AC isolation switch.

2.1.5 Batteries

In standalone solar power applications, where the PV module is not connected to the local grid and all electrical energy produced by the modules is purposed for domestic use, batteries are commonly used as ancillary electrical energy storage devices that store electricity generated by the solar panels during of the day when the sunlight is available and returns it to the electrical equipment of the house or company during the night or in cases where the electricity produced by the PV is rare or inadequate, such as during a cloudy day (Giraud & Salameh 1999).

A battery consists of 5 main components: electrodes, separators, terminals, electrolytes and their casing. PV systems use liquid electrolyte batteries, commonly known as lithium-ion batteries or acid-lead batteries, with electrolyte being the most flammable component in lithium-ion batteries (Hellenic Fire Brigade 2015). An alternate battery option consists of flow batteries, which store energy in liquid electrolytes rather than on electrodes. They are charged and discharged without affecting their service life due to the production of batteries from plant carbon waste (Laukamp et al 2012).

Figure 5: Batteries of a standalone PV system (CAL FIRE 2010)

3. Main fire causes in PV systems

The development of PV systems and their widespread use has been associated with an increased number of fires in areas where they have been installed. For example, it is estimated that in Italy there were approximately 600 fires involving PV systems during 2012 (Fiorentini et al 2015), while there have been also reported fire incidents involving solar power systems in Japan, USA, Germany and the UK (BRE 2017, Namikawa et al 2017). Such fires either included PV systems, or they were a fire extension that had preceded a forest-rural area or originated exclusively from them. Especially during the early development stages of this new technology, due to a limited database and previous experience about the specifications and product standards of PV systems, there were in fires in PV systems stemming from the use of inappropriate material and defective equipment, such as inverters, fuses and wrong connections in the DC section, where high arc temperatures were developed (BRE 2017).

Figure 6. Rooftop PV fire in Scwerinsdorf, Germany in February 2010 (Laukamp et al 2012)

According to recorded databases, another main cause of fires in PV systems was attributed to the lack of qualified personnel, which resulted in the faulty installation of system components, such as incorrect management of shading and exposure to inappropriate conditions, crushing of wiring during installation, lack of external DC disconnect switch, while there have also been reported some fire incidents in self-installed solar power systems, where the do-it-yourself practice from the owners resulted into the inappropriate installation and operation procedure which led to a fire (CAL Fire 2010). Over time, however, such incidents have been decreasing due to the development of specific national regulations, product standard specifications, including fire safety applications and guidelines for installation and operation procedures. Standards for testing the performance of solar panels have been developed at an international level. While some address electrical performance, others address safety of the modules with respect to construction and operation. These safety standards also address fire behavior. The safety standards applied are the IEC 61730 in Europe & Asia, and the ANSI/UL 1703 in North America. Both standards are very similar and contain elements of fire testing based on ASTM E-108/UL 790, "Test for Fire Performance of Roofing Materials (Allianz 2012). As a result of the improved know-how and the better standards applied and developed in the PV industry, the number of fires coming from PV systems due to faulty installation and operation and the lack of specific guidelines has been reduced in recent years.

There is still, however, the risk of fire in PV systems due to a short circuit and electric arc. Under fault conditions, short circuits may occur, resulting in the occurrence of high temperature electric arcs. Typical causes of a short circuit can be, for example, the rainwater entering a PV system's isolation switch that is not insulated. Electrical arcing is the flow of electrical energy through an air gap through ionized gas molecules. Whilst air is normally considered as a non-conducting medium, a high potential difference (voltage) between two conductors in close proximity can result into the air molecules braking down into their ionized constituents, which can then carry a charge from one electrode to the other. The temperature of an electrical arc depends on the level of current flow, which for a typical PV system is sufficient to melt glass, copper and aluminum, thus initiating the combustion of surrounding materials. Even though electrical arcing is not considered an issue for AC systems, in DC systems due to the continuous of voltage, once an arc has been initiated, DC current tends to support its continuation (BRE 2017).

A typical example of the main causes resulting solar fire incidents, is shown below in Figure 7. As can be seen by the graph, these are mainly associated with rooftop DC isolators, which is considered as the main cause in PV systems fire incidents in the UK and Australia according to recent reports (Chiaramonte et al 2016, BRE 2017), improper installation services, solar panels, batteries, inverters and other system components. In Figure 8 a PV system fire due to DC isolator malfunction is presented.

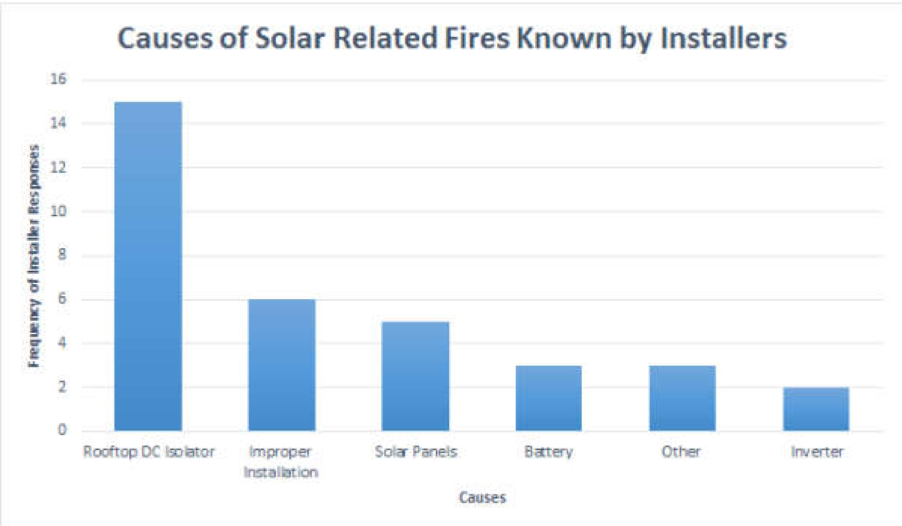

Figure 7. Causes of solar-related fires reported by installers in Australia (Chiaramonte et al 2016)

Figure 8. Localized PV fire where the left DC isolator is completely missing with the next DC isolator and inverted also being damaged by fire (BRE 2017)

4. Dangers imposed from fires involving PV

As previously mentioned, fires in PV systems involve the same dangers as those of a fire in an electrical system. One of the main dangers a firefighter can face when operating in a PV system fire event is an electric shock. Electric shock is an invisible hazard that a firefighter cannot always be aware of its existence. Cut or naked wires, short circuit and electric arcing, non-grounded PV system cores are some of the most known common cases of electric shock risks threatening the life and safety of the firefighter, such as was the case of an incident reported in Rösrath, Germany, even though this accident was subjected to a solar thermal system Laukamp, Grab & Schmidt (2012, which also includes many system components similar to those of a PV unit, such as electrical wiring and panels. Even though solar systems are considered to be operating only during daytime, it is worth mentioning that there could be also the risk of a PV system being energized even under night operations, due to the existence of artificial light, such as the lights of a fire engine, or lamps of the local electric grid located nearby the solar power unit.

Furthermore, where PV systems are connected to batteries, additional risks are to be considered. This is because the batteries used contain flammable and explosive substances. In particular, lead-acid batteries contain sulfuric acid which, when exposed to fire, releases explosive and noxious fumes. Similar is the case for lithium-ion batteries containing liquid electrolyte, where it is irritating when it comes into contact with skin and eyes and produces toxic hydrogen gas which can rapidly ignite. Since batteries are usually stored in closed rooms with limited ventilation, the aforementioned issues are of particular importance when firefighters are operating in standalone PV system fire incidents, while it is suggested that information shall be provided on whether batteries are included also in fires of grid - connected PV systems (Hellenic Fire Brigade 2015).

Another point which needs to be addressed is the risk of inhalation of harmful substances from the combustion of the materials of which the PV system components are made. Elements such as silicon, phosphorus, boron, cadmium, tellurium, arsenic and gallium are contained between the glass and a plastic substrate, which when released in the surrounding atmosphere of a PV system fire pose an additional health risk to operating units due to inhalation (CAL Fire 2010). Dense smoke emitted from the burning PV system components also limits the firefighter's visibility, which is also to be considered, since wires with burnt insulation are "invisible" (Laukamp 2012).

It is also considered as a serious risk that firefighters involved on ceiling mounted PV system fires are threatened by additional hazards such as falling from the roof (e.g. in case of slipping on the inclined solar panel). Such a risk is greater also in night operations, where there is limited visibility due to darkness or dense smoke emitted from the fire. It is also useful to be mentioned that the rooftop area during a fire operation may become slippery from the foam or water application, due to the materials (glass, metal, ducts) installed the PV systems and the panel's inclination (Namikawa et al 2017), thus increasing the chances of a falling accident.

Moreover, the additional weight of the personnel operating in the roof, the amount of foam applied and the weight of the PV system itself can increase the maximum acceptable load and lead to its partial or total collapse if it is not built to withstand extra weight, such as the case shown in Figure 9 below. The failure of the roof and its collapse can also result to the "channeling phenomenon". This phenomenon is attributed to the gap between the ceiling and the panels, where high temperatures are developed due to the entrapped hot air and weaken the ceiling materials. In such cases, it is not only those who intervene on the roof, but also the staff inside the building which are subjected to a considerable risk of a fire injury (Hellenic Fire Brigade 2015).

Figure 9: Roof collapse caused by a solar PV system fire (Shipp et al.2013)

Finally, it must be noted here that in cases of fire incidents where PV systems are included, if firefighters are not aware of the existence of PV systems due to misleading or lack of information provided to the fire brigade about the existence of a solar power system in the area, either because they are located in such a way that they are not visible from the ground or because they might have been illegally installed (CAL Fire 2010), this may result into endangering the lives of the firefighters involved in the operation due to previously mentioned risks included in fire incidents of electrical systems, such as the solar power units.

5. Firefighting tactics in fires involving PV systems

Provided that they are properly installed, operated and maintained by trained personnel, the solar power systems in general do not pose health, safety, or environmental risks under normal operating conditions. However, with the ever-growing deployment of PV systems globally and the myriad of applications—from traditional rooftop and ground-mounted installations to more advanced building-integrated and façade systems —it is becoming increasingly important to develop practices and share knowledge on the safe management and risk mitigation of PV systems under non-routine circumstances such as fire incidents (Namikawa et al 2017).

It is, therefore, necessary to provide continuous training (theoretical and practical) of all fire brigade officers on topics related to extinguishing fires of PV systems. A proper training program should include the identification of solar power system components so that firefighters can easily recognize them and address their risks in case of a PV fire event. It is of particular importance that firefighters must be aware of the parts of a PV system which remain active during the fire, while it is also necessary that they cooperate with all related agencies and professionals involved in such cases, which may include specialized technicians for disconnecting the system from the local supply grid, the owners of the PV application and the local power supply company. It is also suggested that all relevant information including system documentation, schematics, component locations and cable routing must be obtained, preferably under a preventive approach for the area under responsibility of each fire department whenever possible, while sign postings on existing PV systems installed on a building, such as these shown in Figure 10, are necessary for firefighter awareness in case of access to that building in case of fire. A good practice by PV installers is also the fire protected installation of DC cables outside the building skin (Laukamp 2012).

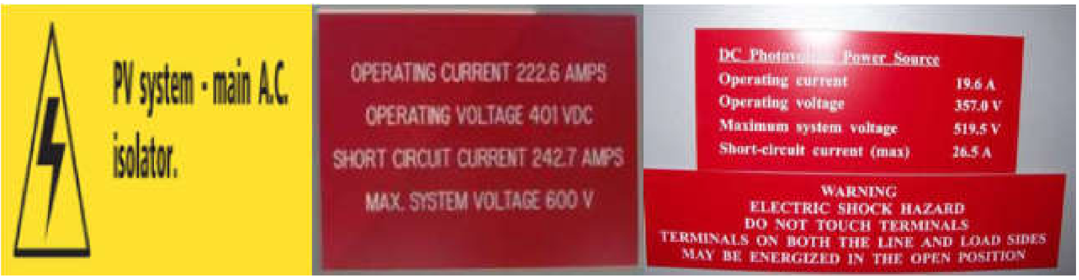

Figure 10. Typical examples of PV sign postings on buildings (Hellenic Fire Brigade 2015)

A key factor in providing safe firefighting and firefighting techniques to fire firefighters in extinguishing a fire involving PV systems is communication between intervention teams. Fire fighters must be able to know their duties, understand the terminology of the PV systems, receive orders, execute them and be flexible on changes that may occur depending on the findings, the data or even the risks during the event. According to the suggested guidelines the intervention teams are the indoor group entering the building, the group of utilities that deactivates each source of energy supplying the building and the roof team which operates at the top of the building. The teams must be coordinated under the direction of the chief (CAL Fire 2010). Thus, in the first stage, a perimeter check is performed on the scene of the event to evaluate and locate the positions of the components of the PV system. If the fire originates from the PV system itself, such as the case shown in Figure 11, the strategy followed must be aggressive in order to mitigate the fire. In case of the fire originating from another source located near a solar power system with a risk of spread to the PV unit, such as the case shown in Figure 12, a defensive approach shall be used to prevent the fire from spreading. Moreover, a process of evacuation and rescue must take place in cases of life threatening incidents.

Figure 11. Fire developed in the Isobox unit of a PV system in Amfikleia, Greece in Spring of 2013 (Hellenic Fire Brigade 2015)

Aggressive firefighting tactics include the use of dry chemical fire extinguishers or water in a 30-degree fog pattern applied at 100 psi. The use of a compact spray of water or foam is forbidden because a column is created which acts as a conductor of the electric current, which can cause an electric shock. If a solar PV system is on fire and firefighters attempt to extinguish the fire with a hose stream of water, the energized panels can electrify the stream of water creating an electric current travelling towards firefighters posing a risk of being electrocuted. It is recommended that a safety distance of at least 10 meters away from the energized source must be ensured for the firefighters (Namikawa et al 2017). In case of a PV system connected with batteries, it is also suggested that CO_2 or dry chemical fire extinguishers must be used instead of water. Firefighters unfamiliar with grid-tied systems with battery backup might assume that all interior mains circuits are dead after the meter is pulled, while in fact they might still be live and powered from an inverter and battery bank.

Figure 12. Forest fire spread into a PV unit in Kythnos, Greece in 2012 (Hellenic Fire Brigade 2015)

It is also necessary that firefighters prior to their entry to the hot zone of fire must wear personal protective equipment including electrically insulated tools and clothes, and respiratory devices for protection of toxic gas inhalation and electric shock. Accidentally breaching any module with an aluminum roof ladder or while cutting into the modules with a demolition saw can expose a firefighter to the full voltage potential of the entire series module string. It is also extremely important to keep clothes and boots dry, since they provide little or no protection when wet.

Another useful approach towards eliminating fire is the vertical ventilation of the building from the rooftop team of firefighters to prevent pressure from building up. Such an approach is not suggested, nevertheless, in cases where no information is available about the location of the cables connected to the PV system. In case that a vertical ventilation cannot be applied, it is suggested that horizontal ventilation can be applied instead (CAL Fire 2010). The team tasked for roof access and ventilation must also be aware that the PV module strings on the roof are very fragile and can be energized to a DC voltage up to 600 V when exposed to light. The use of microinverters and per-module DC optimizers is a firefighter-friendly suggested measure to be applied by solar professionals, since individual modules in such cases operate at less than 50 Voc in full sun instead of the lethally dangerous 600 V string (Fink 2011).

Figure 13: Firefighters use the ventilation method (CAL FIRE – Offline of the State Fire Marshal 2010)

Finally, a general inspection of the area after fire extinguishment, also known as the mop-up process must be carefully considered, since scene inspection after a fire is very dangerous, and PV systems can add complications. In a midnight attic fire, for example, when the sun comes up, PV source circuits (and even the conduit itself, if shorted to a hot wire) can become live in case that the insulation of the PV source wires has been compromised inside the metal conduit in the attic, and shock firefighters who are trying to mop up (Fink 2011). Apart from disconnecting current switches and isolating the solar PV system from the local grid, another suggested approach of turning turn off the system is to block the incoming light to the panel. This can be accomplished by covering the panels with dark colored sheets, which block the transmission of light, as shown in Figure 14.

Figure 14: Blocking light using black plastic sheets (Backstrom & Dini, 2011)

6. Conclusions

Due to the continuous increase of PV installations and the lack of previous experience about fire incidents including solar systems, PV-induced fires pose new challenges to Fireservice departments around the world. Such incidents must be treated as electrical fires including potentially hazardous materials and toxic gas inhalation, with all relevant measures to be applied in firefighting tactics and strategies. Provision of proper training to fireservice crews is of utmost importance for their safety as well as for the effective elimination of fires in PV systems. The purpose of this study is to highlight the key factors necessary for ensuring the maximum possible safety of firefighters involved in solar power fire incidents. Since there is a lack of commonly practiced international action protocols in such fire incidents, the purpose of this study is to review and present some of the most commonly practiced approaches by fire departments in various countries.

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EVALUATION OF GEOTECHNICAL PROPERTY VARIABILITY: THE CASE OF SPOIL MATERIAL FROM SURFACE LIGNITE MINES

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Abstract

Soil is a complex material whose properties often vary in the vertical and horizontal direction. From a geotechnical perspective, quantification of soil's variability is important, because it allows for computation of a geo-structure's reliability and for implementation within risk analyses. In this context, the present work deals with the variability of geotechnical properties of a large spoil heap in northern Greece. The examined spoil heap has been constructed from waste ground material from two nearby surface lignite mines. In the first part of the paper, a brief literature review on the variability of in situ soil properties is provided, and the principles of major statistical parameters, often used in geotechnical literature, are briefly presented. In the second part of the paper, results of statistical analysis of a large database are presented. The database contains data from lab testing of 100 samples from 10 boreholes, each about 40 m deep, drilled in the spoil heap's body. Index properties, physical properties, and shear strength and compressibility parameters are statistically treated and relevant parameters (mean, median and characteristic values, as well as coefficients of variation, skewness, and linear correlation) are revealed. Results are critically discussed and compared with data previously published in the literature. A major conclusion drawn from this work is that the spoil heap's body is highly heterogeneous, and a significant outcome from the work is the quantification of this variability. It will be shown that the variability of spoil properties exceeds the usual variability from in situ ground material.

Keywords: soil mechanics, spoil heap, waste dump, surface lignite mine, statistics, uncertainty

1. Introduction

Sustainable management of wastes from the mining and extractive industry is a priority for modern societies around the world. In Greece, and particularly in the Region of Western Macedonia, hundreds of millions of cubic meters of waste ground material is being deposited annually due to intense surface lignite mining, forming the so-called spoil heaps (also known as waste dumps or waste embankments). These structures impose a major financial, social and environmental accountability on the lignite producers. This is so, because potential incidences of excessive movements of the heaps or, even worse, catastrophic slope instabilities may lead to disruption of lignite production and to environmental hazards and society's concerns. Such failures have actually taken place in the past in Greece (Steiakakis et al., 2009). So, in order to guarantee a secure and sustainable closure and reclamation process of the spoil heaps, their long-term stability is important. In order to ensure this, one needs to properly assess the physical and mechanical characteristics of spoil material and then make use of them within relevant analysis methods of slope stability, bearing capacity, and deformation assessment (limit equilibrium, finite elements, etc).

Generally speaking, soil is a complex natural material that has been created by a combination of several geological, environmental, and physical-chemical processes throughout geologic time (Phoon and Kulhawy, 1996). Consequently, soil properties on most sites vary in the vertical and horizontal plane. This is also obvious from in situ and laboratory test results, which often imply substantial variability in the properties of soils, not only among different sites, but even within homogeneous strata of the same site, as stated by Baecher and Christian (2003). From a design point of view, being aware of geotechnical property variability is of major importance. Based on the above, the scope of the present work deals is to compute the variability of geotechnical properties of a large spoil heap in northern Greece, and compare it with variability typically demonstrated by in situ ground material. The examined spoil heap has been constructed from waste ground material from two nearby surface lignite mines. In the first part of the paper, a brief literature review on the variability of in situ soil properties is provided, and the principles of major statistical parameters, often used in relevant geotechnical literature, are briefly presented. In the second part of the paper, results of statistical analysis of a large database are presented and critically discussed.

2. Variability of in situ soil properties

Several researchers in the past have published coefficients of variation (COVs) for a wide variety of soil properties, based on data from in situ and/or laboratory tests (see among many others, Lumb, 1974, Lee et al., 1983, Lacasse and Nadim, 1996, Phoon and Kulhawy, 1999, Baecher and Christian, 2003). Quite often, the range of the reported values for a certain property is very wide. As such, these can only be considered as suggestive of conditions for preliminary studies. A collection of previously published data has been compiled by the authors and is presented in Table 2. When a range is mentioned and a value exists in parentheses, this is a suggested standard value of COV. Physical and engineering properties are all provided in the same table and in alphabetical order. Based on the table, the following comments can be made:

Regardless of the type of soil (coarse- or fine-grained), unit weight and density seem to demonstrate significantly less variability than most other soil properties. To be more exact, reported COVs are typically less than 10%. This is rather reasonable for two reasons. First, unit weights of soils highly depend on the specific gravities of soil minerals, which typically vary within a very narrow range. Second, measuring unit weight is a reasonably precise procedure and the relevant measurement errors are usually small. As far as the moisture or water content is concerned, a wide range of COV values (from negligible up to almost 65%) have been reported for clays and silts. However, as stated by Baecher and Christian (2003), most sites demonstrate considerably smaller values than 65%. In addition, they state that, although everything depends on local site conditions, there is generally some evidence that sandy soils are characterized by smaller variability in water content compared to clays. In terms of Atterberg limits, liquid and plastic limits often have COVs of 30% or more. In addition, liquid limit and plasticity index are almost always strongly, positively correlated, while liquid limit and plastic limit are usually positively correlated, but not so strongly (Baecher and Christian, 2003).

In terms of permeability or hydraulic conductivity, it is well known from soil mechanics that it varies over many orders of magnitude: from values on the order of 10^{-12} cm/sec or even less (for clays) to nearly unity (for material such as gravels). Likewise, the COV of hydraulic conductivity can also be very large, i.e. on the order of 200 to 300% (or even higher). In terms of consolidation parameters, such as the coefficient of consolidation and the compression / recompression indices, COV values may reach up to 100 and 50%, respectively. Last but not least, as far as shear strength properties are concerned (which are of paramount importance in the stability analysis of soil slopes), a lot of statistics, both from in situ and laboratory test data, have been published in the literature. In the present work, only data obtained from lab experiments is presented. Generally, as shown in Table 2, variability significantly varies depending on the type of soil. For cohesionless soils, such as sands, reported COVs rarely exceed values of about 15%. This is not the case for cohesive soils (clays), on which COVs may exceed values on the order of 50%. In the absence of any lab or in situ tests, or in the case of limited data, Table 3 provides typical ranges and suggested COV values of fundamental soil parameters.

3. The Soulou spoil heap

The Soulou spoil heap is located between the cities of Ptolemais and Kozani, about 500 km north - northeast of Athens, and lies between two adjacent surface lignite mines owned by the Public Power Corporation (PPC): the Kardia mine and the South Field mine. The dimensions of the heap are about 5 km length, 150 m height, and several hundred meters width. Several discussions have taken place in the past about the long term management and valorization of the dump, after the disposal of spoil material ceases. In this context, about ten years ago, PPC conducted an extensive geotechnical investigation, in order to assess the major physical and engineering properties of the dump. Among others, the investigation consisted of ten sampling boreholes, each one about 40 m deep, which were drilled along the embankment axis at representative locations. The following lab tests were conducted on 100 samples taken from the boreholes:

Table 2. Reported values and/or ranges of COVs for different soil properties.

Property or test	Reported COV (%)	Source
Angle of friction (various soils)	9	Lumb (1966)
Angle of friction (sands)	5-15 (10)	Lee et al. (1983)
Angle of friction (sands)	2-5	Lacasse and Nadim (1996)
Angle of friction (sands)	5-15	Lumb (1974)
Angle of friction (clays)	12-56	Lee et al. (1983)
Angle of friction (clays)	40	Kotzias et al. (1993)
Angle of friction (alluvial soils)	16	Wolff (1996)
Angle of friction (tailings - copper)	8-12	Baecher et al. (1983)
Angle of friction (tailings - uranium)	17	Baecher et al. (1983)
Angle of friction (tailings - gypsum)	14	Baecher et al. (1983)
Cohesion (undrained, clays)	20-50 (30)	Lee et al. (1983), Lumb (1974)
Cohesion (undrained, sands)	25-30	Lee et al. (1983)
Compressibility	18-73 (30)	Lee et al. (1983)
Compressibility (all soils)	25-30	Lumb (1974)
Compression, recompression index (c_c, c_r)	25-50	Lumb (1974)
Consolidation coefficient	25-100 (50)	Lee et al. (1983)
Consolidation coefficient	25-50	Lumb (1974)
Consolidation coefficient (limited data)	10-17	Tanaka et al. (2001)
Density (apparent or true)	1-10 (3)	Lee et al. (1983)
Density (all soils)	5-10	Lumb (1974)
Density (clays, silts)	< 10	Baecher and Christian (2003)
Elastic modulus	2-42 (30)	Lee et al. (1983)
Liquid limit	2-48 (10)	Lee et al. (1983)
Liquid limit (clays)	3-20	Lacasse and Nadim (1996)
Liquid limit (clays, silts)	6-30	Baecher and Christian (2003)
Moisture content (clays)	6-63 (15)	Lee et al. (1983)
Moisture content (clays, silts)	8-30	Baecher and Christian (2003)
Permeability (all soils)	200-300 (300)	Lee et al. (1983), Lumb (1974)

Plastic limit	9-29	Lee et al. (1983)
Plastic limit (clays)	3-20	Lacasse and Nadim (1996)
Plastic limit (clays, silts)	6-30	Baecher and Christian (2003)
Plasticity index	7-79	Lee et al. (1983)
Relative density	10-40	Baecher and Christian (2003)
Specific gravity	see density	Lee et al. (1983)
Unconfined compressive strength	6-100 (40)	Baecher and Christian (2003)
Unit weight (submerged, all soils)	0-10	Lacasse and Nadim (1996)
Void ratio	13-42 (25)	Lee et al. (1983)
Void ratio (all soils)	15-30	Lumb (1974)
Void ratio, porosity (all soils)	7-30	Lacasse and Nadim (1996)

Table 3. Typical range and suggested COV values of major soil parameters (Schneider, 1997, Orr and Farrell, 2000).

Soil property	Range of typical COV (%) values	Suggested COV (%) value in the case of limited test results
Friction angle ϕ', tanϕ'	5-15	10
Cohesion (drained) c'	30-50	40
Cohesion (undrained shear strength) c_u	20-40	30
Coefficient of volume change m_v	20-70	40
Unit weight γ	1-10	0

index property tests (grain size with sieves, combined with liquid and plastic limit tests), physical properties (water content, moist unit weight, specific gravity), and engineering properties (unconfined compression test, consolidated - undrained triaxial compression tests with pore pressure measurements (CUPP), and 1D consolidation tests). In the context of the present work, part of the above data was treated statistically in order to assess geotechnical property variability of the spoil heap.

Figure 11 shows the resulted classification of spoil material over depth and along the longitudinal axis of the dump, according to the Unified Soil Classification System (USCS). It is obvious that the stratigraphy is quite fuzzy and no distinction of separate layers can be easily established. Nonetheless, it seems that silty material (MH, ML) is the most dominant. So, given its nearly chaotic structure, the heap is treated as a unified volume of ground mass.

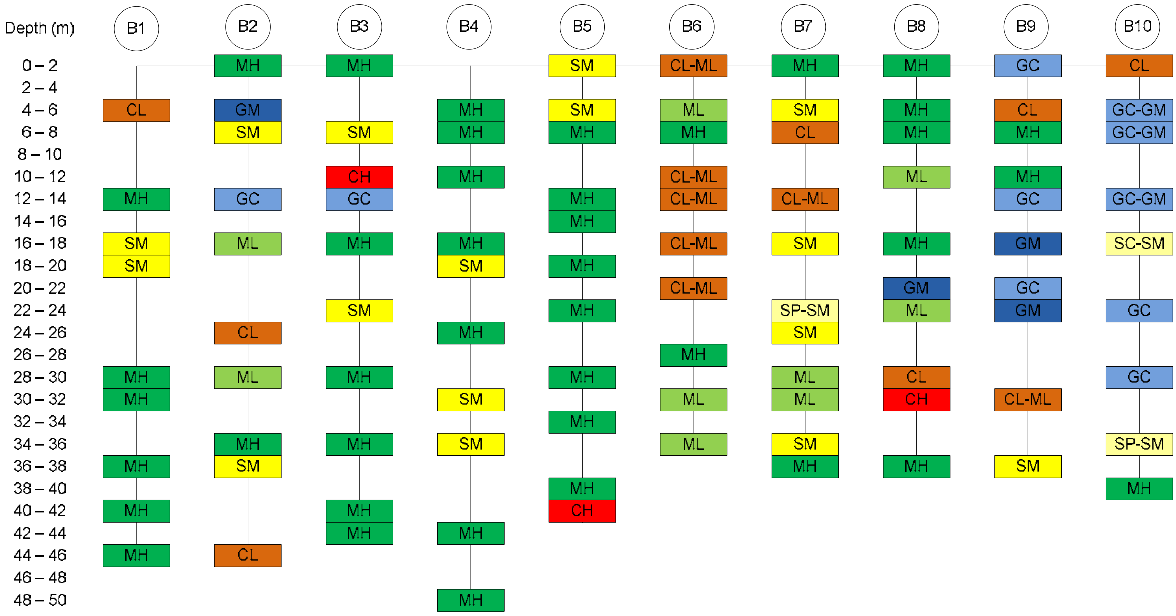

Figure 11. Classification of spoil material (according to USCS) along the longitudinal axis of the spoil heap.

4. Principles of major statistical parameters

The following statistical parameters have been used in the context of the present study:

Suppose there is a sample of observations x_1, x_2, ..., x_i, ..., x_n of some population X. The mean μ of the sample may be computed as following:

$$\mu = \frac{1}{n}\sum_{i=1}^{n} X_i \tag{1}$$

If the observations are ordered from smallest to largest: $x_{(1)} \leq x_{(2)} \leq \ldots \leq x_{(n)}$, the median $\tilde{\mu}$ of the sample is described as:

$$\tilde{\mu} = \begin{cases} x_{(n+1)/2} & \text{if n is odd} \\ 1/2\left(x_{n/2} + x_{(n+1)/2}\right) & \text{if n is even} \end{cases} \tag{2}$$

An interesting illustration of very different mean and median values will be shown in the following paragraphs based on actual cohesion data of the spoil heap.

The *standard deviation* σ, whose dimensions are the same as those of the observations, is computed as following:

$$\sigma = \sqrt{\frac{\sum_{i=1}^{n}(X_i - \mu)^2}{n-1}} = \sqrt{\frac{\sum_{i=1}^{n}\left({X_i}^2 - n\mu^2\right)}{n-1}} \tag{3}$$

The *coefficient of variation COV*, often designated as a percentage, is defined as:

$$COV = \frac{\sigma}{\mu} \tag{4}$$

In geotechnical engineering, as a rule of thumb, coefficients of variation below 10% are considered to be low, between 15 and 30% moderate, and greater than 30%, high (Harr, 1987).

In recent design frameworks (e.g. Eurocode 7 in Europe or LRFD in the USA), the previously defined mean value is not directly used for analysis and design purposes. For example, in the EC7 framework, it is the so-called *characteristic value* X_k (and the finally resulting *design value* X_d) of a soil property that shall be used for design purposes. The characteristic value may be considered as the best possible estimate of the classical mean value of the selected layer. Following comparative calculations, Schneider (1997) demonstrated that a decent approximation of X_k is achieved if the characteristic value is taken equal to one half a standard deviation below the mean:

$$X_k = \mu - 0.5\sigma \tag{5}$$

The above equation has gained wide acceptance within the geotechnical community (Orr and Farrell, 2000).

The coefficient of skewness β_1 is a dimensionless measure of the degree of skewness or assymetry of a probability distribution around its mean. If $\beta_1 > 0$ (positively skewed or skewed right), the distribution's long tail is on the mean's right side (i.e. the density function or frequency curve is extended towards larger numbers). On the other hand, if $\beta_1 < 0$ (negatively skewed or skewed left), the distribution's long tail is on the mean's left side. Finally, if $\beta_1 = 0$, the distribution is symmetrical. The coefficient of skewness is computed using the following expression:

$$\beta_1 = \frac{n}{(n-1)(n-2)} \sum_{i=1}^{n} \left(\frac{X_i - \mu}{\sigma} \right)^3 \tag{6}$$

For further discussion on the use of β_1 with respect to applications on geotechnical engineering, interested readers are addressed to relevant literature (Rethati, 1988).

The dependency between two variables is assessed through the linear correlation coefficient (ρ). For any pair of X-Y variables, ρ is given by:

$$\rho_{XY} = \frac{Cov(X,Y)}{\sigma_X \sigma_Y} \tag{7}$$

In the above equation, *Cov* is the variables' covariance (which is different than the coefficient of variation *COV*) and σ_X, σ_Y are the variables' standard deviations. For the linear correlation coefficient holds true that $-1 \leq \rho \leq 1$.

5. Results

Table 4 provides statistical parameters of index properties of the Soulou spoil heap. As shown in the Table, per average, fine grained material (silts and clays) dominate (54.7%) within the spoil heap body. For illustrative purposes, a grain size distribution curve from one sample is shown on Figure 12. In terms of Atterberg limits, mean values of liquid limit and plastic limit were found equal to 50 and 35, respectively. The corresponding COVs were found equal to 26% and 34%, i.e. within the range reported in the literature (Table 2). Table 4 also provides physical parameters, such as moist and dry unit weight, specific gravity and moisture (water) content. The void ratio is also provided in the Table. The mean values of the moist and dry unit weight are 16.8 and 11.8 kN/m^3, respectively, while characteristic values (according to equation 5) are as expected slightly decreased (15.9 and 11.0 kN/m^3, respectively). On the other hand, scattering of unit weights is larger than usually reported in the literature. More specifically, while typically COV values range from 0 to 10% (Table 2), computed COVs in the present study were 14% and 25% for moist and dry unit weight, respectively. Larger than usual COV values were also found for water (moisture) content (46%), while rather normal scattering was computed for specific gravity (6%) and void ratio (33%).

Table 4. Index properties and physical properties for the Soulou spoil heap.

Parameter	Grain size (%)			Atterberg Limits (%)			γ (kN/m^3)	γ_d (kN/m^3)	G_s (-)	w_c (%)	e_0 (-)
	Gravels	Sands	Fines	LL	PL	PI					
n	100	100	100	83	83	83	97	97	47	100	44

μ	12.1	32.8	54.7	50	35	15	17.1	12.6	2.54	40	1.21
$\tilde{\mu}$	-	-	-	-	-	-	16.8	11.8	2.56	-	-
X_k	-	-	-	-	-	-	15.9	11.0	-	-	-
σ	15.0	13.2	18.0	13	12	6	2.4	3.2	0.16	18	0.40
COV (%)	124	40	33	26	34	42	14%	25%	6%	46%	33%
min	0	6	9	22	16	3	12.5	7.3	2.20	7	0.65
max	60	91	94	84	62	35	22.3	20.3	2.80	82	2.50
range	60	85	85	62	46	32	9.7	12.9	0.60	75	1.85
β_1	1.5	1.1	-0.4	-0.3	0.2	0.7	0.1	0.4	-0.5	0.2	0.8

LL: liquid limit, PL: plastic limit, PI: plasticity index, γ: moist unit weight, γ_d: dry unit weight, G_s: specific gravity, w_c: water content, e_o: initial void ratio.

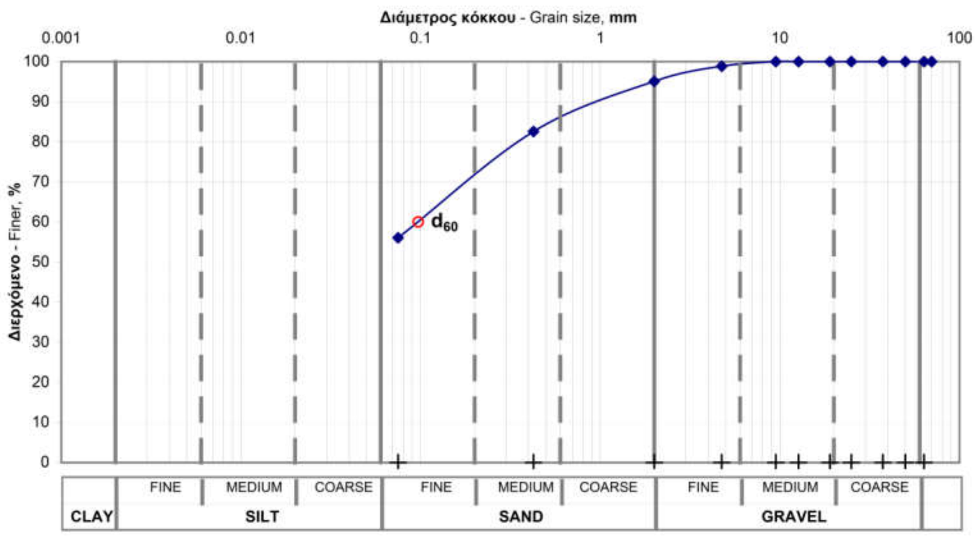

Figure 12. Indicative grain size distribution curve on a spoil heap sample.

In order to evaluate the engineering response of the spoil heap, 27 consolidated undrained with pore pressure measurement (CU-PP) triaxial compression tests were performed. Table 5 provides statistical results with respect to these tests in terms of effective friction angle *φ'* - effective cohesion *c*. As far as the friction angle is concerned, mean and standard deviation values were computed equal to 25.9° and 7.2°, leading to a characteristic value equal to slightly larger than 22°. The COV of the friction angle was computed equal to 28%. As shown in Table 2, this value is quite high when compared to coarse grained soils, but relatively reasonable (and towards the upper limits) when compared to fine grained soils.

Table 5. Shear strength and compressibility parameters for Soulou spoil heap.

Parameter	φ' (°)	c' (kPa)	c'_{mod} (kPa)	C_c (-)	C_r (-)
n	27	27	23	44	44
μ	25.9	14.2	6.7	0.216	0.037

$\tilde{\mu}$	26.9	6.6	3.9	0.194	0.037
X_k	22.3	4.1	2.4	-	-
σ	7.2	20.3	8.4	0.086	0.014
COV	28%	143%	127%	40%	39%
min	8.2	0	0	0.064	0.013
max	39.2	72.5	29.3	0.398	0.090
range	31.0	72.5	29.3	0.334	0.077
β_1	-0.5	1.7	1.3	0.5	1.1

φ': effective friction angle, c': effective cohesion, c'_{mod}: effective cohesion excluding the four values larger than 50kPa, c_c: compression index, c_r: recompression index.

On the other hand, when it comes to the results with respect to cohesion, one of the first things that is noticed is the extremely large COV (143%) and the big difference between the mean (14.2 kPa) and the median (6.6 kPa) value. These results are due to the fact that nearly half of the measurements of cohesion (11 out of 27) were found equal to or almost equal to 0. So, as discussed earlier, this is a typical case on which mean and median values are considerably different. Figure 13 illustrates the variation of cohesion values with sample depth for the 27 laboratory tests. From a design point of view, the characteristic value drops to 4.1 kPa, which shows that the relationship suggested by Schneider (1997) captures the effect of the significantly large standard deviation. It should be noted that if one ignores from the statistical analysis the four "extreme" values of c' (50.8, 53, 54, and 72.5 kPa), then the mean value decreases by more than 50% (it becomes equal to 6.7 kPa), while the characteristic value also decreases (it becomes equal to 2.4 kPa). This is shown in column c'_{mod} of Table 5.

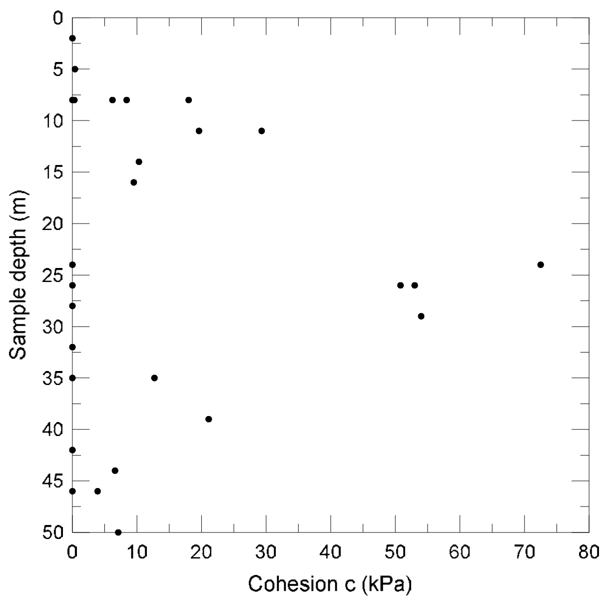

Figure 13. Variation of cohesion with depth.

Table 5 also shows statistical parameters for the compression and re-compression indices based on 44 1-D consolidation tests. As far as the compression index c_c is concerned, mean and median values were found equal to 0.216 and 0.194, respectively. According to Holtz et al. (2010), values around 0.2 correspond to the lower limits of compression indices for normally consolidated medium sensitive clays (with a typical range between 0.2 and 0.5). The mean and the median recompression index c_r were both found equal to 0.037, i.e. about 20% of the value of c_c which is quite reasonable. As far as scattering is concerned, COVs for both indices were about 40%. This is well aligned with values between 20 and 50% reported by Baecher and Christian (2003). The dependency between c_c and c_r was investigated by means of the coefficient of linear correlation, and it was found positive and equal to 0.50. In this context, Figure 14 illustrates the variation and dependency between the two indices. Given that the compression index is often related via empirical correlations to parameters such as the liquid limit, the water content and the void ratio, the dependency between c_c and LL, w, and e_o was also investigated by means of coefficients of linear correlation and it was found equal to 0.36, 0.43, and 0.50, respectively.

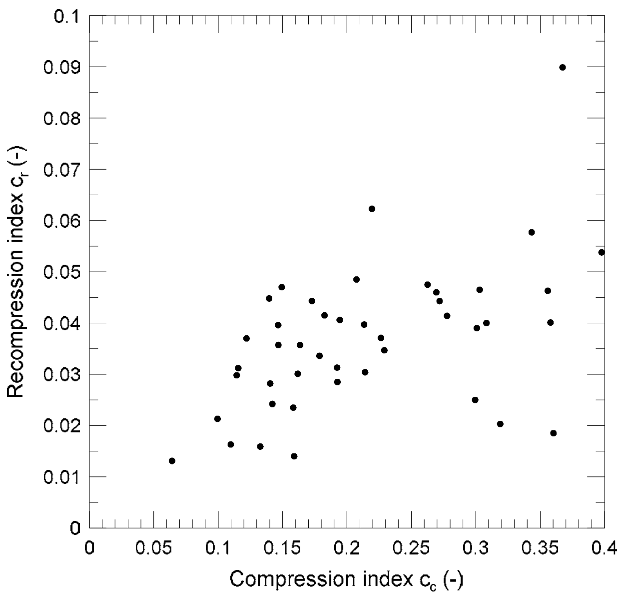

Figure 14. Dependency between c_c and c_r.

6. Conclusions

A database with results from extensive lab testing on samples from a lignite spoil heap was compiled and evaluated in the context of the present study. Index properties, physical properties, and shear strength and compressibility parameters were statistically treated and relevant parameters (mean, median and characteristic values, as well as coefficients of variation, of skewness, and of linear correlation) were revealed. Results were critically discussed and compared with data from in-situ soils previously published in the literature. A major conclusion drawn from this work is that the spoil heap's body is highly heterogeneous, and a significant outcome from the work is the quantification of this variability. Based on the results, it seems that the variability of spoil properties exceeds the usual variability from in situ ground material. This is anticipated to be due to man-made reasons related to the construction of the dump. This is so, because in addition to the natural processes, more factors affect the actual conditions of formation (and thus, the stress state) of the heaps. Such factors are the spoils' transportation method (e.g. conveyor belts or haul trucks), the dumping method (whether a top-down or a bottom-up directed method), and of course the origin of the spoil material (if it comes from one or more different mines with same or different geology).

7. Acknowledgements

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THE IMPACT OF CLIMATE CHANGE ON PUBLIC HEALTH IN THE MEDITERRANEAN BASIN

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Abstract

There is strong evidence that indicates that human activities affect the climate of the planet. Climate change is an important and emerging threat to public health and is one of the greatest environmental, social and economic threats. According to the World Health Organization, health risks related to climate change may be significant and different depending on the geographical area and are often irreversible. Risk factors related to climate change and diseases are among the major contributors to the global health burden, including malnutrition, diarrhea and malaria. Such situations as well as other health impacts will be increasingly affected as climate change accelerates due to their negative effects on food production, water supplies and human resistance to hosts and pathogenic microorganisms.

The aim of this work is to critically study and present the impacts of climate change on public health, the vulnerability of populations to climate change and the presentation of trends and policies developed to mitigate these impacts in the Mediterranean basin indirectly through dealing with natural disasters or directly.

Keywords: climate change, Mediterranean basin, vector born diseases, water born diseases, heat waves.

1. Introduction

As the world warms up, evaporation rates increase and hot air retains more water vapor. Eventually when these masses of air encounter or collide with mountain ranges, huge volumes of rain or snow are released. This goes in line with the predictions of climate scientists, which were first expressed in the 1990s. Meanwhile, governments are still referring to these events that occur globally simply as tragic "natural disasters". It seems that we are slow to take our lesson. There is not only the risk of increased air pollution and ozone pollution, greater pollen spread and hence the more frequent occurrence of allergies and respiratory diseases, but also the increase in deaths due to heatwaves, floods, droughts, fires, decreased availability and cleanliness of drinking water, reduced food safety and a reduction in the provision of health services, while high temperatures will change the distribution and increase the overall burden of certain diseases from hosts, food and water.

2. Climate change poses a risk to health determinants

Climate change will inevitably affect the basic prerequisites for maintaining a basic level of health: clean air and water, adequate food and a suitable accommodation. Each year, about 800,000 people die of air pollution related causes, 1.8 million people die of diarrhea, usually caused by lack of access to clean water and cleanliness, and due to inadequate hygiene conditions, another 3.5 million from malnutrition and about 60,000 die from natural disasters. A warmer and more volatile climate can lead to higher levels of some air pollutants, increase the transmission of diseases through contaminated water and contaminated food, endanger agricultural production in some of the most underdeveloped countries, and finally increase their risks due to extreme weather events.

Climate change therefore creates new challenges for controlling infectious diseases. Many of the deadly infectious agents are particularly sensitive to climatic conditions, such as temperature and rain. Thus illnesses such as cholera and other diarrheal diseases, malaria, dengue fever and diseases transmitted by host-carriers are directly related to climate change. In short, climate change threatens to slow down, halt or reverse the progress made by the international medical community in the field of public health and tackling many of these diseases.mIn the longer term, however, the most important health impact may not come from a sudden emergency, such as a natural disaster or an epidemic, but a gradually created pressure on the natural, economic and social systems that support public health, and which are already in place under pressure in most of the underdeveloped world. This escalating pressure includes the reduction and seasonal change in the availability of drinking water, local decline in food production and rising water levels. Each of these changes may potentially lead to population displacement and increased risk of civil warfare (WHO, 2008).

3. Climate change in the Mediterranean region

The vast majority of scientific data shows that today we live in a remarkable, unusual and high-risk moment in the history of humanity: climate change and other global and regional environmental changes that are caused by human being, pose serious threats to the life on Earth in general and in the Mediterranean region specificly (Rockstrom J, et al., 2009). The emergence of large-scale environmental changes over the last few decades, will raise everyone's concerns and lead to a serious re-examination of the way we live, the tremendous pressures we place on the natural environment (McMichael AJ., 2001) Without a substantial transition, environmental and social conditions that support human well-being, health and the survival of future generations can not be attained globally and in a fair way. By contrast, a world 100-200 years later, which could be up to 4-6 ° C warmer would be a world of non-habitable areas, with a wide lack of food and water, affected by frequent weather disasters.

Climate change will have a global impact on health, but here we are focusing on the Mediterranean region. Climate change has direct and indirect effects on human health and both are important in this area. Direct results include higher temperatures, increased ultraviolet radiation and local storms and floods. There are indications that extreme temperatures are clearly associated with increased human mortality and morbidity, and recent findings indicate that heavy rainfall can accelerate the development of diseases related to the water and the disease vectors. Indirect health impacts are related to the degradation of air, soil and water quality in the Mediterranean region.

For example, the increased exposure to allergens, air pollution and infectious diseases associated with climate change will significantly contribute to the higher incidence of respiratory diseases (Flahault et al., 2015). The duration and impact of heat waves are expected to increase with climate change and the mortality rates associated with overheating are expected also to increase significantly during the 21st century (Casimiro et al., 2006). It is expected that these adverse effects will primarily affect vulnerable people, especially the elderly, who are more likely to suffer from chronic dieseases (Oudin Åström et al., 2015). Another possible consequence is the increase in exposure to ultraviolet radiation with its known consequences for skin cancers.

Changes in precipitation patterns are also expected with increased flood and drought risks, although they may differ from one region/country to another (Messeri et al., 2015). In addition to their direct health effects, mainly through mosquitoes that can transmit tropical infections, these changes are likely to affect agriculture and food supply. There is reason to worry that it may eventually lead to a change in the Mediterranean diet, the value of which is universally recognized.

4. Possible impacts of climate change on health.

Climate change increases health risk in many regions of the world and can affect it directly and indirectly. Direct effects include often extreme weather phenomena such as heatwaves, which mainly affect the elderly and sick people. Floods and storms can injure or kill many people. But even more important are the indirect impacts caused by the reduction of water availability and changes in food production. Particularly serious is the further spread of sensitive to temperature changes parasites, microorganisms and infectious diseases transmitted by insects - such as malaria, dengue and schistosomiasis (McMichael et al, 1996). Such indirect effects mainly concern the majority of poor people in developing countries. A detailed reference will be made to these impacts of climate change on health.

4.1 Infectious diseases

As far as communicable diseases are concerned, it has to be noted that to date the area around the Mediterranean basin has received little attention and that the available data and results on the impact of climate change on infectious diseases are few and inconsistent with each other (Navarra and Tubiana 2013). The effects of climate change on the spread and intensity of infectious diseases have been studied only in countries along the northwest and west coasts of Mediterranean region, while the eastern and southern regions lack the appropriate data. These regions have already faced many humanitarian crises, from conflicts to natural hazards and recent political changes, and climate change is likely to exacerbate health impacts.

The Mediterranean region is known to be vulnerable to climate change and the significant increase in average temperature has been recorded over the last decades. Extreme weather conditions have become more frequent by increasing the frequency and severity of heavy storms or the heatwaves in the western and southern ridges along with the reduction in rainfall. The projected reduction in rainfall in North Africa is also a major health problem as 22% of the world's population experiencing water scarcity is concentrated in the Mediterranean (Giorgi and Lionello, 2008). As a result of these continuous changes, infectious diseases, which are transmitted directly or via some vectors or hosts, or both, are expected to be affected. For some infections such as Chikungunya and West Nile, climate change is still seen as the main driver of the increased local transmission risk in the area, while for others, such as many water and food-related diseases, the risk of spreading to the immediate future is real.

4.1.1 Direct impacts of climate change on the transmission of viral diseases to humans

Higher temperatures on the Earth's surface will cause an increase in global average rainfall, although in some latitude regions it will become more dry. Rainfall may favor the transmission of vector-borne pathogens, the creation of reservoirs on the ground and other breeding sites for insects. In addition, drought may cause stagnant running water, can also urge people to store water in tanks, and cans, which also serve as mosquito breeding areas (McMichael AJ, et al, 2006)

One could assume that the mass clearance of forests exposed to warming could allow contacts between unimmunized humans with dangerous viral infective cycles and their respective reservoirs in the forests (Weiss RA and McMichael AJ, 2004). Thus, the spread of "exotic" viruses could be observed in Europe. One can think emerging arboviruses (viruses related arthropods) as the virus dengue, virus Chikungunya, virus, West Nile virus, encephalitis Tick-Borne, virus Rift Valley Fever virus, Japanese encephalitis, the Crimean Congo haemorrhagic fever and forest viruses could threaten people such as yellow fever virus (Geisbert TW and Jahrling PB., 2004).

4.1.2 Indirect effects of climate change on the spread of viruses

A significant impact could be identified in the climatic conditions that disrupt the organization of the social and economic characteristics of the populations. Thus, population displacement and overcrowding could facilitate people-to-people contacts, between humans and animals, as well as between humans and polluted waters, by favoring infections related to intestinal or respiratory viruses (Choi K. et al. 2006). These pathogens, under these ideal conditions of dispersal, could cause such large epidemics possibly worldwide for diseases such as influenza.

4.1.3 Diseases transmitted through water

Cholera is an infectious disease that is transmitted by bacteria that are mainly found in stagnant water and estuaries, as well as water and fountains, responsible for 3 to 5 million cases and more than 100 000 deaths per year. It occurs mainly in countries where clean water supply and adequate hygiene is not guaranteed. Especially in slums and refugee camps, but also in areas facing crises are considered as zones of infection (Prüss-Üstün A et al. 2004).

Increased risks from climate change are caused by the fact that due to the increase in temperature, water is used extensively, while the fields are irrigated technically, resulting in addition to natural waters to create additional hotplates for bacteria, which at increased temperature proliferate rapidly (WHO 2006). Since the disease is mostly associated with cyanobacteria (blue-green algae) and their growth is accelerated by higher temperatures and increased rainfall, there is a clear link between climate change and the spread of cholera. Similar conditions exist for the spread of schistosomiasis, a parasitic disease caused by worms transmitted to humans through snail found in waters and in addition to have a impact to the most of human organs, it is also responsible for under-development of children (WHO 2006). In Africa, this disease occurs almost everywhere. The reason for this is because of climate change the placement of artificial water storage and irrigation and the shortening of the reproduction time of the parasite over 15 ° C, while his life is prolonged. In addition, the disease is diffused by refugees, but also from tourists (WHO 2006). A prevention can only be achieved here through increased hygiene measures, water filtration and improved health education.

TABLE 1: Climate-sensitive infectious diseases in the Mediterranean region and the potential risk of spreading. An asterisk means that since the information was published, cases have been detected in the area. These studies were conducted on a global scale. Modified by Rodriguez-Arias et al (2008).

Infectious disease	Already present in the Mediterranean	Number of papers published (2007-2010)	Evidence for an effect of climate variability and change
Food- and water-borne			
Amoebiasis	Yes	4	No
Campylobacter enteritis	Yes	12	No
Cholera	No (potential risk)	9	Yes (SouthAsia,north-west SouthAmerica,WestAfrica)
Cryptosporidiosis	Yes	22	No
Diphyllobothriasis	Yes	2	No
Escherichia coli infection	Yes	10	No
No Food-borne Vibrio enteritis	Yes*	25	Yes (North Sea,Baltic, Atlantic Ocean, Mediterranean Sea)
Giardiasis	Yes	17	No
Legionella infection	Yes	17	No
Leptospirosis	Yes	21	No
Rotavirus enteritis	Yes	7	No
Salmonella infection	Yes	24	No
Schistosomiasis	Yes	3	No
Shigellosis	Yes	6	No
Strongyloidiasis Yes 1 No	Yes	1	No
Typhoid and paratyphoid fevers	Yes	7	No

Air/human to human transmission			
Meningococcal infection	**Yes**	**24**	**Yes (WestAfrica)**
Vector-borne			
Typhus fever	**Yes**	**12**	**No**
Chikungunya virus disease	**Yes**	**25**	**No**
Dengue and dengue hemorrhagic fever	**Yes*Some doubts**	**14**	**Yes (South-EastAsia, northern SouthAmerica)**
Malaria	**Yes**	**13**	**Yes (South-EastAsia,East Africa,northern South America)**
RiftValley fever	**Yes**	**6**	**Yes (SouthAfrica)**
West Nile virus infection	**Yes**	**40**	**No (controversies)**
Plague	**Yes***	**4**	**Yes (CentralAsia)**
Leishmaniasis	**Yes**	**31**	**Yes (Southern Europe, SouthAmerica)**
Sandfly virus fever	**Yes**	**15**	**No**
Crimean-Congo hemorrhagic fever	**Yes**	**24**	**No**
Lyme disease	**Yes**	**34**	**Yes (Northern Europe)**
Spotted fever	**Yes**	**21**	**No**
Tick-borne relapsing fever	**Yes**	**2**	**No**
Tick-borne viral encephalitis	**Yes**	**13**	**No**
Filariasis Yes	**Yes**	**4**	**No**
Tularemia	**Yes**	**4**	**No**

4. 2 The impact of climate change on non-communicable diseases in the Mediterranean region

4. 2.1 Extreme weather conditions and related events have a direct impact on health in the Mediterranean region

The frequency of extreme natural hazards and weather phenomena, including heat and cold waves, floods, storms and droughts, has increased in recent decades in Europe, particularly in the Mediterranean region, due to climate change. Among these, the main factors of climate change that directly affect non-communicable diseases (NCD) are extreme temperature events, barometric pressure, floods and storms (see Table 2). Since the 1960s, the Mediterranean region has been warmed up with a significant increase in the frequency, intensity and duration of heat waves (Kuglitsch et al., 2010) and related health effects.

Table 2: Direct and indirect impacts of climate change on non-communicable diseases (NCDs).

Impacts of climate change		Additional factors contributing the indirect impacts	NCDs	Direction of risk
DIRECT:	*INDIRECT;*			
HEAT WAVES			CDV and respiratory morbidity and mortality	Increase
COLD WAVES			Cardiopulmonary morbidity and mortality	Increase
Low atmospheric pressure during storms			ISP	Increase
Extreme weather phenomena (floods, storms, etc.)			Injury, Decreased mental health, Downfall	Increase
Thunderstorms		Polarization of pollen	Asthma	Increase
Drought			Malnutrition, Reduced mental health	Increase
Parasites		Increase in pesticide use	Asthma, Parkinson's disease, cancers	Increase
Aflatoxin (fungal metabolite)		Contamination of cereals	Hepatocellular carcinoma	Increase
Increased temperature, no air conditions	Higher ozone at ground level	Urbanization	Increased respiratory tract irritation, CDV and chronic pulmonary disease and pulmonary disease mortality	Increase
Fire, drought	Higher level of specific matter	Urbanization	COPD exacerbations, Mental illness	Increase
Altered stratospheric ozone recovery track with changes in precipitation and coverage of clouds	Modified ultraviolet radiation (UVR)		Skin cancer Autoimmune diseases (multiple sclerosis)	Increase Decrease

Global warming	Higher pollen allergenicity measurements	Larger pollen season, modified pollen distribution	Allergic rhinitis (allergic rhinitis) and asthma	Increase
Floods	More mold		Allergic rhinitis, sinusitis and asthma, hypersensitivity pneumonitis, mycotoxin toxicity	
*: in temperate zones, including the Mediterranean ISP zones: Spontaneous pneumothorax idiopathic				

4. 3 Air pollution (asthma and COPD)

Increasing atmospheric temperature and associated meteorological effects can aggravate soil-level pollution, mainly ozone (Kinney PL.:2009), leading to decreased pulmonary function, increased use of healthcare and premature death. People with COPD, CVD, diabetes and chronic exposure to ozone are at particular risk (Isaksen et al., 2009). The higher burden of these conditions is disproportionately distributed among low-income people, who often reside in more polluted areas (Isaksen et al., 2009). Climate change can also lead to higher atmospheric concentrations of fine particles (PM2.5) (Zanobetti and Schwartz, 2011). Predicted warming threatens our ability to meet air quality standards for health in the future.

4.3.1 Forest fires (All Respiratory Diseases & CVD (Cardio Respiratory)

Forest fires cause episodes of severe air pollution. Higher temperatures and increased droughts contribute to a higher risk of forest fires (Dennekamp and Abramson, 2011). This increase in fire risk is due to the higher temperatures in spring and summer (Westerling and Bryant, 2008). Higher temperatures will also put forests at risk for new and more widespread threats that further increase the risk of fire (Elliott and Henderson, 2013).

Forest smoke is a complex mixture of particles and gases known to have acute and chronic health effects (Henderson et al, 2011). Most of the epidemiological research focuses on increased PM2.5 during smoke episodes associated with acute respiratory effects (Henderson and Johnston, 2012), including symptoms of pain, irritation, cough, and phlegm (Kolbe and Naeher et al, 2007), visits to intensive care units (Pope et al., 2002), hospital admissions and increased mortality. Further evidence suggests that babies in the uterus during smoke events are at a higher risk for low birth weight (Sahani et al, 2014) and with adverse health effects throughout their lifetime. There have been no studies investigating the long-term effects of fires and exposure to smoke in children and adults. However, it is well known from the literature on air pollution in cities that the increase in the annual average of PM2.5 concentrations is

associated with increased rates of chronic respiratory diseases and CVD's of the population (Wotton et al, 2010).

Since transport emissions and industrial sources are subject to more effective control, fire smoke is expected to play an increasingly important role in lifelong exposure to PM2,5 and hence in the development of chronic diseases (Yue et al, 2013).

4.3.2 Changes in pollen release (asthma and allergic rhinitis)

The production and distribution of plant pollen allergen is affected by climate change, with multiple increases in trees, grass and weeds occurring as a result of higher carbon dioxide concentrations (Ziska and Beggs, 2012) and prolonged growing seasons. Increases in pollen concentrations in the environment are associated with higher rates of allergic sensitization, increased use of health care and large increases in sales of allergic medication (D'Amato, 2011). Drought conditions are also set to increase, and can aggravate these effects, as more pollen, dust and particles are transported in the air under dry conditions.

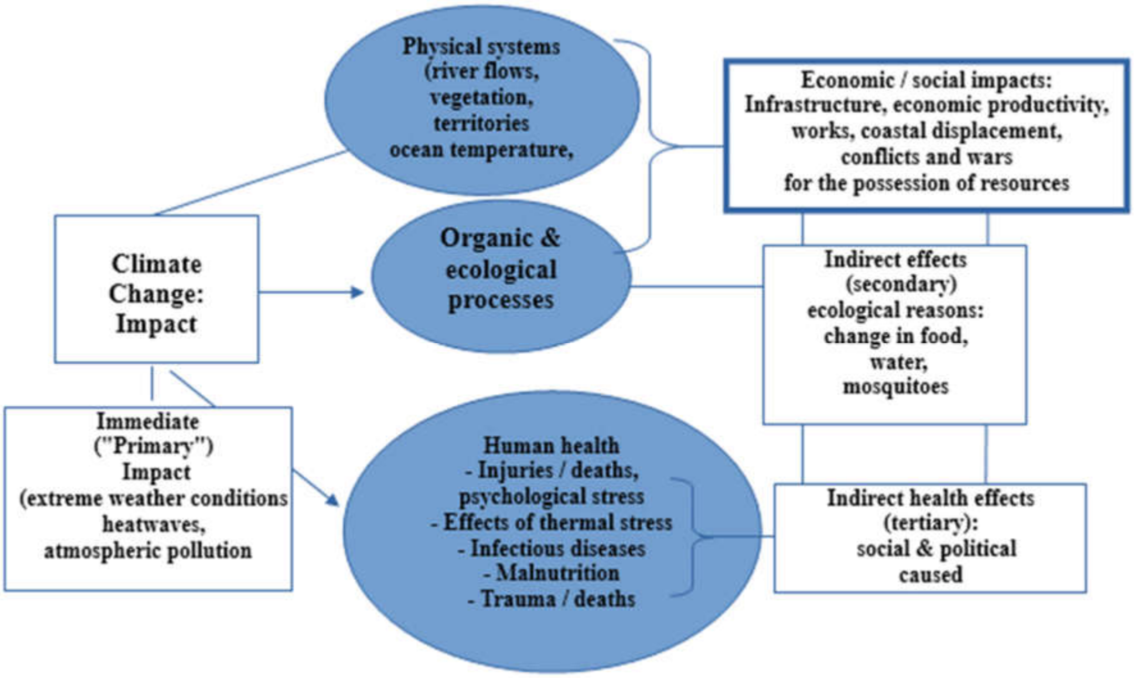
4.4 Exposure to mold

Mold levels can increase with climate change due to increased moisture in building materials and indoor humidity, elevated temperatures and high carbon dioxide concentrations that encourage growth (Wolf et al, 2010). In immunosuppressed individuals, respiratory disease associated with mold exposure is due to elements of fungi that may be allergenic or respiratory irritants, leading to exacerbations of allergic rhinitis and asthma (The National Academy Press, 2004). In immunocompromised individuals or those with concomitant lung disease, fungal infections such as aspirgillosis may occur (Kosmidis and Denning, 2014).

4.5 Mental health

Mental health disorders such as post-traumatic stress disorder (PTSD) can significantly affect the well-being of the population following natural disasters and / or climate change shifts, depending on the impact, the intensity of the experience, personal and community disruption, and long-term exposure to the visual signs of the disaster (Galea et al, 2005). The symptoms of PTSD were found in 75% of refugee children and adolescents (McCloskey and Southwick, 1996).

CLIMATE CHANGE: THE EFFECTS OF HEALTH EFFECTS



5. What should be done

Climate change strategies are usually backed up by two broad approaches: mitigation, including efforts to mitigate climate change itself, while adaptation includes actions to manage the impacts of climate change, which are inevitable despite the mitigation efforts. This framework is closely aligned with the framework for the protection and preparedness of public health. Like adaptation, readiness recognizes that while it is not possible to predict all the negative consequences, they can still be reduced and predicted. For climate change, mitigation and adaptation are broadly accepted as actions for public health. However, public health can also play an important role in formulating public health impacts as a result of climate change mitigation options, both by emphasizing the parallel health benefits of certain options and by identifying possible negative consequences of other possible mitigation strategies (Frumkin 2008).

The widespread, widespread, long-term and unfair distribution of health risks makes climate change a truly global challenge requiring unprecedented cooperation. An effective response will require action from across the spectrum of society: from the people themselves, from the medical field and from social and political partners. A fair and effective response will require a sharing of responsibilities between the population that makes the greatest contribution to climate change and those most vulnerable to its impact in order to safeguard and enhance global security in the area of public health.

5.1 Strengthening public health systems

Strengthening public health systems is already necessary, just climate change makes this need more urgent. In particular, the following should be done:

- Strengthening partnerships between emergency management bodies, NGOs, the private sector and national health systems to address health risks from any emergencies in a community.
- Strengthening the capacity of health systems to manage climate change related risks, including health risk assessments, enhancing preparedness for early warning and addressing emergencies and recovery from extreme weather events
- Protect Critical Medical Infrastructures from Extreme Weather Conditions and ensure the functioning of the central public health services during emergencies, in other words "climate proofing".
- Gathering evidence of impacts and monitoring changes in vulnerability and risk trends over time.
- Enhancing the monitoring and control of infectious diseases
- Effective monitoring and control are the more important under conditions of rapid environmental change and mobility of humans, insect-carriers and infections.
- Rapid and accurate notification of diseases at local, national and international levels, in compliance with international health regulations, is the essential basis for disease control planning.
- Approaches such as integrated host management that make best use of proven interventions such as mosquito nets, insecticide spraying, and environmental management to control malaria, dengue and other host-tropical diseases, protect against climate risks (IASC 2009)
- Improving access to primary care services ensures faster patient care, reducing pain and reducing the risk of spreading the disease. (WHO 2008).
- Enhancing public health emergency response capacity saves lives and protects communities.
- Strengthening health surveillance and control of communicable diseases can protect health at local and global level.
- Improving environmental and social determinants of health is critical to protecting people from climate change.
- Addressing the dangers of climate change requires a fairer access to public health services.
- Develop forecasts for extreme weather events and early warning systems tailored to public health.
- Implement local public health interventions to create community adaptability
- Strategies need to be flexible enough to take into account the different composition of modern societies and to include migrants and individuals from different national and cultural groups and different attitudes in the health sector.

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ARTIFICIAL INTELLIGENCE IN CIVIL PROTECTION: USAGE & ETHICAL ISSUES

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Abstract

Technology evolution is affecting every aspect of the contemporary life. Network expansion on the one hand, and tremendous processing speed on the other, boost Artificial Intelligence's (AI) development. Rendering easier, faster and in many cases full-automated routine procedures, AI usage give plenty of advantages to every human activity. While AI already has a profound impact on society and economy, Civil Protection and disaster prevention and management are also affected. Early Warning Systems (EWS) based on neural networks, Decision Making/Support System (DSS) and Smart Cities are already parts of the contemporary Civil Protection Mechanisms.

However, there are serious ethical considerations to any technology affecting society so profoundly. Is AI reliable enough to be used –in some cases exclusively- in decision making and rescue?

This work summarizes the ethical questions in AI in general and focuses on the possible vulnerabilities, non-reliability and disadvantages of the uncontrolled usage of AI tools on Civil Protection, undertaking indicative case studies. Cybersecurity vulnerabilities, privacy issues, input bias, possible inequality in criteria and usage, hidden algorithms and liability issues are the most highlighted topics. Based on these topics, researchers, legislators and society face the challenge to conclude to an Ethical Code in order to achieve success and fairness on AI usage over the coming years.

Keywords: Artificial Intelligence, Civil Protection, Ethics

1. Introduction

Human brain emulation has been a technological vision for centuries. The ancient Greek philosophy, particularly by Aristotle, has set "logic" as a basis for modern western science (Logic, Wikipedia 2018). In the middle of the 19th century George Bool reflecting the primitive way of human thought, investigated the laws of thought using mathematics by using the truth values true and false, usually denoted 1 and 0 respectively. Boolean algebra has been fundamental in the development of digital electronics (Boolean algebra, Wikipedia 2018). The rapid evolution of digital technology along with the network usage expansion led to conditions matured for the AI development (World Economic Forum/Accenture, 2018).

AI is the science of training systems to emulate human ways through learning and automation, based on the automatic calculation of data combined in functions with parameters and weight factors, simulating the way the human mind weights the parameters and factors in order to make a forecast or a decision. Most modern artificially intelligent systems are based on a derivative of digital machine learning. Machine learning is about training an artificial neural network with already labeled data, so that it comes to understand general concepts out of special cases. By feeding thousands upon thousands of prepared data to the network, the system gradually fine tunes the weight of the individual neurons in a specific layer (Delsh Kevin, 2018). The system's output is the end result of all the neurons weighing complex reading. Obviously the output is depending on the inputs, their weight and the system topology.

Today man uses AI in Civil Protection, in EWS based on neural networks, smart cities, Decision Making/Support Systems, autonomous robots in rescue operations and in systems involving citizens, mostly through social media as input.

Is nowadays AI reliable enough to be used in Civil Protection?

2. Materials and Methods

This study summarizes issues on usage and ethics of AI in general, based on recorded incidents and data, and focuses on these issues when it comes to the AI application in the Civil Protection sector, as well as on possible impact of these issues in case of emergency situations. The study does not give scientifically supported solutions on the issues - it mostly underlines possible risks on –yet- not absolute and exclusive AI usage for emergencies concerning loss of human life.

3. Results and Discussion

3.1 Security vulnerabilities

A Cyberattack is deliberate exploitation of computer systems, technology-dependent enterprises and networks. Cyberattacks use malicious code to alter computer code, logic or data, resulting in disruptive consequences (techopedia.com) that include data deletion or corruption, or networks' collapse. Millions of attacks happen every day (Live Cyber Attack Threat Map, 2018). Among the five most targeted economy sectors is telecommunications and insurance (FireEye, 2018), both neuralgic during a disaster and in post-disaster phase. Cyberattacks on lifelines and hospitals have already occurred. (Graeme Baker, 2008; Smith Jake, 2016)

During an emergency, attacks to communication and transportation systems could have devastating consequences to first responding management, possibly resulting in casualties' increase. All digital systems, especially the ones connected to internet or intranets are vulnerable to malicious attacks.

3.2. Controversial Decision making process

3.2.1. Ethics - Decision Criteria

AI is a core part of the autonomous vehicles decision-making system. Decision-making process itself includes ethics.

The trolley problem is a specific ethical thought experiment among several that highlights the difference between deontological and consequentialist ethical systems: a runaway trolley moving toward five tied-up people lying on the tracks. A man could pull the lever that controls a switch, in order to redirect the trolley onto a side track and save the five people. However, there is a single person lying on the side track. Should he proceed? Which is the "right" decision? The trolley problem has a series of alternative versions: i.e stopping the trolley by putting the only available heavy thing in front of it, a fat man. In an even further development of this example, the fat man is, in fact, the villain who put the five people in peril.

An alternative case, argued by Judith Jarvis Thomson, involves five patients in a hospital, each in need of a different organ to survive. Under lack of available organs to be transplanted, a healthy young traveler, just passing through the same hospital comes in for a routine checkup. In the course of doing the checkup, the doctor discovers that his organs are compatible with all five of his dying patients. Suppose further that, if the young man were to disappear, no one would suspect the doctor. Should the doctor kill that tourist and provide his healthy organs to those five dying persons saving their lives? (Trolley problem, Wikipedia 2018)

A similar ethical test has been published by the Massachusetts Institute of Technology on the occasion of the autonomous cars beta testing; "Moral Machine" test is actually an open online platform including questions - moral dilemmas, where a driverless car must choose the lesser of two evils, such as killing two passengers or five pedestrians. The questions-dilemmas involve also gender, race, age, profession, social status, criminal record etc. of the potential victims (Moral Machine, 2016). A deeper thought is whether any car industry will sale autonomous cars programmed to kill their own driver and/or passengers, regardless of whether it is fair or not. And, by the way, who decides "fair"?

3.2.2. Biased Input, Criteria inequality, hidden algorithm issue

AI is already used in Justice in the USA. In the well-publicized case Loomis v. Wisconsin, the AI decision making system takes gender and race into account in formulating the risk assessment. The sentence was partly based on a secret algorithm; the defendant argued without success that the ruling is unconstitutional since neither he nor the judge was allowed to inspect the inner workings of the computer program (Delsh Kevin, 2018).

According to the assessment software Manufacturer Company "*The key to our product is the algorithms, and they're proprietary. We've created them, and we don't release them because it's certainly a core piece of our business*" (Loomis v. Wisconsin - SCOTUSblog', 2017).

AI is used in many EWS. Since the output of an AI System is depending on the inputs (data and criteria) and their weight, the questions:

- who decides the inputs?
- who decides the weights?
- are the input raw data correct and adequate?
- what if "fake news" are used as input?
- what if a cyber-attack introduced erroneous data as input?
- do we take all factors and players into account?

might never be answered in a "black box" AI system.

3.3. Liability issues

On March 21, 2018 an Uber car killed a pedestrian woman in Arizona (Griggs Troy, Wakabayshi Daisuke, 2018). Who is in this case legally responsible?

- the code developer?
- the LIDAR sensor hardware manufacturer?
- the Uber supervisor?
- the pedestrian?

Regarding the Civil Protection AI application, who is responsible when a Decision Support System suggests e.g. the wrong area to be evacuated during a wildfire?

3.4. Privacy issues

Internet of Things devices and mobile phones host a lot of personal data, that could be used from applications and networks aiming rescue and/or prevention etc. The same data could be used without the owner's agreement from third party applications setup in the same device. The recent facebook - Cambridge Analytica scandal (Facebook–Cambridge Analytica data scandal, WIkipedia 2018) is one of these cases highlighting the problem of controversial privacy policies of the giant company. EU General Data Protection Regulation (GDPR, 2016) is an important change in data privacy legal framework and could be a solution. So far GDPR is already embedded in the UAVs usage regulations (Trilateral Research, 2018).

3.5. Benefits inequality issues

Socio-economic inequality is likely to continue to increase and along with it disaster risk for countries, communities, households and businesses that have only limited opportunities to manage their risks and strengthen their resilience would probably also increase. Research suggests that disasters cause impoverishment, which can lead to a cycle of losses, poverty traps and a slowing of efforts to reduce poverty (UNISDR, 2015). Moreover, inequality is not just about the unequal distribution of income. Access to services, political voice, and social and economic status directly affect disaster risk and resilience (Satterthwaite and Mitlin, 2014). The September 2018 tsunami disaster in Palu, Indonesia is a typical case. Despite the existence of a tsunami early warning system, more than 800 casualties have been reported. People stealing sensors and maintenance budget cuts made the EWS useless (Ehrenkranz Melanie, 2018).

4. Conclusions

There are significant issues in using the AI technology in sensitive sectors and/or exclusively in general. On the other hand, technological developments have been a one-way road throughout the history of humanity, as its benefits seem to be more and more important than its disadvantages.

However, there is an urgent need to define and establish a framework of global ethics for the AI usage, in order to ensure transparency, complementary rather than exclusive use, scientifically documented and social accepted input data and weights, personal data respect and equal rights to the AI benefits.

The AI era comes with promises, challenges and risks.

According to Melvin Kranzberg's first law of technology: "*Technology is neither good nor bad; nor is it neutral*." (Melvin Kranzberg, Wikipedia 2018). It's about the human species to put it to good use.

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DYNAMIC DETERMINATION AND CALCULATION OF THE SAFETY LEVEL IN MAJOR-HAZARD ACCIDENT SYSTEMS: A PROPOSED MATHEMATICAL MODEL

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Abstract

In this study, we propose the **Real**-**T**ime **S**afety **L**evel (**RealTSL**) mathematical model for safety critical systems' safety level determination during their operation, and its dynamic calculation, based on the STAMP accident model. The proposed model utilizes the outcome of an STPA hazard analysis to construct acyclic diagrams composed of nodes and lines, where each node depicts an STPA derived safety constraint and each path of nodes depicts a possible scenario to the defined accidents. Based on the RealTSL mathematical model the safety level is defined as $SL = \max(\vec{\wp}) = \vec{p}_w = (y_w, t^+_{\vec{p}_w}(y_w))$, where $\vec{\wp}$ is the set of all possible safety constraint violation scenarios that can lead to accidents, $\vec{p}_w$ is the most detrimental to safety scenario at any point of time, y_w is the level of completeness of this scenario for the current time value, and finally $t^+_{\vec{p}_w}(y_w)$ is the time left until the most detrimental to safety scenario leads to an accident.

The mathematical model of RealTSL is demonstrated using a fictitious system of the "classical" train door STPA analysis. Aims of the paper are first to open a new perspective in the STAMP literature and on the problem of measuring what the actual safety level is at a certain moment in time at a given context and second, to generate new discussions on the topic of accident forecasting methods.

Keywords: Safety level, STPA, RealTSL, Safety

1. Introduction

Maintaining safety into acceptable levels is among the major managerial concerns in many industries. To address this, concern several safety indicators are used to monitor safety drifts about major hazards. Numerous categories of safety indicators have been proposed in the literature such as event indicators, barrier indicators, activity indicators, and programming indicators (Øien, 2010 and Thieme et al., 2017).

However, recent accidents indicate that safety cannot always be monitored and controlled effectively. Characteristic are the statements of Dekker (2006) on that *"we need to get smarter at predicting the next accident"* and of Dallat et al. (2017) on that "*new approaches to risk assessment are required that support the identification of risks"*. These statements indicate that there are doubts among safety experts on the effectiveness of traditional toolkits that are typically used to measure the safety level. Additionally, the challenge of measuring what the actual safety level of a system is at a certain moment in time at a given context still remains (Knegtering et al., 2013), regardless of the introduction of new accident models that view safety as an emergent system property.

In response to this challenge Dokas et al. (2013) introduced EWaSAP, which guides analysts to a) Select and configure the appropriate sensors, so the controllers of the system will be suitably equipped to comprehend the occurrence of safety constraints violations during the operations phase. b) Define which sensor data or the streams of data are justifiable early warnings to accidents. c) Help analysts in designing early warning messages that will not contribute to the occurrence of accidents.

Leveson (2015) proposed a formal foundation and structured process to identifying and monitoring system-specific leading safety indicators and guidelines in designing a risk management structure to use such indicators effectively. The basic hypothesis in Leveson's work is that useful leading indicators can be identified based on the assumptions underlying our safety engineering practices rather than on the likelihood of loss events. Thus, there is a need to monitor, whether the generated safety assumptions based on which a system was designed, hold during the phase of operations or are vulnerable or changed.

Chatzimicailidou et al. (2016) introduced the RiskSOAP indicator based on which one can compare the safety constraints of existing systems compared to their ideal set of safety constraints that derive from their STPA and EWaSAP analysis. The RiskSOAP indicator has been suggested as a measure for safety regarding the gap between system design and operation, thus increasing the system's risk situation awareness (Chatzimicailidou et al.,2017).

The problem is that **there are no mathematical models** available for determining dynamically what the safety level is at a certain moment in time at a given context and how much time is left for an accident to happen. To address this problem, we propose the **Real**-**T**ime **S**afety **L**evel (RealTSL) process and it's mathematical model for systems' safety level determination and its dynamic calculation based on the STAMP accident model. The proposed model utilizes the outcomes of STPA hazard analyses which are transformed into acyclic diagrams. In these diagrams, each node depicts an STPA based safety constraint, and each path of the acyclic diagram depicts a possible scenario of safety constraints violations that can lead to accidents.

RealTSL defines the safety level (SL) of a system in a specific time t as $SL = \max(\vec{\wp})$ where $\vec{\wp}$ is the ordered set of all possible paths of the acyclic diagram which is generated by STPA that are "active" in time t. $\max(\vec{\wp})$ denotes the path, or the set of paths, which are considered as the "worst" among the paths of the acyclic diagram in terms of: a) Their level of completeness (i.e. how many nodes are left until the "active" nodes in each path reach the node which represents the accident). b) The time left until the accident, based on the characteristics of each path for time t.

The proposed mathematical model is demonstrated herein using the STPA hazard analysis of a fictitious system similar to the "classic" train door STPA analysis example (Pope, 2017). Furthermore, a discussion of its applicability and its limitations is made, together with proposals of future research directions.

2. STPA

STPA is a hazard analysis approach based on the STAMP accident model. According to STAMP safety is an emergent property of systems and accidents can occur not just because of component failures but also due to unsafe interactions among system components that did not fail (Leveson et al., 2018). Thus, the problem of maintaining the system behaviors away from their hazardous states during their operations is, in essence, a dynamic control problem. That means that the feedback control loops that consist the system should be designed, developed and operate in a manner that their controllers will not enforce unsafe control actions in any possible operational context or environment. This could be achieved by applying the STPA hazard analysis, ideally as early as possible, during the life cycle of the system.

The STPA hazard analysis consists of four steps. In the first step, the purpose of the analysis and the boundaries of the system are defined, together with the losses or accidents, the system level hazards, and the system level safety constraints. During the second step of STPA, a functional diagram known as the safety control structure diagram is developed, where the controllers and the controlled processes of the system are shown, together with the control actions and the feedback, which each controller is receiving by the process it controls.

In the third step, the control actions of each controller are analyzed to examine under which contexts they could lead to the identified losses. The so-called Unsafe Control Actions (UCA) are then translated into safety constraints or safety specifications. The fourth step aims at identifying the reasons why unsafe control actions might be enforced in the system. As a result, some loss scenarios are created to explain how incorrect feedback, inadequate requirements, design errors, component failures, and other factors could cause unsafe control actions and ultimately lead to losses. How safe control actions might be provided but not followed or executed properly, leading to a loss (Leveson et al., 2018).

A set of written safety specifications or constraints is the typical output of an STPA process. Table 1 shows indicative examples of STPA derived safety constraints on an automotive Electric Power Steering devise from the work of Martínez (2015). Each row of Table 1 presents a safety specification together with how that specification is linked to Unsafe Control Actions (UCAs), Hazards (H) or Accidents/Losses (A).

Specifically, the first three rows of Table 1 show the specification derived during the first step of the STPA analysis when the losses of the system under study were defined. Rows 4 to 7 show the specifications derived during the first step of the STPA analysis when the system level hazards on an automotive Electric Power Steering devise were defined. Row 8 shows one specification that derived during the third step of the STPA analysis when the UCAs were defined. Lastly, row 9 shows one specification that derived during the fourth step of the STPA analysis when the loss scenarios were defined. The third column of Table 1 informs us how the violations of the loss scenario, UCA, and Hazards specifications can contribute to the occurrence of accidents A1, A2, A3. For example, the bottom cell in column 3 shows that in case of a violation of the loss scenario specification (see row 9) contributes to the violation of the UCA derived specification (Row 8).

Table 1: STPA analysis sample of an automotive Electric Power Steering (Martínez, 2015)

#	Symbols	Description	Links
1	A1	Vehicle occupants are injured during the operation	-
2	A2	The vehicle is damaged (economic loss)	-
3	A3	Loss of customer preference/ brand loyalty	-
4	H-1	Vehicle occupants experience harmful conditions during vehicle operation.	A1,A2,A3
5	H-2	Vehicle does not maintain minimum separation from other moving bodies.	A1,A2,A3
6	H-3	Vehicle does not maintain minimum separation from static bodies.	A1,A2,A3
7	H-4	Vehicle is difficult to operate	A1,A2,A3
8	UCA1	**SCM** (**S**teering **C**ontrol **M**odule) does not provide assistance level command when the driver executes a steering maneuver	H-1,H-2,H-3,H-4
9	S1	**SCM** provides assistance command, but it is not effective because the current to power the motor is low. The current is too low because: ● System voltage is too low	UCA1

3. The RealTSL Methodology and Process

3.1 Overview

The RealTSL methodology is depicted in Figure 1. It comprises two processes. The first is the **RealTSL Model Development** process for the system under study. The objective in this phase is to define a dedicated, to the system under study, mathematical model based on which its safety level will be calculated in real time. The second phase is to plug in to the real system the **RealTSL Operational System** which based on real-time data will calculate its safety level in real time. This paper is focusing only into the first phase of the RealTSL methodology.

The RealTSL Model Development process begins by retrieving the values of the following inputs: a) Safety constraints or safety specifications derived by the STPA analysis, b) The Safety Level Tolerance Managerial Decision k. c) The time ranges associated with the links of the acyclic diagram, and d) The operation method based on which a single time value will be selected to express every time range associated with the links that connect the nodes in the acyclic diagram. It continues then with the transformation of the STPA safety specifications into an acyclic diagram. With the acyclic diagram as a foundation, the RealTSL mathematical model for the system under study can be fully defined.

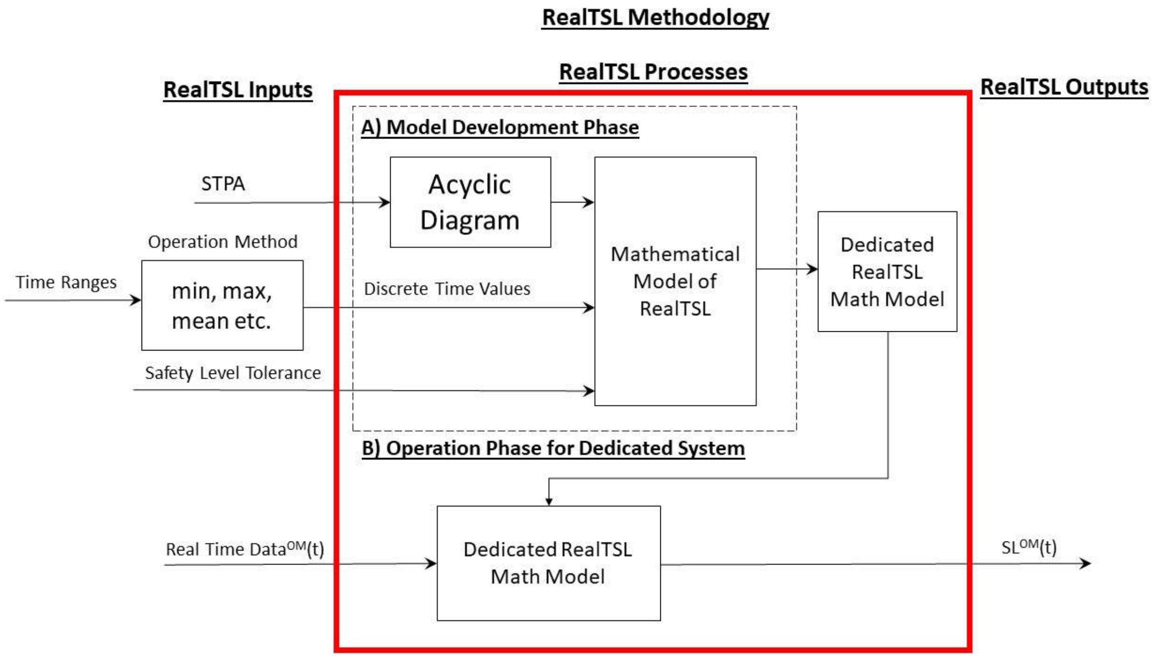


Figure 1: The Real TSL Methodology

After the definition of the mathematical model, the RealTSL Operational System process for the system under study can begin. During that process, real-time data are fed into the Dedicated RealTSL mathematical model which produce as an output the calculated safety level value for the system under study at each time t.

3.2 Definitions

3.2.1 Concepts and Definitions Related to the Acyclic Diagram

As mentioned in Section 3.1 the safety specifications of STPA are transformed into an acyclic diagram. Figure 2 (b) shows the diagram which can be produced by the specifications of Table 1. Each diagram has nodes and connections. Each **node represents a safety specification produced by STPA**, and each **connection represents the link between two safety specifications of STPA** as shown in the third column of Table 1. The state of a node in a given time can be true/active or false/inactive. If a node is active**,** this means that its corresponding STPA safety constraint has been violated in a given time in the actual system and inactive means the opposite.

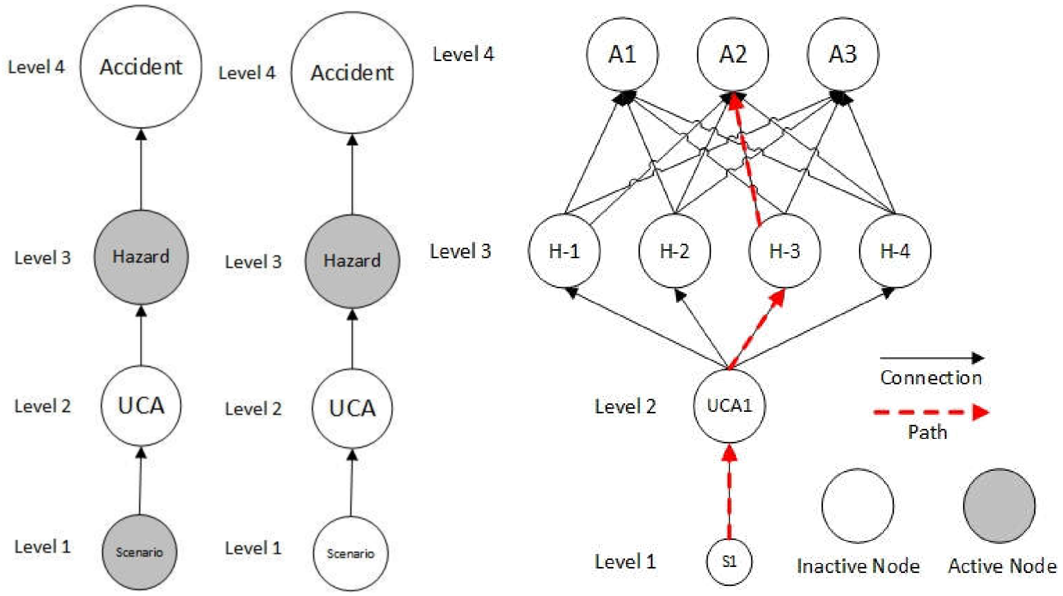
The nodes of the RealTLS acyclic diagram typically form a tree-like structure (see for example Figure 2(b), Figure 5) with the nodes located in four levels. The nodes **in Level 1** of the acyclic diagram, which is at the bottom of the tree-like structure, express the STPA safety specifications which are derived by the loss scenarios (the fourth step of STPA). The nodes representing the specifications from the defined STPA losses are at Level **4**. The nodes from UCAs safety specifications are in **Level 2,** and lastly, nodes from system level hazards safety specifications are at **Level 3**. Figure 2(b) shows these levels using the specifications of Table 1.

A RealTSL **path** is defined as a possible scenario of safety constraints violations that can lead to accidents. It is one of the possible "roads" leading from the lowest level (loss scenarios) to the highest (losses) using the connections between nodes. For example, in Figure 2(b) one possible path is S1→ UCA1→ H3→ A2 (shown with bold arrows), knowing this the example of Figure 2(b) has a total of 12 paths. Each path is comprised of 4 nodes one in each Level of the tree-like structure. Each path has three characteristics.

The first characteristic is the "**Operational Mode"** OM in which the path belongs to. For instance, referring to a plane system during its take-off mode, out of the total set of the acyclic diagram paths that can be produced from the plane system, the paths which will be computed during the RealTSL Operational System process of the methodology will be only those belonging to the take-off mode of plane operations. This is depicted in Figure 1 by the exponentiation symbol OM in the Real Time Data(t) input and into the SL(t) output.

The second is "**Path Completeness"** y which expresses in which Level of the acyclic diagram is the highest active node of a given path $\vec{p}$ in time t. The path completeness characteristic can take one of the following discrete values {1,2,3,4}. Specifically, each path is constructed by four (4) nodes each closer to the accident. When the highest-level node of a path in the acyclic diagram is active, then the path is fully complete, and an accident has occurred. In this case, the path completeness takes the value 4. For example, Figure 1(a) shows the same path in two different instances. In both cases, the path completeness takes the value 3 because the highest active node is in the hazards level (i.e., in Level 3 of the diagram). Thus, regardless that in one instance a node in the scenarios level (i.e., in Level 1 of the diagram) is active the path completeness value is 3.

The third is the "**Time Remaining Until Accident"** $t^{+}_{\vec{p}}(y)$ which expresses the time which is left for a path to reach the node that represents the occurrence of an accident (i.e., the Nodes at Level 4 of the acyclic diagram).



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(a) **(b)**

Figure 2: Examples of acyclic diagrams and representation of **(a)** path completeness, levels an active node, **(b)** paths, nodes, connections,

3.2.2 Time Related Concepts and Definitions

Several RealTSL concepts are related to time. The first is the concept of "**Current Time"** t which is the classical representation of time in physics being a numerical value "ticking" for every second since the beginning of the RealTSL analysis.

The second concept is the "**Managerial Decision"** k which represents the Safety Management preference on which path characteristic among the path completeness y and the time remaining until accident $t^{+}_{\vec{p}}(y)$ will have more impact on the system's safety level, based on the RealTSL model (for example look at chapter 4 and paragraph 5.2).

Third, fourth and fifth concepts are the "Time Range"([x,y]) the "Decision on Utilised Operation", and the "Discrete Time Value" t_{step}. These concepts are associated with the connections of the acyclic diagram.

The **Time Range** ([x,y]) expresses the minimum time x and the maximum time y that will take the next node of the path to change its state from inactive to active. The **Decision on Utilised Operation** concept expresses the Safety Manager's decision of which operation will be used to express the time range ([x,y]) of each connection of the acyclic diagram to a discrete time value t_{step}. In short, the **Decision on Utilised Operation** concept allows the transformation of time range inputs ([x,y]) of each node connection of the diagram to a discrete value t_{step}. Since every path $\vec{p}$ consists of four nodes and three connections then each connection there exists one t_{step} value for each of these three connections $t_{1\to2}^{\vec{p}}, t_{2\to3}^{\vec{p}}, t_{3\to4}^{\vec{p}} \in [0,\infty)$. Meaning one t_{step} from the connections between the nodes in Level 1 and 2, one from the nodes with Levels 2 and 3 and lastly one from the Level 3 and 4 ones. Examples of possible operations that could be selected by the manager are the min, max, mean etc. For instance, if a connection of the acyclic diagram that connects a Level 2 node with a Level 3 node of a path $\vec{p}$ has time range [5,120] and the manager choose the "min" as operation then the connection will have t_{step} value equal $t_{2\to3}^{\vec{p}} = 5$. Alternatively, if the manager chooses the "mean" as the utilized operator, then the connection will have t_{step} value equal to 65.

The sixth concept is the **Time Remaining Until Accident** $t_{\vec{p}}^{+}(y)$". This concept expresses the time which is left for an acyclic diagram path $\vec{p}$ to reach to the node that represents the occurrence of an accident (i.e., the nodes at Level 4 of the tree-like structure). $t_{\vec{p}}^{+}(y)$ is derived from the 3 t_{step}values of the path $t_{1\to2}^{\vec{p}}, t_{2\to3}^{\vec{p}}, t_{3\to4}^{\vec{p}}$ as well as the path's completeness according to [1] (see section 4). Example: $t_{\vec{p}}^{+}(y)$ can be calculated as follows (see Figure 3). Assuming that the path $\vec{p}$ shown in Figure 3 belongs to the set of paths that corresponds to the current operational mode of the system under study and the node in Level 3 is active in the current time t then $t_{\vec{p}}^{+}(y)$ will be equal to $t_{3\to4}^{\vec{p}}$.

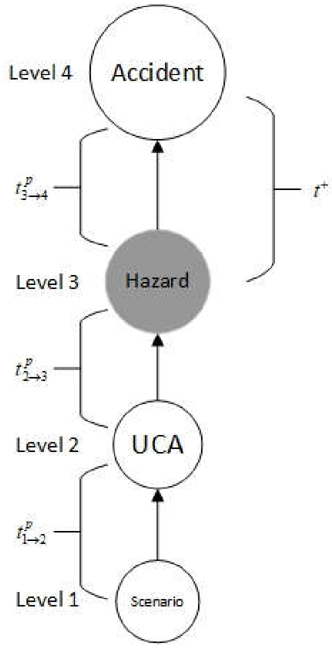

Figure 3: Example path and the corresponding time values

3.2.3 Definitions Related to the RealTSL Output

The only output of RealTSL is the **"Safety Level"** SL at time t and is defined as the most unfavorable path $\vec{p}$ of the acyclic diagram in t, considering the Managerial Decision k as well as the characteristics of Path Completeness y and the Time Remaining Until Accident $t_{\vec{p}}^{+}(y)$ for all paths in the current Operational Mode (for example look at paragraph 5.2)

4. The RealTSL Mathematical Model

Let us suppose the mathematical meaning of a path, as a vector of the following form:

$\vec{p} = (y, t_{\vec{p}}^{+}(y))$, Where:

y the path completeness for $\vec{p}$ in time t, $y \in \{0,1,2,3,4\}$.

$t_{\vec{p}}^{+}(y)$ the Time Remaining Until Accident and is calculated according to the following function:

$$t_{\vec{p}}^{+}(y)=\begin{cases} t_{1\to2}^{\vec{p}}+t_{2\to3}^{\vec{p}}+t_{3\to4}^{\vec{p}} & y\in\{0,1\} \\ t_{2\to3}^{\vec{p}}+t_{3\to4}^{\vec{p}} & y=2 \\ t_{3\to4}^{\vec{p}} & y=3 \\ 0 & y=4 \end{cases} \quad [1]$$

where $t_{\vec{p}}^{+}(y):\{0,1,2,3,4\}\to[0,\infty)$ (see 3.2 for definitions)

We consider the set of all the path vectors is $\vec{\wp}=\{\vec{p}_1,\vec{p}_2,\ldots,\vec{p}_n\}$

In the set $\overrightarrow{\wp}$ of all paths we define the following order relation:

$$\forall\vec{p}_1(y_1,t_{\vec{p}_1}^{+}(y_1)),\vec{p}_2(y_2,t_{\vec{p}_2}^{+}(y_2))\in\vec{\wp} \quad [2]$$

i) If $\left|t_{\vec{p}_1}^{+}(y_1)-t_{\vec{p}_2}^{+}(y_2)\right|>k$ is true

Then

$(y_1,t_{\vec{p}_1}^{+}(y_1))\geq(y_2,t_{\vec{p}_2}^{+}(y_2))\Leftrightarrow t_{\vec{p}_1}^{+}(y_1)<t_{\vec{p}_2}^{+}(y_2)\vee(t_{\vec{p}_1}^{+}(y_1)=t_{\vec{p}_2}^{+}(y_2)\wedge y_1\geq y_2)$

[a]

ii) If $\left|t_{\vec{p}_1}^{+}(y_1)-t_{\vec{p}_2}^{+}(y_2)\right|\leq k$ is true

Then

$(y_1,t_{\vec{p}_1}^{+}(y_1))\geq(y_2,t_{\vec{p}_2}^{+}(y_2))\Leftrightarrow y_1>y_2\vee(y_1=y_2\wedge t_{\vec{p}_1}^{+}(y_1)\leq t_{\vec{p}_2}^{+}(y_2))$

[b]

Where k the Safety Level Tolerance Managerial Decision (see 3.2) and we consider the a and b sub-orderings.

Finally, we define the safety level (SL) of the system of time t as:

$$SL=\max(\vec{\wp})=\vec{p}_w=(y_w,t_{\vec{p}_w}^{+}(y_w))$$

Where: $\max(\vec{\wp})=\max\{\max(a),\max(b)\}$ and a and b are the sub-orderings from above ([2]) and $\vec{p}_w=(y_w,t_{\vec{p}_w}^{+}(y_w))$ is the most detrimental to safety scenario.

5. Case Study

5.1 Train Door

A fictitious system of the “classic” train door example will be utilized to demonstrate the first process of the RealTSL methodology. The example refers to the operation of a typical train door during five operational train modes namely: 1) The train is on route, 2) It is approaching a station 3) It is leaving a station 4) Being stopped at the station and 5) Being in an Emergency situation requiring the evacuation of all the passengers. The STPA analysis of the example identified 91 safety requirements in total. After removing the repeated specifications which were produced during the last step of the STPA analysis (i.e., from the translation of the unsafe control actions scenarios) the analysis defined the following: 1 accident, 3 hazards, 14 unsafe control actions, 4 improperly executed control actions, and 34 safety scenarios. Figure 4 depicts the safety control structure of the system. Table 2 presents the identified accident and the three hazards together with a subset of the identified unsafe control actions and a subset of the identified scenarios of how unsafe control actions may occur (i.e., loss scenarios) and how these are linked together to form accident scenarios.

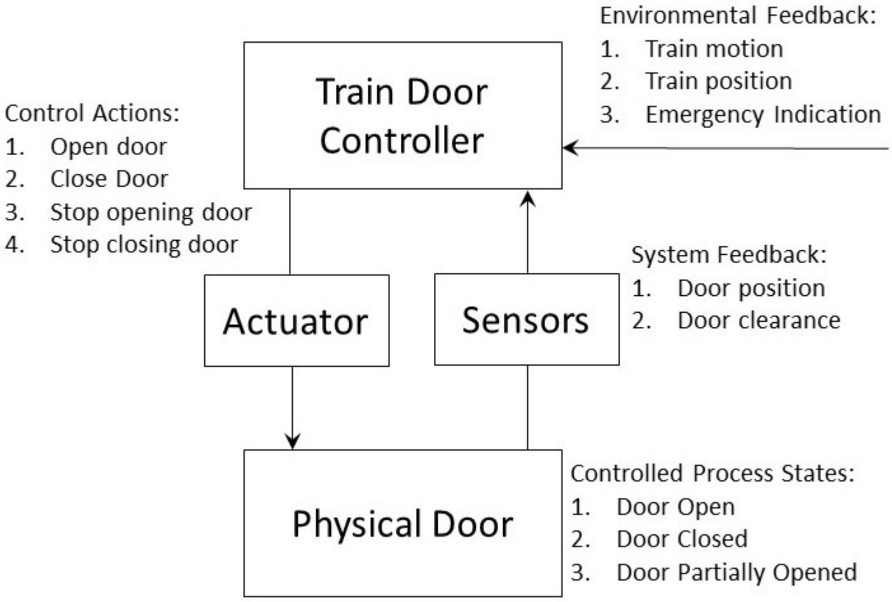

Figure 4: Train Door System Safety Control Structure

Table 2: A subset of STPA Produced Safety Specifications of the Train Door System

#	Symbols	Description	Links
1	A	Passenger loss of life or injury	-
2	H-1	The door is open when the train is moving	A
3	H-2	A person is unable to leave train (by the door) in case of emergency	A
4	H-3	A passenger is caught by the door and the train is moving	A
5	UCA5	Train Door Controller Provides Open Door while the Train is in motion	H-1
6	UCA12	Train Door Controller Provides Open Door while Train is about to reach the platform, but the train has not slowed down	H-1
7	S12	The sensor is not compatible with certain clothes materials, and as a result it cannot count that person	UCA2, UCA4, UCA8
8	S22	Evacuation mode misfire	UCA5

The entire acyclic diagram which is produced based on the results of the STPA analysis is shown in Figure 5. The diagram comprised of 56 nodes, as the total number of the unique safety specifications of the STPA, properly distributed into the appropriate Levels as described in section 3.2.1. The 56 safety specifications are connected in a manner which resulted in the creation of 159 paths into the acyclic diagram.

For example, a path might be S22 → UCA5 → H1→ A, which means that a misfire of Emergency signal (S22) may lead to the Open Door CA being given with wrong timing before train has had time to slow down (UCA5) which may lead to the Door being open while train is moving Hazzard (H1) leading to passenger loss of life or injury Accident (A).

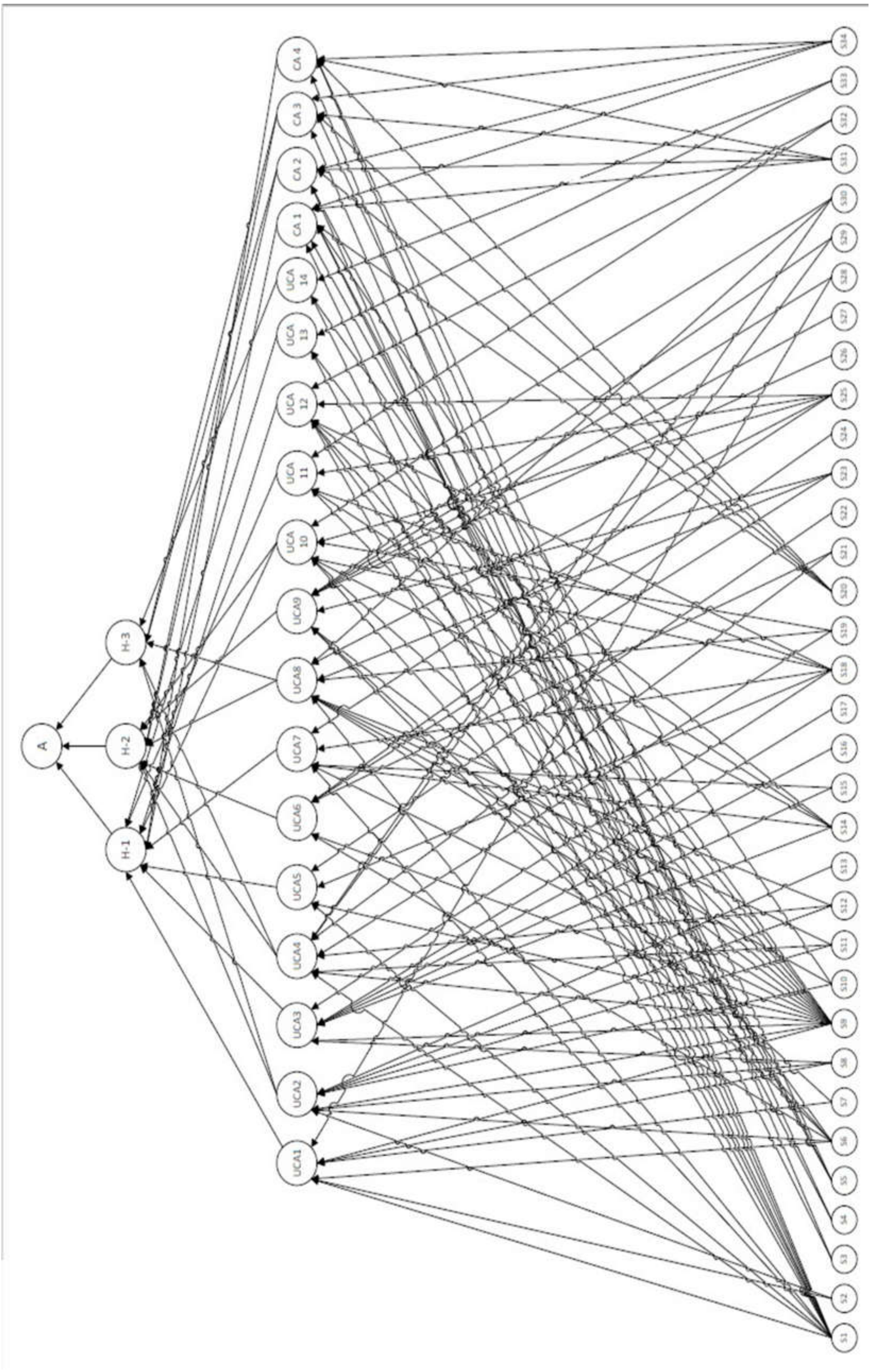

Figure 5: The acyclic diagram for the train door model

5.2 A RealTSL Mathematical Model Demonstration

Let's assume that a RealTSL system was plugged into a train door system and the Safety Manager decided to set the k Managerial Decision to the value of "60 seconds" and the Decision on Utilised Operation to the value of "minimum". The above decision means that in a given time t, in case where more than one alternative paths have nodes which are active and the time remaining to completeness for each path take values where their difference is less than 60 seconds, then the safety level is calculated based on the path completeness value of each path.

Let us also suppose that at a time t the plugged into the train door RealTSL system gets as feedback:

- Someone has pressed the emergency button in one of the wagons (i.e. S22 in Figure 5)
- Some of the doorway clearance sensors were lackluster (i.e. S12 in Figure 5)
- While the Train is about to reach the platform the "Open Door" control action was given prematurely before the Train slowed to acceptable speeds (i.e. UCA12 in Figure 5))

Based on that feedback data the RealTSL can comprehend that the system operated within the context of the 2nd Operational Mode (i.e., approaching a station) and given that an emergency button was pressed also operates within the contexts of the 5th Operational Mode (i.e. Being in an Emergency) also.

The RealTSL mathematical formula will operate as follows.

Given that the emergency button is pressed at a time t this will make the node "S22 = misfire of the Emergency signal." active. This is a node of the following path:

Misfire of Emergency signal (S22) → Open Door CA being given with wrong timing before the train has had time to slow down (UCA5) → Door being open while the train is moving Hazzard (H1) →passenger loss of life or injury Accident (A). Alternatively, using the codes of the acyclic diagram shown in Figure 5 the path is $\vec{p}_1$: S22 → UCA5 → H1→ A.

Let's also assume that the time ranges (in seconds) for each connection of this path are as follows:

I. S22 → UCA5 with time range $[90, 180]$
II. UCA5 → H1 with time range $[4, 10]$
III. H1→ A [4,60] with time range $[4, 60]$

Given that the min operator was selected, and the time values are as above we can calculate the discrete time values as follows:

I. $t^{\vec{p}_1}_{1\to 2} = \min[90, 180] = 90$
II. $t^{\vec{p}_1}_{2\to 3} = \min[4, 10] = 4$
III. $t^{\vec{p}_1}_{3\to 4} = \min[4, 60] = 4$

Based on the above inputs the dedicated RealTSL mathematical model will calculate first the path completeness value as follows.

Given that the node S22 is located in the 1st level of path completeness then $y_{\vec{p}_1} = 1$

Then it will calculate the time remaining until accident path characteristic as follows.

So knowing the path completeness time remaining is $t^{+}_{\vec{p}_1}(1) = t^{\vec{p}_1}_{1\to 2} + t^{\vec{p}_1}_{2\to 3} + t^{\vec{p}_1}_{3\to 4} = 90 + 4 + 4 = 98$ from [1].

Based on the above calculation the path vector takes the following value $\vec{p}_1 = (y_{\vec{p}_1}, t^{+}_{\vec{p}_1}(y_{\vec{p}_1})) = (1, 98)$

The feedback on the doorway clearance sensors that were lackluster can activate the node (S12) at the 1st level of completeness for six different paths see Figure 5. But they all fall in the 3rd and 4th Operational Mode (i.e., leaving a station and being stopped at the station). Given that the train operates at the 2nd and 5th Operational Modes these paths are then not acknowledged further.

Given that the "Open Door" control action was given prematurely before the Train slowed to acceptable speeds activates at a time t this will make the node UCA12, this is a node of the following path:

"Open Door" control action given prematurely before the Train slowed to acceptable speeds (UCA12)→ Door being open while the train is moving Hazzard (H1) → passenger loss of life or injury Accident (A). Alternatively, using the codes of the acyclic diagram shown in Figure 5 the path is $\vec{p}2$: UCA12 → H1→ A.

Let's also assume that the time ranges (in seconds) for each connection of this path are as follows:

I. UCA12 → H1 with time range $[30, 60]$
II. H1→ A with time range $[4, 60]$

Given that the min operator was selected, and the time values are as above we can calculate the discrete time values as follows:

I. $t^{\vec{p}_2}_{2\to 3} = \min[30, 60] = 30$
II. $t^{\vec{p}_2}_{3\to 4} = \min[4, 60] = 4$

Based on the above inputs the dedicated RealTSL mathematical model will calculate first the path completeness value as follows.

Given that the node UCA12 is located in the 2nd level of path completeness then $y_{\vec{p}_2} = 2$.

Then it will calculate the "**time remaining until accident**" path characteristic as follows.

So, knowing the path completeness time remaining is $t^{+}_{\vec{p}_2}(2) = t^{\vec{p}_2}_{2\to 3} + t^{\vec{p}_2}_{3\to 4} = 30 + 4 = 34$ from [1].

Based on the above calculation the path vector takes the following value $\vec{p}_2 = (y_{\vec{p}_2}, t^{+}_{\vec{p}_2}(y_{\vec{p}_2})) = (2, 34)$.

From the above process two path vectors are outputted: $\vec{p}_1 = (1, 98)$, $\vec{p}_2 = (2, 34)$

$|98 - 34| = 64 > 60 = k$ so we continue with [a] to $34 < 98 \Rightarrow (2, 34) > (1, 98) \Leftrightarrow \vec{p}_2 > \vec{p}_1$.

The result makes sense because the difference in time remaining is a bit over the k so weight is given to the time remaining and the paths are ordered accordingly.

6. Concluding Remarks and Future Work

In this paper the mathematical model of the RealTSL methodology was presented and demonstrated in a fictitious system. Aim of RealTSL is to enhance the capabilities of safety management systems towards preventing accidents and losses, by calculating in real time the safety levels of safety critical processes. It is the first time where a mathematical model is presented to address the problem of determining dynamically what the safety level is at a certain moment in time at a given context and how much time is left for an accident to happen. The RealTSL is based on the results of STPA hazard analysis. This is another novel aspect of this paper since there are no previous works on real time safety level calculation based on the STAMP accident model. A limitation of the presented mathematical model is that it does not cope with uncertainty. It is planned however to address this problem in a future work where the presented model will be enhanced with concepts of the fuzzy sets' theory. The future work list also includes the creation a RealTSL operational system where it will be installed into a real system to calculate its safety level in real time.

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THE ROLE OF MEDIA IN DISASTER MANAGEMENT SYSTEM

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Abstract

The media are linked to the democratic system of the country. Through these, political information is provided to voters, with the public supporting its choices in SME's information material. At the same time, the identification of social problems is achieved through these and is a key tool to address these. Also, the media is seen as preserving democracy, as various mistakes and injustices and injustices come from the existing power. Consequently, SMEs operate at specific levels and standards, as defined by democratic society. The aim of the research is to help all those who are interested in developing the necessary skills to be able to deal effectively with critical situations. Our research has the sole purpose of optimizing existing logical practices and tactics to address and respond. As a method, design-based research and approach to living labs are adopted. It builds on the existing knowledge of the International Telecommunications Union and the European Broadcasting Union.

Through the media, topics are touched with an interesting story that is considered fascinating to the audience. These stories include human stories and conflicts. The fast and painless safeguarding of history serves the success of publication as long as it is based on a reliable source. This information stems from the audience itself through the interview process, so each person reports on his experience how he lived and felt an event and describes it accordingly. However, these interviews push SMEs into conflict with crisis managers, as they provide a safe and honest picture of what they are describing. The conflict is, of course, due to the fact that, in addition to their personal experience of the event, the emotional reactions of the public, their subjective judgment, etc. are recorded. The conflict, at the same time, is also due to the crisis managers. The managers, therefore, do not pay special attention to raising the awareness of critical media situations and events.

1. Introduction

1.1 The role of SMEs in general

Several disciplines are exploring how SMEs influence the political climate and the democratic system. In general, the entire network and the model of this complex network are discussed. Its dominance is due to the competitive tendency, while this model gives the media an impulse to produce entertainment stories to emotionally elicit listeners or viewers. The topics that are mostly chosen to be promoted through SMEs concern risks, hazards. However, this has a significant impact on democracy.

The media are linked to the democratic system of the country. Through these, political information is provided to voters, with the public supporting its choices in SME's information material. At the same time, the identification of social problems is achieved through these and is a key tool to address these. Also, the media is seen as preserving democracy, as various mistakes and injustices and injustices come from the existing power. Consequently, SMEs operate at specific levels and standards, as defined by democratic society.

The media serve specific democratic functions. An example of these may be that they are monitoring social and economic developments, identifying topical issues, giving and triggering debates on various attitudes and positions, controlling the way in which power is exercised, helping to provide citizens with an incentive to be informed, their choice and involvement in political issues, they are a basic resistance to the efforts of diverse interests that undermine the independence of citizens.

However, the worrying case is that SMEs do not guarantee and do not properly and properly serve these functions of democracy. Accordingly, with those who criticize the democratic spirit of the media, SMEs operate purely commercially and are controlled to a certain extent or often by multinational corporations, so they have come to the opposite of democratic power by supporting the government.

As a result of this, the media choose to show more entertainment content rather than as informative, also choosing gossip, scandals, sex and violence. The news piece that is being promoted by them concerns more personalities than ideologies. At the same time, there is a lack of serious debate and clear information to the public. This gives the impression that SMEs focus more on wrong issues, exemplifying the scandalous issues of different people and their personal lives.

It is considered more profitable and self-sufficient to deal with the media with the personal lives of political figures while ignoring or ignoring the impact of political decisions. Often, it is also the phenomenon that the media make the public feel fearful of them. Thus, the important problems for the life and survival of the citizen are overtaken and left unnoticed, while they are enormous in size through their exposure to hysteria dangers.

There is a failure of the risks of reporting injustice and industry. An example is the fact that issues related to public health are often neglected and pose a public health risk to citizens. An example is the report and the update of the smoking habit. This is due to companies that are sponsors of SMEs and that prohibit this type of promotion. It is also worrying that alternatives are being put in place instead of information on the health risk posed by smoking. Thus, in essence, SMEs are conspiring with industry effectively, with the ultimate goal of removing hundreds of billions of dollars annually from consumers.

The majority of media, such as magazines, newspapers and TV channels, earn money from advertising campaigns and sponsorships. Therefore, the goal of SMEs is to satisfy the interests of their advertisers, which of course do not coincide with the interests of readers and viewers.

Therefore, the interests of consumers are not covered. For this reason, the majority of countries also have public media. Of course, a large proportion of researchers believe that SMEs are essentially shaping consumer preferences and not covering them.

The trends that SMEs have developed over recent decades are as follows:

- fusion of newspapers, radio, television, telephone and internet in technological and economic terms.
- There is a merger of SME businesses and their control is done by fewer owners. As a result of this vertical and horizontal concentration of media businesses, the news comes from shared sources.
- Media owners are multinational companies that may even have their headquarters abroad (globalization).
- No news and entertainment ads are distinguished, but they are unified (commercialization).
- More scenes of violence and sex are displayed, with an intense choice of commentary and criticism on the personal lives of individuals, avoiding controversial issues and serious discussions (superficially).

The fact that the SME market has been liberalized has led to the aforementioned trends of SMEs. Thus, they are chosen because they pay financially.

2. The influence of SMEs

Numerous theories explore the question of the influence of consumer behavior on the media as it is studied below:

- The provision of information by SMEs outweighs the human possibilities of information retention. In order to save information processing by the media, people choose their reading, listening and listening content based on their needs and preferences and interests (cognitive processing)
- SMEs do not have the capacity and capacity of the content of people's thinking, but they have the ability to influence the way people think (regulation of the agenda)
- SMEs have the ability to influence the candidates' crisis criteria for candidates in the elections, as they have the power to turn human attention to specific issues and aversion to other issues. An example is

President Bush of the United States, where his support was limited in 1992 as the interest of the media turned to the projection of the economic recession and not to the Gulf War,

- There is a variety of ways of describing and shaping the image of an event, so that it is chosen to be displayed by the media. An example is news about nuclear weapons development or news about technological progress, military budgets, defense policy for each country, military disarmament and radiation dangers (shaping)
- People's perception of things can be influenced by the media, notably through documentaries, through fiction and entertainment. The repetition and dominance of certain motifs and images and ideologies spiritually and ideologically overwhelms the individual. This can happen even through TV shows and movies. The result of this is that the world really thinks that an event is happening, so it actually exists. An example is the scenes of violence that are projected daily and year after year, so that in the minds of the viewers the idea that the world is violent and that it is a frequent phenomenon of violence (theory of culture)
- SMEs can not change the views of people, but they have the power to strengthen the views that people already have. At the same time, it is considered that SMEs have a significant influence on issues for which people have been completely ignorant (media influence on new issues).

3 Crisis management by SMEs

When there is a critical situation, then those who manage the media focus on it. There is not always focus on communication and information management when crisis management is planned. This is due to the fact that Crisis Planning and Training focuses on resource and staff management. This requires training of managers and staff of the agencies in their relationship with other people and their relationship with the media.

It seems that effective communication management is as important as effective crisis management is important. It is therefore the public, considered to be important, with the views of the public being shaped according to the content of what they hear, they see and read about an event.

Particular importance and priority should be given to SME management. When they manage SMEs effectively, they can distract positive criticism of a critical event from the public about the emergence of the critical situation and about how an organization manages the critical situation.

However, there are stereotypes and prejudices about journalists. The attitude and position that journalists, regardless of their personal effort and their ability to manage SMEs adequately and effectively, are therefore the result of their work is not always desirable. In particular, there is the impression that the work of journalists is not always objective. It is a fact that there is no SME management strategy that can be sure of success, but the journalistic manipulation can limit the conflicts, misinterpretations and the image of the organization that will have it after the outbreak of the crisis. Crisis managers and journalists may collide because managers feel they have no appreciation of their efforts to resolve the critical situation while they feel they are being criticized by journalists and their efforts are underestimated.

Journalists are dealing with a critical fact of distorting it, aiming at increasing viewing, keeping an objective position in the things they present and of course serving their personal interests.

Even SMEs, which are not commercially aimed to make financiers happy. Their financiers may be governments, religious and political organizations and commercial enterprises. Thus, SME organizations earn and secure the jobs of employees working for SMEs.

4. Conclusions

4.1 The way they approach the critical situation of the media

Through the media, topics are touched with an interesting story that is considered fascinating to the audience. These stories include human stories and conflicts. The fast and painless safeguarding of history serves the success of publication as long as it is based on a reliable source.

This information stems from the audience itself through the interview process, so each person reports on his experience how he lived and felt an event and describes it accordingly. However, these interviews push SMEs into conflict with crisis managers, as they provide a safe and honest picture of what they are describing. The conflict is, of course, due to the fact that, in addition to their personal experience of the event, the emotional reactions of the public, their subjective judgment, etc. are recorded.

The conflict, at the same time, is also due to the crisis managers. The managers, therefore, do not pay special attention to raising the awareness of critical media situations and events.

The story to be shown by the media is selected and shaped according to some conditions to be met, which are:

- history should be intense and dramatic to broadcast
- history should touch and relate to personal stories, intimate experiences and experiences of the public who will follow it
- history should be unpredictable and unusual
- Depends on whether history has been re-introduced in the past
- history is considered important new since its previous promotion
- the story is still considered as an important new one
- the story is about important people who will be its main protagonists
- History has negative effects and results.

4.2 The contribution of SMEs

A critical situation can be aggravated by its media exposure. The media, therefore, can refer to a critical situation, causing more episodes and presenting it so that it is further strengthened in intensity, in an exaggerated and dazzling way, with appropriate shots. However, SMEs can make a significant contribution to the critical situation in the following ways:

- SMEs can promote educational material so that the public is aware of potential risks and can thus be able to cope with critical situations
- SMEs to warn the public that there is a threat of a critical event
- SMEs to inform the organization about possible concerns and feelings of those interested in them
- SMEs to provide information to the public on critical situation managers and its evolution, as well as its management.

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NATURAL DISASTER INFORMATION DISSEMINATION ON TWITTER: TESTING AGAINST MAINSTREAM MEDIA COVERAGE

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Abstract

In the last few years, social media have been found to play an important role as additional media for many-to-many crisis communication. Additionally, as a rich source of social data, there has been growing interest in using Twitter for situational awareness. The purpose of the study, is to examine the relationship between mainstream media and Twitter agendas, during natural disasters in Greece. This paper has collected Twitter data during natural disasters in Greece, using prominent hashtags. The study also traces media coverage during the same period, to test the hypothesis that the mainstream media agenda has an influence on the social media discussion. It aims to answer a series of research questions about information dissemination and the role of social media. The material was analysed on the basis of contents of tweets and popularity in terms of retweets. The paper applies two theoretical frameworks: Bourdieu's (1991) analytical concept of habitus and field theory, and Castells' (2009) theory of power in the network society. The preliminary findings suggest that while mainstream media define the news agenda, Twitter help communicate the news to a large mass of people. In addition, our analysis provides insights on how Twitter may be challenging the dominant position of mainstream media during periods of crisis in Greece.

Keywords: Social media, Twitter, communications, natural disasters, data analysis

1. Introduction

In an age of digital communication, social media are heavily used for communicating with the public. Social media can play a vital role before, during, and after natural disasters. Twitter has increasingly infused itself into daily life being an important medium for the public in order to be informed. This study aims to contribute to research on Twitter, by examining the differences on the agenda settings between the mainstream media and Twitter agendas during the recent national disaster of Zorbas in Greece. In addition, the study investigates if Twitter can change the dominant position of mainstream media during periods of crisis in Greece and whether it can be used for communicating news to a large amount of people.

1.1 Social media -Twitter

The emergence "of Internet-based social media has made it possible for one person to communicate with hundreds or even thousands of other people about products and the companies that provide them" (Mangold and Faulds, 2009). As Huberman (2009) claims referring to social media people that someone shares a social relationship with, in reality people interact with very few of those "listed" as part of their network. Especially for young people the use of social media has increased in recent years. In terms of platform popularity among young adults (between 18 and 29 years old) with Internet access, 87% use Facebook, 53% use Instagram, and 37% use Twitter (Duggan et al., 2015). Twitter is different from a social network concerning the relationship among users that requires no reciprocation. In fact, the user (in this case, the follower) can follow others (influencers) without being necessarily followed by them. The follower receives the messages of followed users (tweet) and if he finds the tweet is very interesting and worth sharing with his network, he can decide to spread information to others (retweet) (Minazzi, R., 2015). A popular microblogging service, it is quite interesting that although tweets were originally limited to only 140 characters, there is still a huge amount of information carried over (Dossis et al., 2015). Tweets and Twitter's "following" mechanism link people in a variety of ways, ranging from short (but often meaningful) conversational dialogues to interest graphs that connect people and the things that they care about.

1.2 Related work

In recent years, Twitter has been used, among other things, for informing people about forthcoming disasters and for reporting the consequences of catastrophic phenomena. Kongthon et al (2012:2231) in the research "The Role of Twitter during a Natural Disaster: Case Study of 2011 Thai Flood," analyzes how twitter was used during these major floods. According to their results, Twitter has shown potential to be an effective tool for Thai citizens to obtain and disseminate up-to-the-minute information. With its real-time enabled platform, Twitter allows traditional journalists as well as "citizen reporters" to provide instant situation reports.

Takahashi (2015) on the same track examined the use of Twitter during and after Typhoon Haiyan pummeled the Philippines. What is interested in their work is that Journalists used Twitter for their traditional role of disseminating information but local residents also did not use Twitter to request help during the typhoon.

Another important study that was published was that of Mandel et al. in 2012. In their work they examined the use of Hurricane Irene on Twitter by collecting over 65,000 Twitter messages related to Hurricane Irene. Their results after the analysis of Twitter messages relating to Hurricane Irene showed that there are different in sentiment depending on a person's gender or location. Another significant study was conducted by Acar and Maraki (2011) reporting the Japan's tsunami of 2011. They derived that people in directly affected areas tend to tweet about their unsafe and uncertain situation while people in remote areas post messages to let their followers know that they are safe.

Finally, Kumar et al (2011) in their work about Cholera 2010 crisis in Haiti, investigated the purpose of Twitter as a tool for helping these first responders gain situational awareness immediately after a disaster or crisis. It examines how the geo-location and specific keywords in a tweet help first responders gain situational awareness during disasters.

1.3 Mainstream media and social media

Wallstenon (2007:546) on an early work in 2007 examined the relationship between the mainstream media and blog agendas. Her work tracks media coverage and blog discussion of 35 issues during the 2004 presidential campaign to test the hypothesis that the mainstream media agenda exerts a substantial impact on the blog agenda against the increasingly popular hypothesis that the blog agenda exerts a strong influence on the mainstream media agenda. What her results showed was that on the vast majority of issues there was a complex, bidirectional relationship between mainstream media coverage and blog discussion rather than a unidirectional media or blog agenda-setting effect.

Boyle and Schmierbach (2009) claimed that alternative media are positively related to alternative participation and underline the emerging importance of Web-based media. Agenda setting is based, with the development of social media, to a user-generated content as it could be an effective way of communication.

Salman, Ibrahim, Abdullah, Mustaffa and Mahbob in their work about the impact of New Media on Traditional Mainstream Mass Media in Malaysia in 2011 found that the new media and conventional media will continue to coexist and reinforce each other. Finally, Farinosi and Emiliano (2014) in their work tried to explore the motivations that drove many ordinary people to produce citizen journalism after the earthquake that destroyed the Italian city of L'Aquila in 2009. Their results showed that on one hand that non-professional journalists also had to face a series of obstacles, such as risks of fragmentation and lack of professionalism, but on the other hand, that local citizens used digital media to provide an alternative version to the one presented by Italian mainstream media.

2. Methodology of the study

Our objective in this work was to select suitable, popular hashtags, determined by close observation of the communication on Twitter and to compare with the presentation of the news found on the newspapers. Firstly, we extracted all tweets related to the "Zorbas" and "Xenophon" hurricanes and performed a tweet text content analysis in order to highlight mainly the dimensions of who, when and what compared to traditional media coverage of the expected extreme weather phenomenon. As it turned out, there is no significant network structure and thus no particular discussion is taking place among bloggers. There are however quite a few retweets and favorites as well as mentions and hashtags and these are reported. No key bloggers or other structural and conversational patterns in this global engagement of communication on the specific topic were identified, as e.g in a previous work (Mylona and Amanatidis, 2017).

There are several approaches in extracting the tweets, e.g. by accessing the Twitter API, or using a third-party, off-the-shelf tool, such as NodeXL. However, there are some limitations when using the free versions of these tools. Usually, these are limitations with respect to the total number of tweets, or time limitations, hindering the extraction of tweets older than a week ago. Therefore, we exploited Python as a means to circumvent this obstacle. We opted for seven query strings, the two hurricane names in Greek ("ζορμπάς" and "ξενοφών"), the two correct English names ("zorbas" and "Xenophon"), the two "greeklish" terms ("zormpas" and "xenofon") and the "medicane" term, which was a trending hashtag at the time, adopted mainly by non-greek bloggers and weather monitoring and forecasting professionals. The term is a portmanteau to indicate the special case of a Mediterranean Hurricane, which are milder compared to other hurricanes or tornadoes. The dates were restricted to lie within the 3-day interval from 28/09/2018 to 30/09/2018. The tweets were collected at 17 October 2018, in less than an hour. The following table shows the number of tweets extracted for each term.

Table 4: Number of tweets containing the search strings

query string	"ζορμπάς"	"ξενοφών"	"zorbas"	"xenophon"	"zormpas"	"xenofon"	"medicane"
number of tweets	63	58	60	37	5	21	61

The tweets were imported into a .csv file and filters were set to enable ordering by different features, calculation of statistical measures and generation of graphs. Importantly, at this point, after sorting by date (and time) we were able to identify duplicates in our dataset, as quite a few tweets had more than one of our search terms, mainly as hashtags. Our final dataset consists of 273 tweets and Figure 1 depicts an excerpt of the dataset. A column was also inserted to indicate the content category, after manual examination of the tweet text. It would be interesting to perform an automatic sentiment analysis on the tweets texts, employing a learnt model. This however constitutes future work.

	A	B	C	D	E	F	G	H	I	J
1	permalink	date	retweets	favorites	photo	category	language	text	mentions	hashtags
89	https://twitter.com/StephanAitch/status/10456007913718947 84	28-09-18 12:07	0	0	NO	New information on developments	german	Mögliche Zugbahn von # medicane # Zorbas https://twitter.com/meteogreen/status/1045599802480893959 ...		# #
90	https://twitter.com/georgemant13/status/10456033486852464 64	28-09-18 12:17	14	90	YES	Critical/negative/ironic comments	greek	Παιδια εκει στη @ Vodafone_GR @ vodafonecu απλα κοιταξτε εξω απ το παραθυρο.Κατι σας εχει διαφυγει μαλλον # Ξενοφών # Ζορμπας # κακοκαιριαpic.twitter.com/JJIsW7s4eN	@ @	# # #
								Τη Δουρου την εντοπίσαμε;; ή θα την ψάχνουμε πάλι ;; Ελπίζω Ο # Ξενοφων και ο # Ζορμπας να μην γίνουν ακόμα μια ατυχία στη βάρδια της...		

Figure 5: An excerpt from the dataset

Concerning the collection of news from the newspapers we include in our research the newspapers with largest circulation in Greece according to ARGOS distribution agency. Those newspapers were: Ta Nea, DimoKratia, Eleutheros Typos and Efimerida ton Syntakton. In order to make the compassion with the tweets we search for news about Zorbas and Xenofon. The period of searching was from 28th of September till 30th of September. The news that were found were categorized in the following sessions: reporting, editorial, interviews and opinion articles.

3. Results

In order to examine the relationship between content emphasis in news articles and Twitter messages, the top content categories were identified across Twitter. These five categories were: news and a negative comment/irony, news along with a positive comment, new information on development, critical/negative/ironic comment and analysis on development (Chart 1). Additional, the content frame coded newspaper articles according to the following categories: reportage, opinion article, interview and editorial (Chart 2).

In our research we found that Greek Twittersphere during breaking news such as natural disasters, is similar to Western countries (Rosenstiel, 2015). The classification results on Chart 1 shows that the most frequent content categories included news on development and comments among with irony or criticism. A deeper investigation of the dataset, reveals that in times of crisis, more user accounts start to publish comments (Stieglitz & Kruger, 2011). In one sense, Twitter users tend to be news consumers during natural disasters in Greece, as "new information" is one of the primary activities that they engage in using the platform. However, their usage seems participatory, as they comment, post and share images while such events are moving. Another category worth highlighting, due to the display frequency, is the "news and a negative comment/irony". Although they are not mentioned as frequently as some of the other content categories, these tweets had a significant reach.

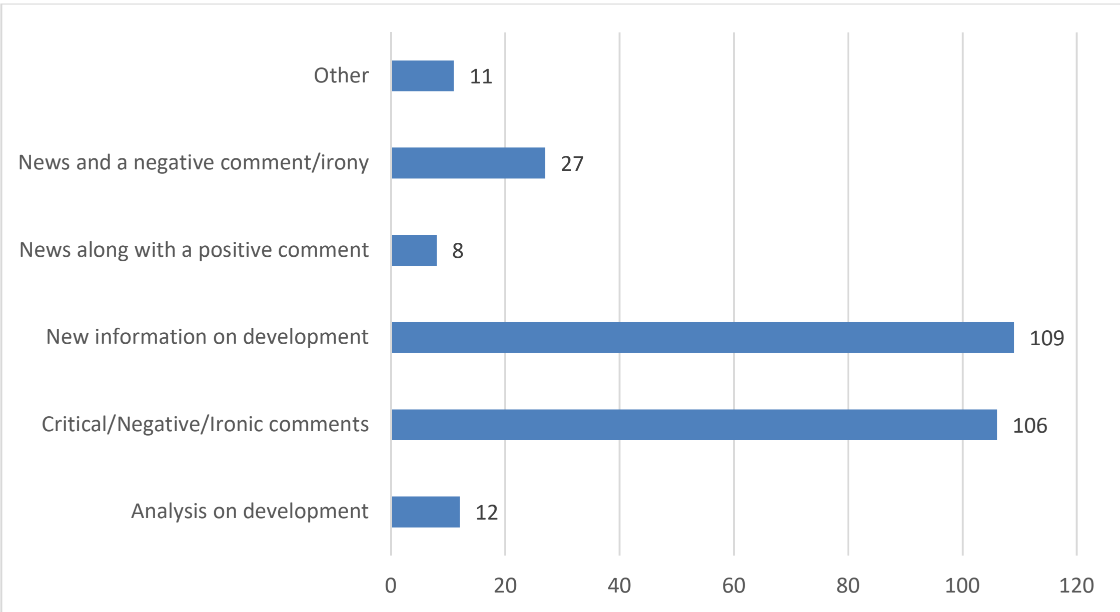

Chart 6: Textual tweet analysis, the most frequent content categories

Studying the content of the tweets more prominently, we see that many messages are a combination of personal opinions and links related to the journalists' work (Chart 2). Those URLs direct to mainstream media websites, meaning that users often reproduct articles found in online newspapers.

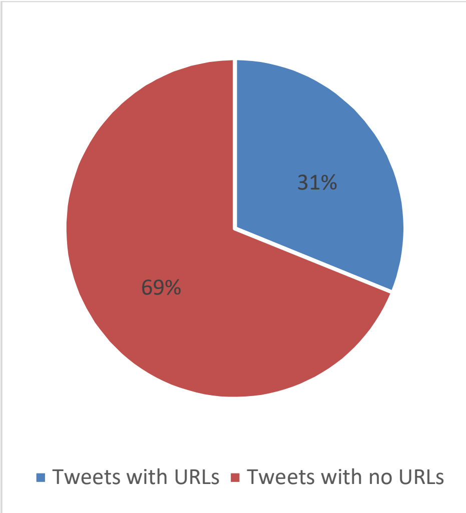

Chart 7: Percentage of Tweets with URL

Additional attention was also paid to the images accompanying the text, as approximately half of our tweets sample (51%) included an image related to the discussed subject. Descriptive statistics for this sample of tweets are summarized in Chart 3.

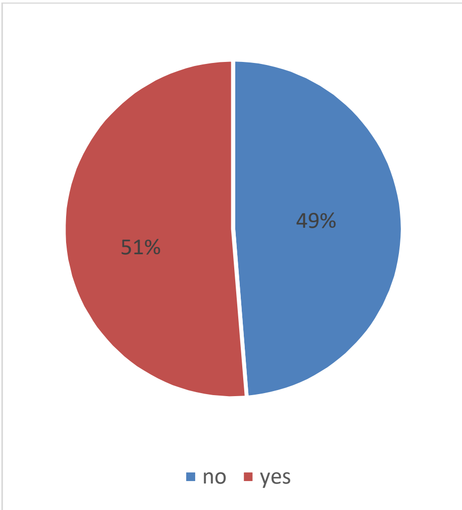

Chart 8: Percentage of Tweets with image

On the other hand, the results on newspapers show prominence of reportage (Chart 4) and photographs (Chart 5), rather than article view and interviews. Approximately one third of articles in our sample had been published with more than one image.

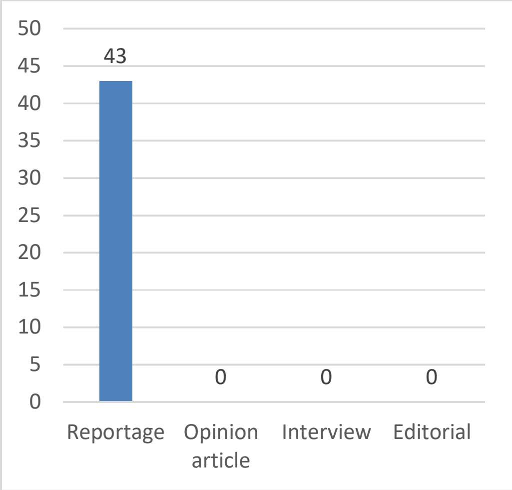

Chart 9: Prominent content categories on newspapers

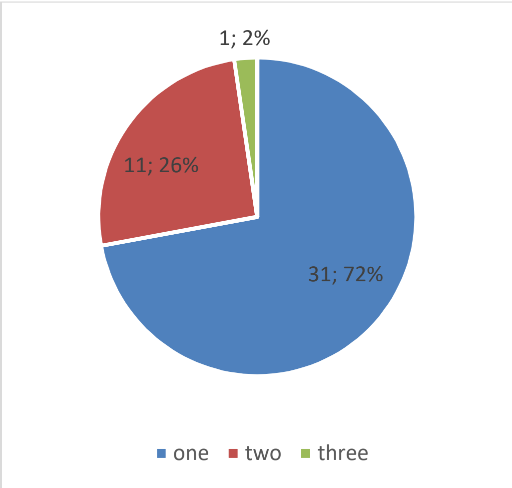

Chart 10: Number of images on newspapers

Figure 2 shows the tweeting frequencies of the dominant #hashtags across the three days and nights of the natural disaster. Through this, two periods of tweeting activity can clearly be identified: (1) early morning to late night, 28th of September and (2) early morning 29th of September to 30th evening, 30th of September. Furthermore, the activity dramatically increased in the early morning 28th of September, a little after the press conference that was given as a result of the agencies involved in civil protection meeting. The classification results on Figure 2 shows that during the time window between the two nights (28-29 September 2018), tweets were virtually absent. The above results, make obvious that crisis situations (such as Zorbas extreme weather phenomenon) seem to cause a strong relative growth of Twitter activity beyond the normal, day-to-day base-line of activity (Stieglitz & Kruger, 2013).

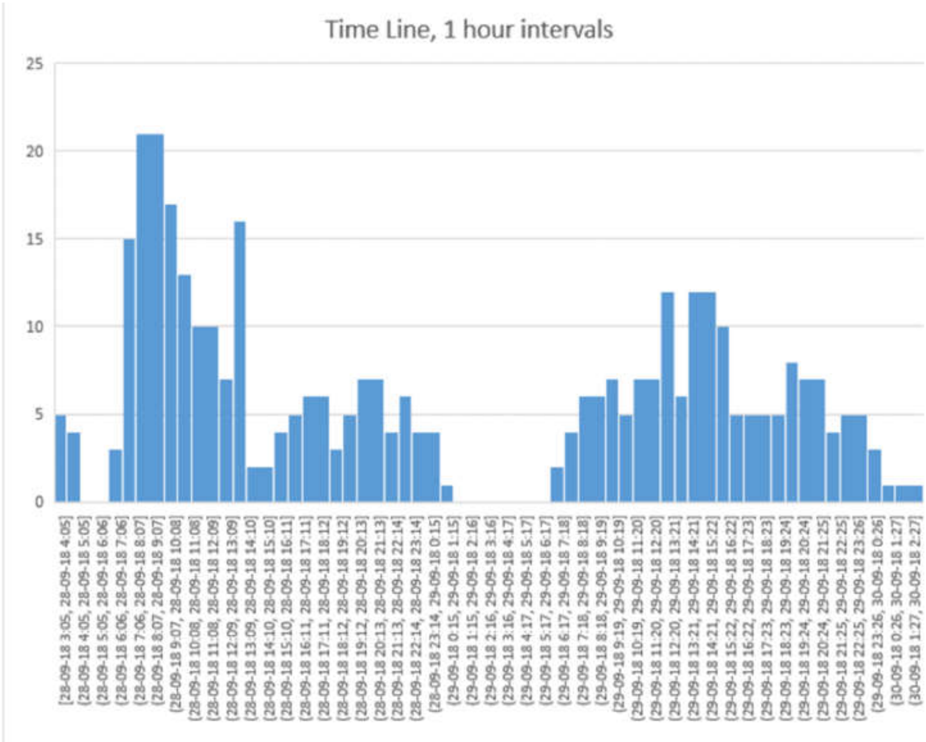

Figure 2: Total tweeting activity over the three nights/days

On the other hand, most articles published in the newspapers are being observed on 29th, meaning a day after the press conference. The post-phenomenon days (30th of September) also exhibits the highest volume. Chart 6 compares the distribution of articles over time.

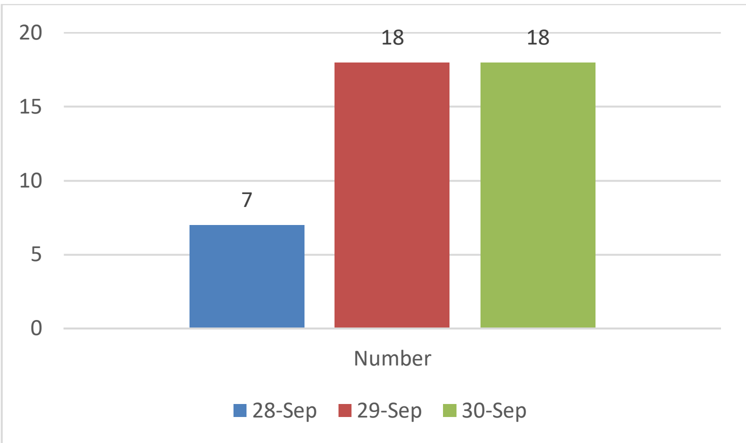

Chart 11: Number of newspapers' articles during the studying period

Therefore, it can be said that the analysis (Figure 2 and Chart 6) shows Twitter and traditional news media appear to have a symbiotic relationship. Specifically, considering the nature of newspapers due to their circulation times, and Twitter as a source of real-time news and information, it is reasonable that the platform can have a significant impact on newspapers and their next-day news agendas.

What it can be observed in Chart 6 is that during these three days and nights, the dominant language on Twitter messages, almost the 48%, was Greek rather than English. However, a closer inspection shows that the majority of these tweets are not Greek, but other European languages (Chart 7). Probably, this is because Greek people wanted to externalize what was happening in the country, rather than discussing the facts with each other.

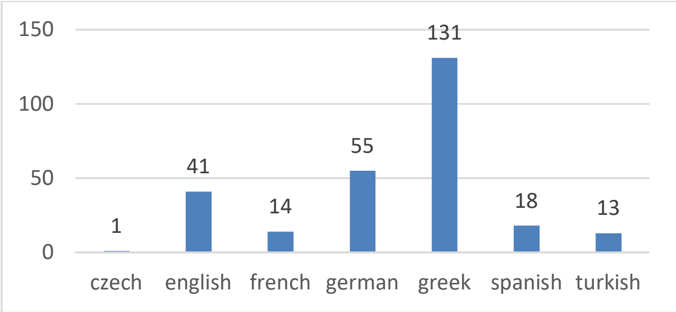

Chart 12: The languages of the Tweets

On the other hand, Chart 8 displays the dynamics of hashtags during time periods analyzed. Hashtags, which were used to guide data collection in the present study, are "thematic keywords which are convenient for demarcating Twitter searches and archiving tweets" (Lang, 2013). In order to develop a better understanding of communication on Twitter, we took under consideration the display number of used #hashtags, which reached up to thirteen. It does make obvious that Twittersphere in Greece uses a wide range of words in its hashtaging.

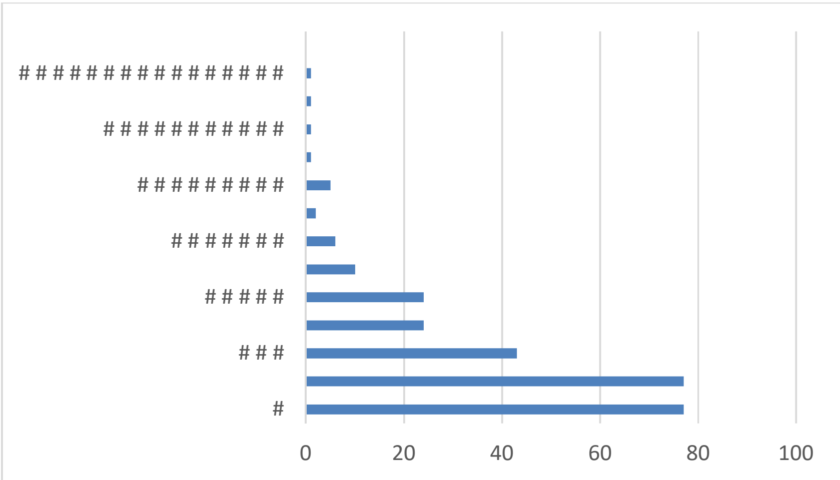

Chart 13: Count of hashtags in the Tweets

4. Discussion - Conclusions

It does make obvious that crisis situations seem to cause a strong relative growth of Twitter activity beyond the normal, day-to-day base- line of activity (Stieglitz & Kruger, 2013). In addition, it could be observed that communication on Twitter is strongly influenced by articles in traditional media, as mainstream media influenced Twitter feeds of the users. More specifically, newspapers are dominant on Twitter agenda, as there were 83 newspaper-links over 273 tweets.

Also, the findings clearly indicate that in newspapers reportage and photographs are dominate, rather than article view and interviews. On the other hand, the most frequent content categories in Twitter included comments, while there is a prominence of photographs and links. It seems that Twitter lead to be more participatory and better reflection of sentiments than mainstream media, as data show how deep is the citizen's dissatisfaction about Greek politicians and journalists - the most frequent content categories included "irony" or "criticism". As a conclusion, it appears that newspapers remain dominant on agenda news, although Twitter help communicate the news to a large mass of people in a short time.

Indeed, we aim at further research to analyze how Twitter is used in Greek communication between citizens and journalists, during times of crisis. To draw reliable conclusions, we have to analyze the Greek Twittersphere in more occasions to see if its constitution has changed in a significant manner.

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LIABILITIES - CRIMINALIZATION OF ENGINEERS ABOUT GREEK STRUCTURES AND ABSENSE OF SPECIFIC LEGISLATION IN CASE OF EARTHQUAKES' COLLAPSE - CASE STUDY: COLLAPSE OF "RICOMEX" FACTORY IN 1999

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Abstract

After seismic catastrophic events, justice searches the involved people's liabilities about negative impacts. The engineer is considered to be the principal responsible person. Obligations and rights of engineers are deriving from the Legislation or from Instructions in any of their role. This research answers about liabilities and criminalization of engineers, in case of failure at technical projects after earthquakes. Laws in Labor, Criminal, Civil Code and also Jurisprudence are investigated. The paper shows the serious criminalization of the profession (even from negligence), without taking into account other factors (deterioration due to time, interventions by the owner etc). In Greece, the lapse of the offense commences from the collapse of the building, from death or from severe physical injury. The non-existence of specific legislation about natural hazards is proved as the paper didn't find inside the Legislation, any references about specific conditions that influenced the creation of the damages (e.g. shock loads, crowd and duration of earthquakes etc). It is investigated as case study, the "judicial adventure" of engineers that were involved with the collapse of Ricomex Factory in Athens in 1999. The timeliness of the Judicial Decisions is documented and the final Decision of the Courts on liability and criminalization is highlighted. That Decision was without incriminating other factors (earthquake's conditions, safety of construction rules over time, etc). A review of Daily Press editions is being carried out. In conclusion, liabilities for earthquake's negative impacts are sought in the profession of engineers (who are getting heavy punishments), while there exist a lot of reasons for the collapse. Also, the Court notes that collapse is not considered to be in a causal connection with other factors (earthquake's conditions, etc). There must exist a framework of legislation specialized in earthquakes which will focus to the mentioned factors.

Keywords: Earthquake, Engineer, Liability, Ricomex

1. Introduction

The negative impacts of catastrophic earthquakes are a lot. After seismic period, the liabilities of the involved people are sought in order to provide the citizen with a Justice feeling, to correct the wrong things in legislation, technical practices, etc. Some of the involved people are engineers that always been considered to have the exclusive liability for studying and supervising buildings (Koutinas, 2004).

Obligations and rights of engineers are deriving from the Legislation or from Instructions in any of their role. Some of their roles are Designers, Supervisors, Safety Technicians, and Inspectors in Post-seismic period etc.

Internationally, some relatives of victims in the collapsed buildings, at the L'Aquila earthquake in Italy, pressed charges against participants of an Experts Meeting that took place a few days before the event in 2009 (Massimiliano S. et al, 2016). Defectlaw (2019) notes the "*Duty to Warn*" people living in a dangerous un-retrofitted building. In some countries, the earthquake insurance policy states that the insurer would pay the cost of buying another house (Gifforddevine, 2015). Directions about liabilities of businesses and owners or tenants of buildings are given by Gifforddevine (2017).

In Greece, every Building that houses many people must employee an engineer called Safety Technician. Safety Technicians, take care of the health and safety of its occupants (ELINYAE, 2001). Also, another engineer's role is the duty to estimate buildings' stability, rapidly, after performing Post-seismic Inspections. Additionally, liabilities exist for owners, manufacturers, public services and others.

This research attempts to highlight the liabilities and the serious criminalization of engineers (even from negligence), which doesn't take into account other factors (deterioration due to time, interventions by the owner etc), that contribute to the failure of a Structure after a catastrophic earthquake. Also, investigated themes are the existence (or not) of specific legislation about earthquakes, or references about particular conditions in a post seismic environment (eg shock loads, crowd and duration of earthquakes, time pressure for engineers' decisions etc), (E.P.P.O., 2001). Laws (Civil, Criminal, Labor), Jurisdiction and Limitation of Liability are focused. The paper tries to raise awareness about the absence of specific legislation for involved engineers in order the Law to be supplemented.

A case study about a real case of a building's collapse after an earthquake is investigated. Building of Ricomex Factory that collapsed in the earthquake of Athens on 7-9-1999 is focused legally. Athens earthquake was one of the most important catastrophic events in Greece. This choice (as case study) was made because of the special features of that earthquake, (eg major impacts to the country's capital, "judicial adventure" of involved parties, etc). The timetable of the Judicial Decisions is documented and the final Court Decision about liabilities is presented. Daily press is investigated and a review of publications is being attempted. Generally, justice is a time consuming process.

2. Methodology

Justice focuses on the liabilities that come from the consequences of heavy building damages, human injuries and deaths, in post-seismic period. The risks of structures exist during their construction and after their completion. Greece has attributed liabilities and rights to all involved (including engineers), based on legislation. Indicatively, Karatsolis (2011) records such Legislative Orders as Royal Decree (RD), Presidential Decree (PD), Laws(L) and Legislative Decree (LD) and Ministerial Decisions (MD)- Circulars.

It should be noted that in Greece, any governmental, judicial, etc decision should be published on the Internet via the link of "DIAVGEIA" (https://diavgeia.gov.gr/). Also, judicial websites, lawyers, are publishing legal documents (Laws, Jurisdiction, etc.)

The methodology followed in the paper was the finding of Legal Articles, Jurisprudence from the Judicial Code, and scientific publications to prove the existence of increased liabilities for engineers. It is referred as example, that when a building collapse is occurred, the lapse of the offense commences, begins from the human death or from severe physical injury. Laws, Orders etc included in Labor, Criminal, Civil Code and Jurisprudence are investigated through Internet publications of Public and Private Services.

The aim is to show (through these Legal texts) that other factors such as creep, interventions by the owner, etc. are not taken into account. Also, through the above legal literature, the search focuses to the existence or not of specific legislation on natural disasters. This legislation should include the conditions of the earthquake, and their relation with liabilities.

About the methodology that is followed in the case study (earthquake in Athens in 1999), an online search of Court Decisions about the case of Ricomex Factory collapse is carried out and is searched the attribution of liabilities. Also, a review of Daily Press editions about the collapse is being carried out. The timeliness of the Judicial Decisions is recorded and is focused to the final Decision on Liability. It is investigated if other factors (earthquake's conditions, etc), were taken into account in the decisions on the award of liabilities for the incrimination of engineers.

3. Liabilities –Criminalization of Engineers

According to the Court Laws, when an earthquake occurs, there exists ***liability about Tort Practices***, for the death of people due to the collapse of a building. The reasons of a collapse may be: a) violation of the rules of building, b) violation and non-application of the static studies (assuming that they are correct and perfect), c) negligent behavior of the supervising engineer. Liability about unfair practices will exist only if the human fault has the following characteristics: a) there exists a human behavior b) it is unlawful c) it causes bad effects d) it causes damage and e) if it exists a causal link between the perpetrator and the damage (Fotopoulou, 2018a).

The liabilities of engineers are determined by Civil and Criminal Laws (Boudiklaris, 2011). Technical Associations of engineers, as Technical Chamber of Greece ("TEE"), have analyzed the mismatch between legislation and real needs, the criminal liability of engineers, by their Legal Council (TEE, 2006).

3.1 Civil Code (CC)

The Basic Principle is: "Anyone who is harming someone else illegally and wrongfully has an obligation to compensate him" (Law 914 CC). The compensation is a pecuniary penalty. It concerns the liability associated with negligence, error or omission. An obligation to rectify the damage caused to any influenced person is created. Damage may be personal injury / death, material damage and consequent financial loss.

There is employers' liability towards the workforce. In the case of work contracts, liability is determined by the stipulations signed by the project cooperating parts (contractual obligations), (Technical, 2008). Basic articles on the usual activity of engineers in relation to construction, and their liabilities, are: Article 681CC, 685CC, PD696/1974 and LD17/7-16-8-1923. Also, there exist specific Articles without references to earthquake factors as Article 698CC about Liability for project risk and Article 925CC about Liability for damage to a third party due to a partial or total collapse of a construction (Boudiklaris, 2011).

The most important orders of the Civil Code related to the event of an accidental occurrence (including earthquake) are:

3.1.1 Article 925CC**:** *Liability of building collapse*

"The owner of a building or another construction that is connected with the land, shall be liable for the damage caused to anyone else because of its total or partial collapse, unless it proves that the fall is not due to defective construction or poor maintenance". However, the owner is not relieved of liability when a natural event, (eg earthquake) was the reason for the inadequate maintenance of the construction (Margaritis, 2017).

b) Article 932CC**:** *Satisfaction of moral consequences*. It is activated usually after a building's collapse (including earthquakes). The Court may award a pecuniary satisfaction for moral consequences, irrespective of the compensation for property's damage. This applies to the person whom health, honor or ignorance was influenced or his liberty was deprived. In the case of a person's killing, this financial satisfaction can be awarded to the victim's family because of non-material damage suffered.

3.1.2 Labor Law Orders

In accordance with Presidential Decree 1073/1981 and Law 1396/83, when technical works are done, the designer and the supervising engineers share the liability for the applying of safety measures about the protection of workers and anyone else. Health and safety measures are published by ELINYAE (2001). According to these Laws, there exist plenty of Internet publications about legislation on constructions safety measures, the obligations of the contractor, the developer and the supervising engineer, etc. (ELINYAE, 2018). It's a legal framework which consists of obliges for engineers (having as result their criminalization) but without references to earthquake conditions.

As it is proved there exists a framework of legislation that obligate engineers to compensate a pecuniary penalty, when they are guilty for risks, collapses etc. At Civil Code Laws the earthquake is referred indirectly without any reference to the earthquake's conditions (duration etc) or to any factors that influenced the collapse (as creep of the structure etc). For example, a long duration of earthquake shock may collapse the structures while they would probably not be collapsed undertaking short durations. Both Civil Laws and Labor Law Orders don't include specific Orders that take care of the liabilities' allocation due to earthquakes.

3.2 Criminal Code (CrC)

Fundamental principle: *"Everybody that, damages someone deliberately, by deceit or by very great negligence must be punished". It is not enough criminal persecuted person to compensate someone but he is punishable also by imprisonment (or* pecuniary penalty*) depending on the orders of the law.* In particular, it is investigated whether the offense is negligent or deceitful (Milonopoulos, 2011). Basic articles on the usual liability of engineers in relation to constructions are as follows (Boudiklaris, 2011), but exist uncertainties, in case of earthquakes:

Law / Article of CrC	**Caution / Result**	**Punishment**	*Uncertainty, e.g.*
Article 286 CrC "*Violation of Building Rules - Criminal Liability*"	*s.o. acts (intentionally or negligently) during the direction or execution of buildings, in spite of the commonly recognized technical rules. Risk to human life or health*	*imprisonment for up to 2 years*	If a dropping element of the building (in case of earthquake) caused harm *negligently or not*
Article 299 CrC § 1 <u>manslaughter intentionally</u>	*s.o. killed another people, intentionally. "Positive" action or by omission removal of human life*	*imprisonment of all his life*	If it was *"positive" action* that an engineer follows rules of another period that the rules were not so safe as today
Law 2331/1995 (Article 20). Amendment of Article 286 CrC	*s.o. acts <u>intentionally or through negligence</u> during <u>Building Studies</u>, during direction or execution of a building project (or other similar work or demolition), in spite of the commonly recognized technical rules and thus constitutes a danger to human life or health"*	*imprisonment until 2 years*	Punishment for engineers *even in the stage of the Building Studies*, having a lot of uncertainties as the consideration about the probability of an earthquake in the future
Law 4315/2014 (Article 13). (Law 2331, 1995)	s.o. acts in spite of the commonly recognized technical rules, *<u>in the stage of a study</u>* or during the management or execution of a building or during actions of other similar works or demolition	*<u>imprisonment of</u>* *<u>a) 1-5 years</u>* and a pecuniary penalty (creation of risk) b) *<u>up to 15 years</u>* (serious bodily injury) *<u>c) 10-15 years</u>* (creation death) d) <u>for all his life</u> (creation many deaths) If the action is caused by *<u>negligence, the punishment is up to 2 years</u>* or a pecuniary penalty	Similarly to above
Article 434 CrC. "*Breach of*	s.o. violates rules about health and safety for constructions and	*detention or pecuniary penalty*	If there is *prevention of all risks* in case of

building regulations"	does not *<u>prevent of the risks</u>* which may arise. Actions at the period of construction or demolition that causes harm *<u>negligently</u>*.		earthquakes. The factors that contribute to the collapse are too many.
Article 458 CrC	*<u>s.o. intentionally violates imperative or prohibitive rules of administrative Laws</u>*	*imprisonment of up to 6 months* and / or by a pecuniary penalty	Arbitrary constructions have not Building Permission. Must it be punishment in case of earthquake?
Article 458A CrC *"Infringements of EU regulations*"	Infringement by intention of sanctions or restrictive measures about EU regulations	*imprisonment of up to 2 years*	If there exist mismatching about laws with EU, the uncertainties because of earthquakes will be multible
Article 302 CrC	Negligent manslaughter	*imprisonment at least 3 months*	Many people with different liabilities react for the construction of buildings
Article 314 CrC	Physical Injury by negligence	*imprisonment up to 3 years*	Similarly to above

Other interesting articles about responsibilities and liabilities of engineers (that have not any reference about the earthquake's conditions), are the following Articles: 197CC, 288CC, 198CC, 534CC, 914CC, 928-932CC, 28 CrC, 386CrC and the Laws: 1599 /1986, 1337/1983, 1396/1983 (Article 9), and 3850 / 2010.

As it is proved, there is a framework of Laws for hard punishment of engineers (even at the stage of the Building Studies) without taking into account earthquake conditions. There is no Law in Criminal Code that takes care of the liabilities' allocation due to an earthquake.

3.2.1 Limitation of Liability

Article *286 CrC*, mentions that Criminal Liability does not start from the time when the perpetrator acted (or ought to have acted), as defined for all crimes (Article 17 CrC). It starts from the day on which the offense was committed, either by deceit or by negligence. This fact puts the engineers and their heir's lifelong hostage, as the limitation of civil claims is the same just like a crime (article 937 CC § 2) (Technical Chamber of Greece, 2006).

Other interesting articles about heavy punishments for engineers for a long time are the following Articles: *693 CC*, *937 CC*, *111 CrC*, and the Laws: *2331/1995, 4315/2014* (Article 13), and *289CrC.*

As it is proved, Laws about limitation of liability punish engineers almost for all their lives. The lapse of the offense commences from the collapse of the building, (from death or from severe physical injury). These Laws shows the serious criminalization of the profession (even from negligence), without taking into account other factors (deterioration due to time, interventions by the owner etc).

3.2.2 Jurisprudence

It is stated in Case-laws that the engineer who supervise and construct a building project must check and complete the deficits of the project, or to stop executing the project. This process is regardless of arbitrary constructions or the correctness of building studies, or any failure to apply the studies, or whether or not the studies were actually verified by the competent Urban Planning Department. The engineer must inform the owner of the building about the danger. An interesting case is the Decision of the Supreme Court with no.

603/2015 stating that "*the manufacturer is liable only for manslaughter or personal injury ... which is not a “positive act” ... but by failing to avert the risk*" (Katras, 2015). Other interesting Decisions of the Supreme Court are reported by Sakkoulas, (2018), (Supreme Court, 2018).

As it is proved, there is jurisprudence that punishes engineers because they failed to avert the risk. The punishment is extremely hard as they *will be judging for manslaughter or personal injury*. There is no legislation that associates the liabilities’ allocation due to earthquakes’ conditions or other factors with specific Jurisprudence.

3.2.3 Uncertainties about liability

Below, there are some typical examples of the uncertainties that exist about liability. Manufacturer's liabilities and criminalization are searched usually at Jurisprudence instead from legal orders. It is noted that there is not any legal framework about manufacturers of private projects. Suppliers of products are not almost checked about compliance with specifications at their products. Liabilities are existed for owners as Article 7 of PD305 / 1996 mentions that if exist coordinators in a Technical Project, then the commanders are not relieved of their liabilities. Critical issue is the cause of the building collapse, but not the behavior of the owner of the building. The issue of proof is not how the construction was built but what is the reason for the collapse (e.g. bad construction or maintenance) (Decision 3747, 2011).

In addition to the existing and constantly enriched legislation, there are many uncertainties to ensure if justice is properly attributed. Such uncertainties are the characteristics of the risk, the broad scope for objects of engineers in private and public sectors, the duties and obligations of all the parties involved - depending on the construction phase of the project, and the disproportionate - unilateral legislation according to the state's priorities at a certain period. Greek Justice is characterized by multiplicity and sometimes by contradiction of legislative orders (Koutinas, 2004). Politicians either selfish interventions or corporate pressures are made in legislative texts. Legislators perceive social pressures and adapt them accordingly. State agencies may be malfunctioning because of their staff lack, so then there exists little supervision to constructions. Technical projects are produced by a large number of factors that are dissimilar to each other and need to be coordinated. In this environment, the engineer acts and makes decisions having liabilities, perhaps for all his life.

Additionally, different time periods respond to different levels of safety, having as consequence laws to be delimited with data, perceptions, etc. of previous time. For example, safety of Regulation for buildings in 1959, is different with those in 1995 or those in 2000, in Greece (E.P.P.O., 1999), (E.P.P.O., 2000). Characteristically, in "Kanepe" Intervention Regulation for damaged buildings, it is mentioned that the existing structures: “*reflect the degree of knowledge during the time they were studied and constructed, possibly containing inaccurate errors, and may have undertaken unknown strains and effects. Also in the same Regulation it is assumed that a certain probability of failure is acceptable, for new constructions. The uncertainty level and the probability of failure are increased by adding the uncertainties involved in existing structures especially from the study phase of them. These uncertainties must be taken into account when defining the obligations and liabilities of project stakeholders "(E.P.P.O., 2017).*

Random Events are not due to offense (fraudulent or negligent). “*Force majeure*” is included in the broad sense of the incidents of chance, which establishes a deviation from the central principle of Laws about Faults (principle of liability). “*Force majeure*” refers to a case of a sudden, irresistible and unpredictable incident that is impossible for human forces to prevent it, even with measures of extreme diligence and prudence of average person (Fotopoulou, 2018b).

As it proved, there are a lot of uncertainties beside Laws and jurisprudence that punishes hard engineers but they are not the only responsible for the damage. These uncertainties allocate liabilities unequally during and after the construction. Court Decisions perhaps are not correct, because of them. A new framework of legislation must be adopted so as to include them.

4. Case Study: Criminalization of engineers –Liabilities from the collapse of the RICOMEX Factory at Athens’ earthquake in 1999

In Greece, Municipalities have the liability to issue Building Permissions. The Building Permission lasts 4 years for usual buildings and can be revised without time limits, in case of addition, removal or changes to a part of the construction (ecopress,2019). There exist rules about the height of the building to each area of the country and about the percentage of the area that would be constructed according to the plot of the owner of the area. The owner of the plot employ an Engineer so as to create (Architectural, Static, etc) Studies of the building. The study of the ground resistance is not necessary for simple buildings. Also, he employs a Construction Company or a worker to apply the Building Studies. The Engineer owes to supervise all the works about the building. At the end of works, he certifies that all the works carried out, as the Building Studies described. In the past, the need of sheltering pushed people to construct structures without Building Permission. In the framework of city's household, the government allows, sometimes, inhabitants to permit legalization of their arbitrary structures. This procedure requires the payment by the owner and is carries out under specific conditions (Law 4495/2017, Law 4178/2013, Law 4014/2011, Law 3843/2010, Law 3775/09, Law 1337/83, Law 720/1977).

On September 7, 1999 at 14:57, a very powerful earthquake (magnitude 5.9 Richter scale) struck the Attica Basin (E.P.P.O., 2018). It was the deadliest earthquake that has taken place in Greece over the last 50 years (Wikipedia,2018). Acropolis and other monuments of Athens either remained intact or suffered minor material damage. Parthenon and Erechthion were undertaken a slight rotation of some columns. Several of the 19th-century stone-buildings were not damaged. The central Church of "Mitropolis" in Athens had to be restored. The earthquake caused significant damage to Monuments as "Daphne monastery" and "Castle of Fyli" (ToVima, 2018).

Collapses occurred to buildings, including factories, a block of flats in New Philadelphia-City etc. Technical representatives of Super Market DIA and Continent (department stores) were accused, and the Court had acquitted them. The owner of FIALOPLAST Factory (with three died women) was found guilty of negligent manslaughter, and had punishment of eight-month imprisonment, (but died before). Four defendants were acquitted for the collapse of FARAN factory (where four people died). The offenses were deleted for the collapse of a block of flats in Psichari Street, in Metamorfosi-City (where 8 people died).

At FOURLIS factory, were died 6 people, the owner, civil engineer and architect were accused for manslaughter intentionally, with a possible deception, in 2001. A deliberation by the Counterfeiting Council ceased the persecution of them. The reason for stopping the prosecution was because of the limitation of the offenses (twenty years have elapsed from the erection of the building). That is, the Court applied Article 111 Code of Limitation on a Deceitful Act and not Law 2331/1995 on Limitation from the day of the offense (which was the most recent). (Kathimerini, 2001b)

Ricomex Factory involved to the collapsed buildings having 39 workers died (2 of them were pregnant women). During 1969-1999 too many changes took place to the building of Ricomex. Some of them were Building additions at height and at recess, arbitrary and unplanned extension of the semi-floor, arbitrary of warehouses, sheds, etc, and arbitrary of C' Basement underground applying excavation of the stream of Chelidonous. Large fire occurred in 1993. Later, an architect engineer was employed, for repairing only the steel structure. Meanwhile municipality of Ag. Paraskevi's Urban Planning was compiled inspection and recorded the arbitraries of the construction.

Many urban planning offenses in the Ricomex building involved engineers. In these violations, there was sometimes organized intervention (eg study). The engineer was not the only one that caused changes in the building's stability (eg fire, arbitrariness). But, after the building collapse, the engineers were the first people to be liable.

4.1 The Performance of Liabilities - Criminalization

After Athens' earthquake in 1999, the Commission of Ministry "YPEHODE", for investigating the Causes of Collapse reports that there have been great violations of legislation.

Criminal Liability: Articles 286 CrC (§1), Article 1 of PD 778/1980, and Article 7 of Law 1396/1983, in conjunction with No. 3046/304 / 30-1 / 3-2-1989 Decision of Ministry "YPEHODE". The engineer involved in the steel structure, was initially accused by the court, as it was considered to be a dangerous arbitrary addition of the building, for which he acted in fact as a supervising engineer. He was therefore *legally obliged to ensure compliance with safety standards* and to prevent the execution of dangerous works. It was considered that these works, caused death or injury to life and health of third parties. In particular, the Court of Appeal Decision at no. 8945/2003 Decision (9/7/2007) states: "He (the engineer) also contributed to the collapse of the building ... and to the workers' death." Afterwards, they were acquitted in the Supreme Court.

4.2 Civil Liability

Wikipedia (2018) reports bankruptcy of the company, asset seizures, indemnities for psychological distress, disputes between the bank and relatives of the victims (about ranking in the compensation list) etc. It is interesting that the court decision states: if the victims must be compensated by auctioning, *the Bank would suffer irreparable damage*! (Eleftherotypia, 2011). The case had been judged by all levels of Justice as well as by the European Court of Human Rights (Kendristakis, 2016). Among others, the following important Judgment Decisions about engagement of engineers were issued: Decision of One-Member Court of First Instance of Athens 2344/2002, Decision of Court of Appeal, Athens 8945/2003 and 6858/2006, Decision of Supreme Court 835/2006 and 3/2011 at plenary session.

The final Civil Decision 2692/2009 Council of State states that the competent Town Planning authority did not check the completeness of the structural design and studies submitted and did not carry out even an inspection until completion of the building. Thus, the State was responsible for unlawful omissions and actions of its Bodies (Menoudakos, 2014). The Prefecture must compensate the victims for € 18 million. In 2012, the Regional Council of Attica decided to pay for the relatives of victims (Wikipedia, 2018), (Region of Attica, 2014).

The Final Decision (Decision of Court of First Instance of Athens 12150/2011) states that: "... *the collapse of the RICOMEX building and the death of the applicant's family member is in a causal connection with the illegal acts and omissions of the competent bodies of the Town Planning Service in Acharnes-City when they used the public authority entrusted to them. Also, the causal link is not interrupted by a force majeure. The decision claimed that it was not the intensity of earthquake that contributed to the collapse of the building (since it was possible with less vibration), but its unlawful construction*". Thus, the Region of Attica was issued the Decision 2534/2014 for the payment relatives of victims" (Region of Attica, 2014).

Apart from Judicial Decisions, newspapers and news websites of that period recorded the course of Justice Performance. Indicatively, such publications are named at *References/Magazines, Newspapers, Information sites of Internet*.

It seems clear that liabilities are sought between the engineers (private or public sector). Moral consequences due to their involvement are great in case of human victims. The improper construction of the building was not purely due to one engineer or one factor. The seismic conditions and parameters (size, intensity, etc.) are not blamed, but the Court considers them to be independent of the illegal actions and omissions of the construction. So under the existing legislation, the Courts do not take into account the earthquake, during the incrimination of engineers.

5. Results - Conclusions

Framework of Laws specialized in Earthquakes doesn't exist (eg including the "Duty to Warn" occupants living in unreinforced building, insurance policy etc). The Framework must also focus to any other factor that contributes to building damages. Legislators must focus, record and incorporate the seismic parameters and factors that may affect the construction. Such seismic parameters may be the magnitude, intensity, duration of the earthquake, etc. Factors that may affect the construction may be the absence of standardized procedures, (eg standard contracts), the periods of study and construction, the materials of construction, creeping interventions etc. Problems may be verbal agreements, non-existence of inspection of ground resistance etc. Specific legislation is needed.

The accused engineers are not the only responsible for building collapses. Legislative determination of responsibilities and liabilities of each involved is required. There must be a Legislative Review of the limitation period, which today starts from the occurrences of death or serious bodily harm!!! It is considered to be practically an inalienable crime. There is unfair and unequal criminalization of the profession of engineer (even if in case of negligence), without taking into account other factors. Of course, allocation of liabilities must be particularly cautious, due to many uncertainties in a construction.

Regarding the Legal Process, Legislation and continuous Safety Checking is required. Other issues are marking and removing risks, mitigation of damaging effects of structures, the involvement of political power in decisions etc.

About the collapse at Ricomex's factory in 1999, engineers were among the first to blame. Civil liabilities were assigned but criminal liabilities were not existed. According to the criminal judgment, all of the 33 accused for the collapse, were acquitted of the accusations, despite the absence of specific legislative framework. The Public Sector (Prefecture) was obliged to indemnify the relatives of the victims for civil liability. Justice is a time consuming process, which afflicts (especially mentally) those who involved.

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RESILIENCE OF INFRASTRUCTURE IN THE ENERGY SECTOR TO NATURAL HAZARDS AND CLIMATE CHANGE

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Abstract

A natural disaster can cause loss of life and property, damages to the natural and built environment and economic and social losses whose severity and size depends on vulnerability, adaptability and the ability to recover. This study attempts to link the concept of resilience of infrastructure projects, with the risk of natural hazards as earthquakes, tsunami or even sea level rise due to climate change. Initially, the concept and objectives of the resilience of energy infrastructure projects are presented. Next, a simple methodology consisting of four steps to quantify resilience of critical infrastructure in the energy sector is demonstrated. In this methodology resilience is measured in terms of risk. The methodology is applied on a case study of a coastal power plant in an island in the Eastern Mediterranean Region. The region faces many types of disasters, e.g. earthquakes, landslides, tsunami, future sea level rise. Energy supply and rehabilitation costs are used as indicators to quantify risk. Based on the results of the case study, it can be concluded that resilience assessment can be a useful tool in prioritizing mitigation actions to minimize the likelihood of a disaster and its consequences, either by reducing the probability or magnitude of an event or mobilizing the appropriate means to overcome the threat. This work is a preliminary approach in the development of an integrated methodology for quantifying the resilience of critical infrastructure against multiple natural hazards.

Keywords: resilience, risk assessment, seismic hazard, tsunami hazard, sea level rise, climate change

1. Introduction

The severity and frequency of natural disasters have steadily increased in recent decades, partly due to climate change, urbanization, population growth and environmental degradation. Burton and Kates (1963) described natural disasters as "those elements of the natural environment which are harmful to man, coming from outside of him”. According to a qualitative definition of broad acceptance, a natural disaster is a serious, large-scale, adverse event as a result of natural processes of the earth and the biosphere. Typical examples are floods, volcanic eruptions, earthquakes. A natural disaster causes loss of life and property, injuries and health problems, damages to the natural and built environment, and in most cases leads to economic and social losses, whose severity and size depends on vulnerability, adaptability and the ability to recover (Sapoutzaki and Dandoulaki, 2015). Europe is a densely populated and economically developed continent, which means that in the event of disasters, the effects can be truly devastating and cause great financial damage. (COM/2014/0216 final, 2014). Social and economic impact of natural disasters is constantly increasing. With the advent of science and technology over the past century, natural hazards can now be understood and measured, but cannot be prevented. However, their impacts can be reduced by appropriate disaster management and efficient use of modern information technologies. Recent climate change also leads to an increase in the impact of various environmental hazards associated with atmospheric and hydrological phenomena. Economic and environmental changes at global and regional level threaten to create new risks and strengthen existing ones such as landslides, floods, heat waves and droughts. Governments and International Organizations have been involved in a race to stop and curb the trend of increasing the impact of natural disasters through strengthening research, improving technological equipment and shaping policies that exploit and to make the most of the new developments in all three stages of natural disaster management, namely the pre-catastrophic, catastrophic and post-disastrous levels.

The results of scientific research have shown that extreme climatic changes, as well as natural disasters, can greatly affect life, functionality and security of critical -both for the state and its citizens- infrastructure (Boin and Mc Conell, 2007, Cannon et al., 2013), such as energy and transport, the urban environment and construction, shipping, and networks. Severe disruptions of vital infrastructures have enormous social and economic repercussions. The Scientific Council of European Academies has estimated an increase in damage costs of 60% due to the extreme weather conditions in Europe for a period of 30 years, with critical infrastructure accounting for the largest share of economic losses. (Sfetsos, 2016). The European Critical Infrastructure Directive 2008/114 / EC (Official Journal of the European Union, 2008) on the identification and designation of European Critical Infrastructure and on assessing the need to improve their protection, focuses especially on the energy sectors (electricity, oil, gas) and transportation. To perform efficient decision making on the protection of existing critical energy infrastructure their resilience against “expected” and “emerging” natural hazards should be assessed.

Generally, resilience is the ability of a system to react and recover from unpredictable disturbances and events as opposed to the system's ability to have an acceptable low probability of failure for a given function and specific operating conditions. Since reliability, at least indirectly, limits the focus on a given set, the term resilience is therefore preferred in situations where there are any kind of stresses and disturbances to be taken into account. (Hokstad et al., 2012). There have been several research efforts to provide methodologies to quantify risk in infrastructures (Giannopoulos et al., 2012; Salzano et al, 2009) and to measure their resilience.

The purpose of the present research work is to demonstrate a simple methodology to quantify resilience of critical infrastructure in the energy sector based on a case study of a coastal power plant, located in an Eastern Mediterranean Region island. Eastern Mediterranean European countries have a high degree of diversity in their cultures, protocols and their social and political development. Societies and economies are in transition, making the area vulnerable to natural disasters and particularly interesting for investigation. The region is facing many types of hazards, constantly (earthquakes), rising (floods) and potentially (landslides, tsunami, future sea level rise in islands and coastal areas). This work is a preliminary approach for the development of an integrated methodology for quantifying the resilience of critical infrastructure against multiple natural hazards. The main goal is to assist in prioritizing mitigation actions that should be taken when addressing natural hazards to minimize the likelihood of a disaster and its consequences, by reducing the probability or magnitude of an event or mobilizing the appropriate means to overcome the threat.

2. Risk Assessment Methodology

Risk assessment is the process of observation, identification and monitoring of the risk in order to determine its dynamics, origin, characteristics and behavior. The aim of infrastructure risk assessment is to recognize the intensity and possibility of occurrence of a phenomenon or event, along with its impact on the infrastructure. In spite the fact that natural disaster risk cannot be eliminated, it can, however, be assessed to provide valuable information for the resilience of the infrastructure and for reducing their consequences. The main threat to infrastructure and, consequently, to the energy sector, stem from extreme weather events (rainfall, storms, extreme temperatures, heatwaves, cyclones, floods, landslides, muddy landslides). A methodology to address these risks is presented in the following section. Although, the application that is demonstrated is limited to one facility, the framework of the methodology could be applied to different types of infrastructure and hazards (e.g. Na-Tech).

Figure 1 presents the flowchart of the methodology; it follows the pattern of other well-established risk assessment methodologies (FEMA, 2001).

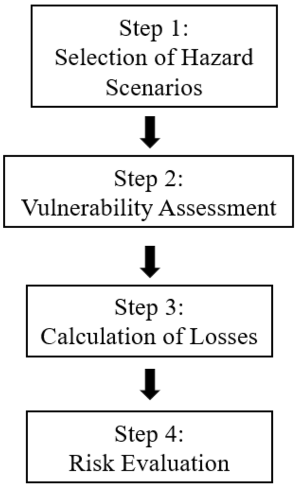


Figure 1: Flowchart of Simplified Risk Assessment Methodology

The methodology consists of four steps. The first includes hazard analysis that is conducted based on code provisions, historical data, model simulations and future projections for hazards that depend on climate change. The second step is referred as vulnerability assessment. Vulnerability is defined as the ability of a system to predict, cope, resist, and recover from the effects of a disaster, that is, a concept that expresses the vulnerability and susceptibility of a system when it is affected by a stimulus or action. In the presented methodology vulnerability is assessed by using damage states and threshold values from literature. Since vulnerability depends on the nature of the hazard, the investigated infrastructure has variable vulnerability for the different types of hazards. The process continues with the third step that is the calculation of losses. Since the methodology used herein focuses on critical energy infrastructure losses connected with power supply are taken into account. As it will be shown in the next section, this parameter is a more preferable indicator for the resilience of the critical infrastructure instead of solely considering rehabilitation costs. The methodology concludes with the risk evaluation, which is the interpretation of combining the selected hazard scenarios, vulnerability and loss estimation.

3. Coastal Power Plant Case Study

The objective of this section is the exploration of the resilience of an autonomous power plant in Paros Island in Greece located in the Eastern Mediterranean Region. The reason for the selection of this case study was the exposure of the station to multiple natural hazards: the seismic hazard, tsunami and sea level rise due to climate change. The case study is indicative also for other applications in similar power stations in coastal regions.

3.1 Description of the station

Figure 2: Paros Power Plant Station is a coastal station, exposed to natural hazards that will be analyzed later on.

Building (A) of the original Plant Station was built in 1975, is made of reinforced concrete and is statically independent of the buildings (B,C) that was built as an extension in 1984. The buildings have a basement that is 2.30m high and is located 1m above sea level. The maximum building height is 9.5 m. Power generators are located at the ground floor of building A and the transmission substation is located at the basement of buildings A and B. Those utilities are critical for the operation of the station. Resilience of the power plant buildings complex is explored based on the simplified methodology presented in the previous section. It is noted, that this case study is a preliminary approach for the development of an integrated methodology for assessing resilience of energy infrastructure to multiple natural hazards.

Figure 2: Power Plant Station (source Google Maps)

3.2 Resilience to seismic hazard

In the present study two seismic hazard scenarios are selected to assess the resilience of the power plant station. The first scenario corresponds to Seismic Zone I as defined in Eurocode 8-Part 1 (CEN 2004) Greek National Annex, which is region's zone. For this Seismic Zone, the seismic spectrum is developed for a=0.16g with a return period of 475 years. The second scenario considers increased seismic intensity, Seismic Zone II, 0.24g, that corresponds to earthquakes beyond the design level.

To assess vulnerability, damage levels are obtained by the damage states defined by Hazus (FEMA, 2001) (Figure 3). In particular, the threshold values for each damage state are shown in Table 1. It is noted that the inadequate design level is considered since the buildings were build at least 30 years ago and present already ageing and corrosion damages. To estimate physical damages in the buildings seismic analysis results for two earthquake directions, longitudinal and transversal and for the three statically independent buildings were used. Analyses were conducted for both the selected seismic hazard scenarios. The analysis results are shown in Figure 4. In Table 2, the vulnerability of the power plant buildings is demonstrated for the selected seismic hazards scenarios. It is shown that medium and extensive damages are expected for seismic scenario I and II respectively. Only the third building will experience light damages in the transverse direction for seismic scenario I.

Figure 3: Damage Levels (FEMA, 2001)

Damage (Drift)			
Slight	**Moderate**	**Extensive**	**Collapse**
0.0050	0.0080	0.0200	0.0500

Table 1: Threshold values for the selected damage states

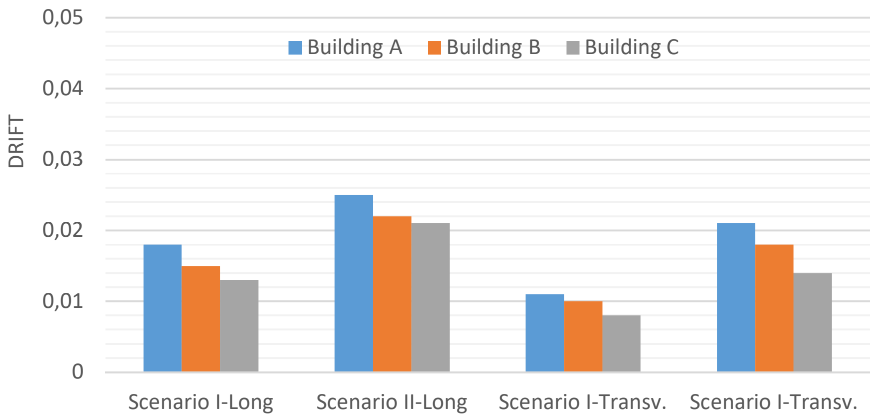


Figure 4: Analyses results

Longitudinal Earthquake Direction

Seismic scenarios	No	Slight	Moderate	Extensive	Collapse
I			A,B,C		
II				A,B,C	

Transverse Earthquake Direction

Seismic scenarios	No	Slight	Moderate	Extensive	Collapse
I		C	A,B,		
II			B,C	A	

Table 2: Physical Damages in Power Plant Station

Since physical damage cannot be the only indicator of the power plant station's resilience, two parameters are selected. The first is the loss of power supply after a seismic event and the second is the restoration of the building as a percentage of the construction cost of a complete replacement of the station. It is noted that in this particular case, where the island's electricity network is directly dependent on this energy source, a conservative approach to the resilience of the entire island's electricity network is the assessment of the station's resilience. Due to limited data, a rough estimation of the station's losses is attempted. The energy loss is calculated based on bibliographic references and the characteristics of the particular station. The rehabilitation costs are derived from Hazus methodology (FEMA, 2001). Table 3 shows the respective losses expected for each damage state expressed in the percentage of energy supply loss and rehabilitation cost.

Damage level	Energy Loss (EL) (%)	Rehabilitation Cost (RC) (%)
No	0	0
Slight	10	2
Moderate	60	10
Extensive	80	50
Collapse	100	100

Table 3: Losses for each damage state for seismic hazard

To account for total system (three buildings) losses, two weighted equations for the two resilience indicators were used. The assumption on the weight factors of each building is based on the importance and size of the building compared to others in the complex.

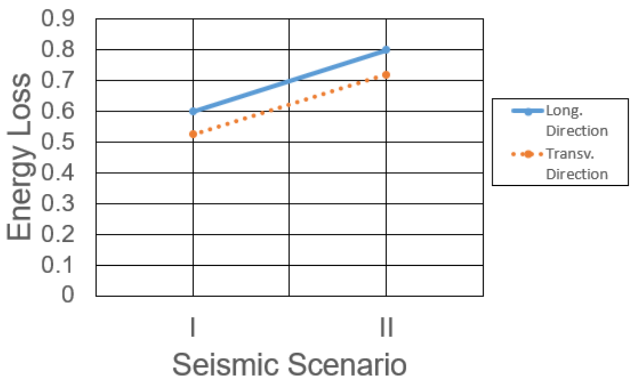
The first to locate the power loss:

$$EL\ (i) = CA \times EL\ (Ai) + CB \times EL\ (Bi) + CC \times EL\ (Ci) \quad (1)$$

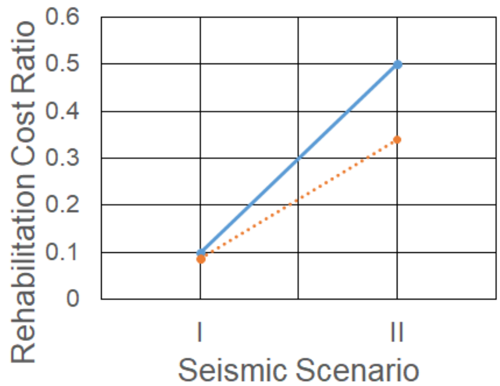
$$RC\ (i) = CA \times RC\ (Ai) + CB \times RC\ (Bi) + CC \times RC\ (Ci) \quad (2)$$

Where CA is the weight factor for building A equal to 0.6, CB is the weight factor for building B equal to 0.25, CC is the weight factor for building C equal to 0.15 and Ai, Bi, Ci is the loss measured for A, B, C building, respectively, for each investigated scenario.

In Figure 5, loss estimation for the seismic hazard is presented. It is calculated that island's energy loss can reach up to 80% of the total supply, while the rehabilitation costs rise up to 50% of the total cost of building replacement. Risk can be considered in three levels: low (0-0.33) which is the acceptable level, medium (0.33-0.67) and high (0.67-1). It can be concluded that, when the energy supply loss is considered, the power plant faces medium and high risk for scenarios I and II respectively. According to these calculations, the power plant lacks resilience to seismic hazard and further mitigation actions are needed. When rehabilitation cost is considered it is observed that risk is under estimated.



(a)



(b)

Figure 5: Losses due to seismic hazard a) Energy supply Loss, b) Rehabilitation cost ratio.

3.3 Resilience to tsunami hazard

The location of the power plant close to the coast triggered the investigation of the resilience against the tsunami hazard. It is a fact that no tsunami of large height has been recorded in the region in the last years. The last was recorded in the 1950's after Amorgos earthquake (Okal et al., 2009). However, there have been some research studies that simulate tsunami generation in the Eastern Mediterranean (Tinti et al., 2005) (Gogou, 2017). Based on these studies and on the topography of the area, two tsunami scenarios, one of low inundation height and the second as a worst case scenario, are selected for risk assessment and resilience evaluation (Table 4). Vulnerability is taken conservatively and it is assumed that if the height of the tsunami reaches the altitude of the basement, the operation of the station is stops completely.

Tsunami Hazard Scenarios	Inundation Height at the power plant
Ts. I	1m
Ts. II	20m

Table 4: Tsunami Scenarios

In Table 5 physical damage levels are adopted as a function of the inundation height (in m) in the flood zone according to Gardi et al. (2011).

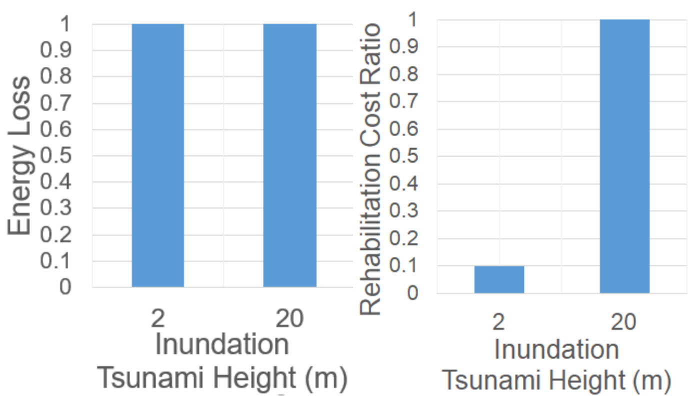
Damage level	Height of water (m)
No Damage	0
Light	0-3
Moderate	3-6
Extensive	6-9.5
Destructive	9.5-12.5

Table 5: Levels of damage due to flooding

Table 6 shows the energy supply loss and rehabilitation costs for each damage level. The energy loss ratio is determined based on the operational characteristics of the particular power station. To estimate the costs expected from the impact of the tsunami on buildings, it has been taken into account that no strong, harmful tsunami has affected the Mediterranean region over the past 60 years and therefore there is no data available on the damage to buildings. Thus, for the cost of replacing buildings due to tsunami damage, the cost of earthquake damage is considered as an assumption. The total system losses are calculated by using Eq. 1 and 2. The results are shown in Figure 6. According to these calculations, for both cases the power station's loss of operation is 100%, while the cost ratio for rehabilitation differs. It is highlighted that risk is underestimated also for tsunami hazard. Based on the results it can be concluded that the power plant faces high tsunami risk, although rehabilitation cost ratio underestimates it for the first tsunami scenario. Therefore, the power plant has low resilience to tsunami hazard, as well.

Damage level	Energy Loss (EL) (%)	Rehabiliation Cost (RC) (%)
No	0	0
Slight	100	2
Moderate	100	10
Extensive	100	50
Collapse	100	100

Table 6: Losses for each damage state for tsunami hazard



(a) (b)

Figure 7: Losses due to tsunami hazard a) Energy supply Loss, b) Rehabilitation cost Ratio.

3.4 Resilience to Sea Level Rise

Climate change has started to become more and more evident in the last years and its impact can be severe. Sea level rise in coastal regions is a critical threat that can cause serious operation issues to coastal infrastructure. The Bank of Greece Report (2011) states that forecasts of sea level rise in coastal areas in Greece up to 2099 range from 0.2 m to 0.59 m while more extreme projections reach 1.5 and 2 m. These projections are used in this case study to estimate the resilience of the power plant. Damage levels adopted are the same adopted for the tsunami hazard. Only energy loss is used as resilience indicator, since rehabilitation cost for sea level rise, which will lead to a permanent new situation, is more complicated and difficult to assume compared to costs after an extreme event like earthquakes or tsunamis. Figure 8 presents the resulting losses to power supply. It is evident that the risk that the power plant faces for sea level rise height larger than 1m is high. In order to increase power plant's resilience to climate change, immediate actions should be taken. The mitigation actions may include either the protection of the specific infrastructure, or the selection of different pathways to provide energy to the island (with the latter maybe proving more cost effective).

It has been observed that the power station has not the necessary resilience to the potential threats investigated. In fact, it should be noted that in the last years, authorities have turned to other ways for electricity provision to islands, in order to overcome such issues and other operational problems.

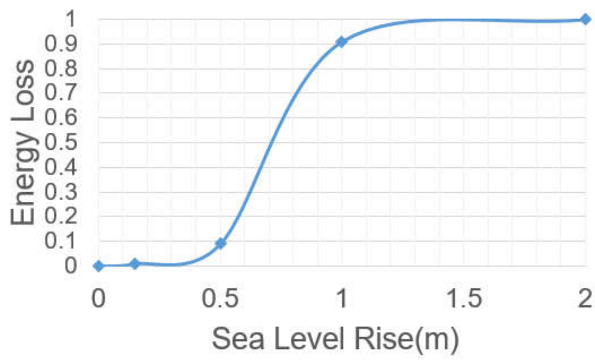


Figure 8: Energy supply losses due to sea level rise

4. Conclusions

It is widely accepted that natural disasters are a major threat for energy sector's infrastructure. Floods, earthquakes, fires, extreme weather events, tsunamis, volcanic eruptions, and landslides are the main natural disasters that have numerous consequences on structures and their operation. Climate change further increases the impact of the natural disasters and should be considered along with the expected natural hazards in a region. Several methodologies have been developed to predict and assess vulnerability and risk to natural hazards which indicate the resilience of infrastructure. In the present study a simplified methodology is considered as a preliminary approach for the development of an integrated methodology to assess resilience of infrastructure in the energy sector. Based on the case study results, the following conclusions can be derived:

- power plant station faces multiple natural hazards (i.e. earthquake, tsunami) due to its coastal location. Climate change is expected to have severe impact in the region with a remarkable increase in the sea level. Therefore, sea level rise was also included in the assessment.
- power station presents low resilience to the seismic hazard. The low quality of aseismic design with former codes and the ageing of the structural elements result in high risk to earthquakes, even for magnitude equal to the design level.
- the facility is not resilient to the tsunami hazard as well. Although such a phenomenon has not been recorded in the last years, the results should be considered in any actions taken for the protection of the station.

- When considering the projections for sea level rise, the infrastructure is found to have low resilience. Thus, measures are required to avoid operational issues when sea level rises more than 0.5 m.
- Reconstruction cost underestimates the actual losses and risk that the infrastructure faces when compared to the energy supply loss.

Future studies could include a more complex approach for losses, e.g. accounting for the downtime. Structure specific fragility curves for the investigated hazards and a probabilistic approach accounting for uncertainties (e.g. material properties) could also be used in future work integrate further elements in the resilience evaluation methodology. However, the simplified methodology used here can be a useful tool for the specific station and for similar coastal infrastructure as a first approach on decision making for mitigating the negative effects of natural hazards and climate change.

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ACTION PLAN FOR CIVIL PROTECTION FOR THE REGION OF IONIAN ISLANDS

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Abstract

The Region of the Ionian Islands, on an initiative by the Regional Governor, collaborated in 2015 with the national Earthquake Planning and Protection Organization (OASP-EPPO), in order to organise an annually driven Pan-Ionian Earthquake Drill. The drill takes place on a different island of the region each year.

The first drill, code named "Telemachos 2015", took place in Zakynthos, the second in Lefkada, named "Lefkadios 2016", while last year's drill with the Homeric name "Alkinoos", was held in Corfu and was remarkably successful. P.I.N.'s (REGION OF IONIAN ISLANDS) initiatives have now been integrated into 2 innovative programs, co-funded by the EU (NSRF 2014-2020), named "TELEMACHOS" and "LAERTIS", which are run by the Civil Protection Department. "Telemachos" focused on the creation of an innovative system for seismic risk management in the Ionian Islands and includes: The elaboration of thematic maps (geological, geotechnical, seismic etc) and soil and vulnerability measurements of buildings, networks and infrastructures, as well as the development of a system to support the exchange of data between stakeholders and their processing in real time. "Laertis" includes the risk assessment of fires, floods, erosion as well as the risk of landslides and the analysis of vulnerability for all the above risks using satellite images. In the meantime, an Emergency Management System based on Wireless Sensor Network technologies is foreseen to provide emergency information to operators, as well as the production of special information material and the provision of the necessary equipment for the prevention and suppression of risks in natural disasters.

Keywords: Earthquake Drill, Telemachos program, Laertis program

Programs' Description

"TELEMACHOS". It is an innovative operational seismic risk management system of the Ionian Islands Region "included in the Operational Program" Ionian Islands 2014-2020 " co-funded by the EU (NSRF 2014-2020). The proposed act refers to the creation of an innovative system for seismic risk management in the Ionian Islands, an area characterized as seismic and tectonic as the most active in the Greek area and one of the most active in the world.

The intense seismicity of this area is attributed mainly to the presence of the transformation fault in Kefalonia and is evidenced not only by the historical but also by the recently recorded seismic activity, which includes large earthquakes with extensive impact on humans, the natural environment, buildings and infrastructure of the Ionian Islands. In more detail, the act will include:

A. The elaboration (based on the analysis of geological, seismic and other data and the use of modern innovative methodologies), various thematic maps (geological, geotechnical, neotectonic, morphotectonic, seismic, seismic risk, geodynamic phenomena) and soil and vulnerability measurements buildings, networks and infrastructures. These actions will be reinforced by the establishment of new or strengthening existing seismological recording networks and systems for the monitoring of seismic precursor phenomena and the measurement of solid bark deformation in the Ionian Islands.

B. Developing (based on the above conclusions) an innovative system for risk assessment as well as supporting the definition of data interfaces between stakeholders, facilitating their coordination, real-time data processing, standardization information process, decision making, action and recording monitoring, file creation automation and event reporting, the development of SMS information system and development national projects in the digital environment and environment Geographical Information Systems (GIS).

C. Developing / organizing business plans and pilot implementation of combined preparedness exercises addressed to all institutional stakeholders at the local level and aiming at familiarizing those responsible with processes and actions of rational management of seismic risk. The program provides for information, education and awareness-raising actions, which will be one of the main tools for the consolidation of program products and the capitalization of its results on a long-term basis.

In particular, it includes the creation and production of special informational material, training and preparation of stakeholders, designing specific actions for communication with the media, information and training of special groups of the population, and information and training aimed specifically at the tourism industry. This is a holistic approach to the management of natural-seismic risk. In all interventions eg. the development of specific Action and Emergency Plans, information and awareness campaigns will take into account the disability dimension.

Beneficiaries of the "TELEMACHOS" Program:

Ionian Islands Region	120.000
National & Kapodistrian University of Athens	430.000
Ionian University	540.000
Earthquake Planning and Protection Organization	50.000
National Observatory of Athens	69.991
Total amount	1.209.991

‘’LAERTIS" is also another innovative operational risk management system for the Ionian Islands "in the Operational Program" Ionian Islands 2014-2020 " co-funded by the EU (NSRF 2014-2020).

It includes: estimating and assessing natural risks through data analysis with innovative methodologies including geo-environmental, geological, hydrometeorological parameters, satellite image analysis and climate modeling, the assessment of the risk of fires, floods, erosion on the shore and coasts, extreme weather events and climate change, as well as the risk of landslides (shore and coast) and accidents; detailed risk and hazard maps for the entire study area, hierarchically depending on the degree of risk.

In the meantime, it will analyze the risk of crashes and study CIM's crash conservation actions. - Develop (based on the above assessment) an innovative system for risk assessment, support for coordination and decision-making (support defining data interfaces between stakeholders and facilitating their co-ordination, real-time data processing, standardization of information evaluation procedures, decision-making, monitoring and recording of actions, automation of File Creation and Event Reports, development of SMS Information System and development of business plans in digital environment and GIS environment).

In the meantime, an Emergency Management System (SDE), based on sensor wireless technology technologies, is planned to be piloted in order to immediately inform operators in emergencies (eg fires)., the preparation of proposals for "smart" interventions (anti-flood, anti-corrosion / anti-fire), taking into account the costs and benefits of the area, such as proposals for river delimitation, specific labels in hazardous areas, and targeted risk reduction or risk reduction interventions. business plans and the Pilot Implementation of Combined Preparedness Exercises, aimed at all institutions involved at local level, aiming at familiarizing them with those responsible for processes and actions of rational risk management and the implementation of Information - Education and Awareness actions, which will be one of the main tools for the consolidation of the risk but also of the results of the operation and the capitalization of its results on a long - term basis.

It is planned to create and produce special informational material, to train and prepare stakeholders, to design specific media communication actions, to inform and educate special groups of the population and to inform and educate the tourism industry as well as the supply and completion of the necessary special equipment for risk prevention and suppression operations, rescue work and assistance in natural disasters. In interventions such as the development of specific Action Plans, information and awareness campaigns will take into account the disability dimension.

Beneficiaries of the ‘’LAERTIS" Program:

Ionian Islands Region	1.421.000,00
National & Kapodistrian University of Athens	529.000,00
TEI of the Ionian Islands	
Ionian University	400.000,00
Regional Association of Municipalities of I.I.	
Technical Chamber of Corfu	100.000,00
Total amount	2.807.269,00

The Region of the Ionian Islands, on an initiative by the Regional Governor, collaborated in 2015 with the national Earthquake Planning and Protection Organization (OASP), in order to organize an annually a driven Pan-Ionian Earthquake Drill.

The first drill, code named "Telemachos 2015", took place in Zakynthos in 2015.

In 2016 took place in Lefkada named "Lefkadios 2016". In 2017 was held in Corfu with the Homeric name " Alkinoos"

SAFE KOZANI 2018

Conference Announcements

Poster Presentations

DISASTER PREPAREDNESS & RESPONSE FOR VULNERABLE GROUPS OF POPULATION: EVACUATION PLANNING OF CRITICAL INFRASTRUCTURES IN CASE OF AN EARTHQUAKE OR A FIRE FOR PEOPLE WITH DISABILITIES

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Abstract

This study examines the key aspects relevant to the evacuation of people with disabilities in emergency situations, e.g. in case of an earthquake or a fire; the latest also includes the need for evacuation due to emission of dense smoke in case of a wildland urban interface (WUI) fire. In that framework, a resume of existing work worldwide relevant to emergency preparedness and response of people with disabilities will be presented; existing legislation and standards for evacuation of buildings focusing on vulnerable groups of population will be presented. With the scope of enhancing self -protection against disaster risks and support training for minimizing them, a number of tips will be proposed for setting up "Personal Emergency Evacuation Plans (PEEPs)", focusing on vulnerable groups; people with disabilities, taking also into consideration the specific type of disability, e.g. mobility impairment, visibility impairment (blind or low vision) etc. In light of the "Universal Design" concept, the newest egress signs specifically designed for people with disabilities will be introduced and integrated for the first time in a building's "Fire Escape Plan" indicative paradigm. The education and training of people with disabilities in copying with disaster is vital, since they are considered vulnerable and potentially in danger. Taking into consideration that everybody may potentially encounter some type of temporary impairment during their lifespan, this is becoming a priority issue.

Keywords: Disaster preparedness, forest fires, WUI fires, earthquakes, people with disabilities, evacuation

1. Introduction

Natural or man-made disasters create significant risks for the exposed population and specifically for the people with disabilities since they are considered more vulnerable; it has been recorded that mortality rate of people with disabilities is two to four times higher than that of the other population, in many disaster situations [1]. This fact can be possibly correlated with inadequate response in emergency situations, such as in case of a fire or an earthquake; an emergency situation might not be recognized on time depending on the type of disability and hence, evacuation signs might not be easily recognized or located in order to safely reach an emergency exit.

Generally, a structural fire can be caused either by accident, or on purpose. However, a structural fire can also be side effect of a forest fire that occurs in wildland-urban interface zones (WUI fires), or of an earthquake due to short-circuit. In such cases, a number of risks are posed, not only due to the fire expansion, but also due to the dense smoke produced; the combustion of different types of fuel formulates a more complex and toxic chemical mixture [2]. Specifically, in case of limited oxygen concentration, such as the case of structural fires, the incomplete combustion is favored and hence, a number of hazardous compounds is produced, like carbon monoxide, fine particles and dioxins; carbon monoxide is asphyxiant by inhalation and particles can irritate eyes and upper respiratory tract, usually causing suffocation [3,4].

An earthquake is usually accompanied with a number of victims due to buildings' collapse but also other potential secondary effects, such as landslides or tsunami effects. It is noticeable that in case of entrapment of disabled people under the ruins, the search and rescue operation (SAR) is more complicated. For example, communication limitations between the rescuer and the victim during the extrication exist, especially for someone with hearing, speech or upper limb impairment, e.g. difficulty in scratching, knocking etc. so that to be located by the rescuers. It seems that early location of people with disabilities in emergency situations creates the need of investigating methods mostly based on human body smell additionally to existing rescue dogs, or chemical methods, such as the so called "electronic noses" [5].

This work is based on a recent publication prepared in the framework of the European Center for Forest Fires (ECFF) activities, which operates under the aegis of the European and Mediterranean Major Hazards Agreement (EUR-OPA), Council of Europe [6]. EUR-OPA was created in 1987 and is considered the platform for co-operation between European and Southern Mediterranean countries in the field of major natural and technological disasters. In the framework of the Council of Europe's initiatives for active inclusion of people with disabilities in disaster risk reduction, a "Toolkit for good Practice" has been recently prepared [1]; a database which gathers good practices from Member States, providing guidance and good practice examples for civil protection professionals and decision makers, disaster officers, emergency managers, organizations for people with disabilities, as well as people with disabilities and their families.

With the scope of enhancing self -protection against disaster risks and for supporting training in order to minimize those risks, a number of tips will be proposed inside this work for setting up "Personal Emergency Evacuation Plans (PEEPs)", focusing on vulnerable groups; e.g. people with disabilities, taking into consideration the specific type of disability, e.g. mobility impairment, visibility impairment (blind or low vision), etc. Moreover, in light of the "Universal Design" concept, the newest egress signs specifically designed for people with disabilities will be introduced and integrated for the first time in a building's "Fire Escape Plan" indicative paradigm.

2. Legislation and standards for evacuation of buildings focusing on people with disabilities

As known, the UN Convection on the Rights of Persons with Disabilities (CRPD) entered into force on 3 May 2008, having as a goal "to promote, protect and ensure the full and equal enjoyment of all human rights and fundamental freedoms by all persons with disabilities, and to promote respect for their inherent dignity "(Article 1) [7]. Moreover, the Council of Europe strongly supports the enhancement of equal opportunities, improvement of life quality and independence of people with disabilities [8], based on the United Nations Convention on the Rights of Persons with Disabilities (CRPD) and the European Convention on Human Rights. The last came into force in 1953, although since its adoption it has been amended and enriched with many additional rights [9]. The Council of Europe Disability Action Plan 2006-2015 was adopted by the Committee of Ministers of the Council of Europe, on 5 April 2006.The main goal of the Action Plan is to provide member states with a forceful mean against any kind of discrimination upon people with disabilities, promoting equal opportunities for all and active participation in the life of the community, as well as improving their quality of life. The "European and Mediterranean Major Hazards Agreement (EUR-OPA)", was created in 1987 by the Council of Europe, and is considered the platform for co-operation between European and Southern Mediterranean countries in the field of major natural and technological disasters. On 24 October 2013, the 64th meeting of the Committee of Permanent Correspondents of the EUR-OPA took place in Paris, where the recommendation 2013-1 on the inclusion of people with disabilities in disaster preparedness and response, was adopted [10]. According to the United Nations Office for Disaster Risk Reduction (UNISDR), a personal preparedness plan for disasters may help someone both to evacuate and survive.

A number of international standards have been set relevant to evacuation of buildings in case of emergencies; the most recent International Standard ISO 23601:2009 "Safety identification – Escape and evacuation plan signs", provides with design principles for preparation of "Fire Escape Plans". Such plans need to be displayed on buildings (usually public or work places), in order to deliver crucial information regarding fire safety, escape, evacuation and rescue of the residents [11]. According to this standard the evacuation plan of a building should include:

- The ground plan of each floor
- The primary and secondary escape routes and exits

- The location of fire-fighting equipment and emergency alarm buttons
- The location of emergency equipment and first aid
- The location of areas-assembly points (shelters)
- The procedures for evacuation in case of emergency

An example of a "Fire Escape Plan", according to the new ISO 23601:2009 standard, is given in Figure 1 [11].

Figure 1. Indicative "Fire Escape Plan" according to ISO 23601:2009 [39]

The Greek legislation for fire safety and evacuation of buildings, including people with disabilities, is the Ministerial Decision No. 81813/5428/93, Presidential Decree 71/1988, article 12A, which refers to "Buildings for Health and Social Providence"; namely, any building used for diagnosis and treatment, medical care of elderly people, or people with disabilities, e.g. cognitive or mobility impairment, etc. Hospitals, clinics, or institutions for people with disabilities are included in this category among others.

3. Proposed Checklist to prepare a Personal Emergency Evacuation Planning (PEEP) for disabled people in case of a fire or an earthquake

A Personal Emergency Evacuation Plan (PEEP) can enhance public preparedness, increasing also the capacity of the disability community upon disaster risks. In order to prepare such a PEEP there is a list of vital questions that need to be answered, taking into consideration the type of disability of the person of interest.

One of the most recent templates for preparing a PEEP is provided by the US National Fire Protection Agency [12]. This checklist includes questions relevant to the ease of understanding the hazard by the disabled person in case of an emergency. This includes prior knowledge of the exact position of the notification systems (e.g. fire warning buttons etc.) and the capability of direct recognition of the alarms during the emergency (e.g. serine, bell, optical warning signals etc.). Moreover, it includes questions regarding response actions, such as the localization of the emergency exits by following the respective escape signs (escape routes), as well as prior knowledge of the refuge areas and evacuation procedures. Moving to a safe place is very important when evacuating a building, so there is also a need to answer how many assigned people might be needed to help a person with disabilities to evacuate, based on the type of disability.

However, it should be emphasized that effectiveness of such a plan needs contribution and training of both people with disabilities and the personnel involved

4. Egress signs for people with disabilities in light of the "Universal Design"

Except for the new ISO 23601:2009 standard for preparing "Fire Escape Plans", there are also other standards relevant to escape/exit signs, such as the ISO 7010 and the ISO 21542:2011; the latest is referred to accessibility. However most of the times, such conventional exit signs in buildings and the respective evacuation routes do not take into consideration the abilities of all the occupants; e.g. somebody may not be able to use a fire escape stairway.

In this work, the new egress signs that have been designed especially for disable people in the framework of "The Accessible Exit Sign Project" (http://accessibleexitsigns.com/) are presented and proposed to be used in the same "Fire Escape Plan" together with the convectional signs, in line with the "Design for All" concept (Figure 2). Specifically, an indicative example of a building's ground plan is provided including escape routes for the general population and the people with disabilities. A hypothetic indicative position inside the building is pinpointed with the phrase "If you are here". The escape routes are highlighted with light yellow color; they are marked for the general population and the people with disabilities, by using the respective escape signs. Moreover, the "Refuge areas" for both the general population and the people with disabilities are pointed out.

However, it has to be mentioned that these signs are not yet included in standard technical or building codes. It should be considered as part of an overall exit signage solution, requiring approval by the relevant legal authorities to be included as additional to the existing building codes.

5. Results and Discussion

It seems that in order to effectively cope with emergencies counting the least possible human losses, it is necessary to raise the public awareness upon disaster risks, as well as to change the social perception and culture regarding disability; strengthen the education and preparation of the population in general, as well as minimize marginalization of people with disabilities by including them in the disaster preparedness and response phases of the disaster management cycle. Preparation of "Personal Emergency Evacuation Plans" tailored to the needs and capabilities of each individual can help reducing vulnerability to certain hazards. However, it should be noted that the effectiveness of such a plan is directly dependent on the education and training upon emergencies, not only of the people with disabilities but also of the staff involved. Accessibility issues, as well as escape signs specifically designed for people with disabilities, should be considered in the context of "Universal Design" or "Design for All" in the future; amendment of current build codes in regard to egress symbols shall be needed to produce new standards.

Figure 2. Part of a "Fire Escape Plan" based on the last updated International Standard, ISO 23601:2009 (Safety identification -- Escape and evacuation plan signs)- Incorporation of the new egress symbols, especially designed for disabled people

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THE ROLE OF MEDIA IN DISASTER MANAGEMENT SYSTEM

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Abstract

The media are linked to the democratic system of the country. Through these, political information is provided to voters, with the public supporting its choices in SME's information material. At the same time, the identification of social problems is achieved through these and is a key tool to address these. Also, the media is seen as preserving democracy, as various mistakes and injustices and injustices come from the existing power. Consequently, SMEs operate at specific levels and standards, as defined by democratic society. The aim of the research is to help all those who are interested in developing the necessary skills to be able to deal effectively with critical situations. Our research has the sole purpose of optimizing existing logical practices and tactics to address and respond. As a method, design-based research and approach to living labs are adopted. It builds on the existing knowledge of the International Telecommunications Union and the European Broadcasting Union.

Through the media, topics are touched with an interesting story that is considered fascinating to the audience. These stories include human stories and conflicts. The fast and painless safeguarding of history serves the success of publication as long as it is based on a reliable source. This information stems from the audience itself through the interview process, so each person reports on his experience how he lived and felt an event and describes it accordingly. However, these interviews push SMEs into conflict with crisis managers, as they provide a safe and honest picture of what they are describing. The conflict is, of course, due to the fact that, in addition to their personal experience of the event, the emotional reactions of the public, their subjective judgment, etc. are recorded. The conflict, at the same time, is also due to the crisis managers. The managers, therefore, do not pay special attention to raising the awareness of critical media situations and events.

1. Introduction

1.1 The role of SMEs in general

Several disciplines are exploring how SMEs influence the political climate and the democratic system. In general, the entire network and the model of this complex network are discussed. Its dominance is due to the competitive tendency, while this model gives the media an impulse to produce entertainment stories to emotionally elicit listeners or viewers. The topics that are mostly chosen to be promoted through SMEs concern risks, hazards. However, this has a significant impact on democracy.

The media are linked to the democratic system of the country. Through these, political information is provided to voters, with the public supporting its choices in SME's information material. At the same time, the identification of social problems is achieved through these and is a key tool to address these. Also, the media is seen as preserving democracy, as various mistakes and injustices and injustices come from the existing power. Consequently, SMEs operate at specific levels and standards, as defined by democratic society.

The media serve specific democratic functions. An example of these may be that they are monitoring social and economic developments, identifying topical issues, giving and triggering debates on various attitudes and positions, controlling the way in which power is exercised, helping to provide citizens with an incentive to be informed, their choice and involvement in political issues, they are a basic resistance to the efforts of diverse interests that undermine the independence of citizens.

However, the worrying case is that SMEs do not guarantee and do not properly and properly serve these functions of democracy. Accordingly, with those who criticize the democratic spirit of the media, SMEs operate purely commercially and are controlled to a certain extent or often by multinational corporations, so they have come to the opposite of democratic power by supporting the government.

As a result of this, the media choose to show more entertainment content rather than as informative, also choosing gossip, scandals, sex and violence. The news piece that is being promoted by them concerns more personalities than ideologies. At the same time, there is a lack of serious debate and clear information to the public. This gives the impression that SMEs focus more on wrong issues, exemplifying the scandalous issues of different people and their personal lives.

It is considered more profitable and self-sufficient to deal with the media with the personal lives of political figures while ignoring or ignoring the impact of political decisions. Often, it is also the phenomenon that the media make the public feel fearful of them. Thus, the important problems for the life and survival of the citizen are overtaken and left unnoticed, while they are enormous in size through their exposure to hysteria dangers.

There is a failure of the risks of reporting injustice and industry. An example is the fact that issues related to public health are often neglected and pose a public health risk to citizens. An example is the report and the update of the smoking habit. This is due to companies that are sponsors of SMEs and that prohibit this type of promotion. It is also worrying that alternatives are being put in place instead of information on the health risk posed by smoking. Thus, in essence, SMEs are conspiring with industry effectively, with the ultimate goal of removing hundreds of billions of dollars annually from consumers.

The majority of media, such as magazines, newspapers and TV channels, earn money from advertising campaigns and sponsorships. Therefore, the goal of SMEs is to satisfy the interests of their advertisers, which of course do not coincide with the interests of readers and viewers.

Therefore, the interests of consumers are not covered. For this reason, the majority of countries also have public media. Of course, a large proportion of researchers believe that SMEs are essentially shaping consumer preferences and not covering them.

The trends that SMEs have developed over recent decades are as follows:

- fusion of newspapers, radio, television, telephone and internet in technological and economic terms.
- There is a merger of SME businesses and their control is done by fewer owners. As a result of this vertical and horizontal concentration of media businesses, the news comes from shared sources.
- Media owners are multinational companies that may even have their headquarters abroad (globalization).
- No news and entertainment ads are distinguished, but they are unified (commercialization).
- More scenes of violence and sex are displayed, with an intense choice of commentary and criticism on the personal lives of individuals, avoiding controversial issues and serious discussions (superficially).

The fact that the SME market has been liberalized has led to the aforementioned trends of SMEs. Thus, they are chosen because they pay financially.

2. The influence of SMEs

Numerous theories explore the question of the influence of consumer behavior on the media as it is studied below:

- The provision of information by SMEs outweighs the human possibilities of information retention. In order to save information processing by the media, people choose their reading, listening and listening content based on their needs and preferences and interests (cognitive processing)
- SMEs do not have the capacity and capacity of the content of people's thinking, but they have the ability to influence the way people think (regulation of the agenda)
- SMEs have the ability to influence the candidates' crisis criteria for candidates in the elections, as they have the power to turn human attention to specific issues and aversion to other issues. An example is

President Bush of the United States, where his support was limited in 1992 as the interest of the media turned to the projection of the economic recession and not to the Gulf War,

- There is a variety of ways of describing and shaping the image of an event, so that it is chosen to be displayed by the media. An example is news about nuclear weapons development or news about technological progress, military budgets, defense policy for each country, military disarmament and radiation dangers (shaping)
- People's perception of things can be influenced by the media, notably through documentaries, through fiction and entertainment. The repetition and dominance of certain motifs and images and ideologies spiritually and ideologically overwhelms the individual. This can happen even through TV shows and movies. The result of this is that the world really thinks that an event is happening, so it actually exists. An example is the scenes of violence that are projected daily and year after year, so that in the minds of the viewers the idea that the world is violent and that it is a frequent phenomenon of violence (theory of culture)
- SMEs can not change the views of people, but they have the power to strengthen the views that people already have. At the same time, it is considered that SMEs have a significant influence on issues for which people have been completely ignorant (media influence on new issues).

3 Crisis management by SMEs

When there is a critical situation, then those who manage the media focus on it. There is not always focus on communication and information management when crisis management is planned. This is due to the fact that Crisis Planning and Training focuses on resource and staff management. This requires training of managers and staff of the agencies in their relationship with other people and their relationship with the media.

It seems that effective communication management is as important as effective crisis management is important. It is therefore the public, considered to be important, with the views of the public being shaped according to the content of what they hear, they see and read about an event.

Particular importance and priority should be given to SME management. When they manage SMEs effectively, they can distract positive criticism of a critical event from the public about the emergence of the critical situation and about how an organization manages the critical situation.

However, there are stereotypes and prejudices about journalists. The attitude and position that journalists, regardless of their personal effort and their ability to manage SMEs adequately and effectively, are therefore the result of their work is not always desirable. In particular, there is the impression that the work of journalists is not always objective. It is a fact that there is no SME management strategy that can be sure of success, but the journalistic manipulation can limit the conflicts, misinterpretations and the image of the organization that will have it after the outbreak of the crisis. Crisis managers and journalists may collide because managers feel they have no appreciation of their efforts to resolve the critical situation while they feel they are being criticized by journalists and their efforts are underestimated.

Journalists are dealing with a critical fact of distorting it, aiming at increasing viewing, keeping an objective position in the things they present and of course serving their personal interests.

Even SMEs, which are not commercially aimed to make financiers happy. Their financiers may be governments, religious and political organizations and commercial enterprises. Thus, SME organizations earn and secure the jobs of employees working for SMEs.

4. Conclusions

4.1 The way they approach the critical situation of the media

Through the media, topics are touched with an interesting story that is considered fascinating to the audience. These stories include human stories and conflicts. The fast and painless safeguarding of history serves the success of publication as long as it is based on a reliable source.

This information stems from the audience itself through the interview process, so each person reports on his experience how he lived and felt an event and describes it accordingly. However, these interviews push SMEs into conflict with crisis managers, as they provide a safe and honest picture of what they are describing. The conflict is, of course, due to the fact that, in addition to their personal experience of the event, the emotional reactions of the public, their subjective judgment, etc. are recorded.

The conflict, at the same time, is also due to the crisis managers. The managers, therefore, do not pay special attention to raising the awareness of critical media situations and events.

The story to be shown by the media is selected and shaped according to some conditions to be met, which are:

- history should be intense and dramatic to broadcast
- history should touch and relate to personal stories, intimate experiences and experiences of the public who will follow it
- history should be unpredictable and unusual
- Depends on whether history has been re-introduced in the past
- history is considered important new since its previous promotion
- the story is still considered as an important new one
- the story is about important people who will be its main protagonists
- History has negative effects and results.

4.2 The contribution of SMEs

A critical situation can be aggravated by its media exposure. The media, therefore, can refer to a critical situation, causing more episodes and presenting it so that it is further strengthened in intensity, in an exaggerated and dazzling way, with appropriate shots. However, SMEs can make a significant contribution to the critical situation in the following ways:

- SMEs can promote educational material so that the public is aware of potential risks and can thus be able to cope with critical situations
- SMEs to warn the public that there is a threat of a critical event
- SMEs to inform the organization about possible concerns and feelings of those interested in them
- SMEs to provide information to the public on critical situation managers and its evolution, as well as its management.

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COMPLETE SEISMIC HISTORY OF SOUTHERN AND SOUTHWESTERN PELOPONNESE (GREECE) AND RESPECTIVE ESI 2007 INTENSITIES

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Abstract

The southern and southwestern Peloponnese is one of the most seismically and tectonically active areas in the Eastern Mediterranean. Based on historical and recent seismicity data, the area has been often struck by destructive earthquakes with significant impact on the natural and built environment. Taking into account various sources, the complete catalogue of destructive historical earthquakes from 550 BC to 1899 AD is presented for the first time with all induced earthquake environmental effects (EEE). Based on the application of the Environmental Seismic Intensity (ESI 2007) scale, the most susceptible areas to EEE are the Kalamata (Kato Messinia) basin followed by Sparta basin, the eastern slopes of Mt Taygetos, the Ionian coast of Messinia and the Kyparissia Mts. The maximum local environmental seismic intensities assigned are $X_{ESI\ 2007}$ for Sparta basin, VIII-$IX_{ESI\ 2007}$ for Kalamata basin, $VIII_{ESI\ 2007}$ for the Ionian coast of Messinia and $VII_{ESI\ 2007}$ for Kyparissia Mts.

Key words: historical earthquakes, environmental effects, ESI 2007, southern Peloponnese, Greece

1. Introduction

Earthquake environmental effects (EEE) are the effects induced by an earthquake on the natural environment (Michetti et al. 2007). They are classified into two types: (a) primary EEE, which include surface faulting, coseismic surface ruptures and permanent ground dislocations of tectonic origin and any other surface evidence of coseismic tectonic deformation (Michetti et al. 2007) and (b) secondary EEE classified into eight main categories: (i) hydrological anomalies, (ii) anomalous waves including tsunamis, (iii) ground cracks, (iv) slope movements, (v) trees shaking and vegetation damage, (vi) liquefaction phenomena, (vii) dust clouds and (viii) jumping stones (Michetti et al. 2007). The EEE can be used for the evaluation and the comparison of the seismic intensity not only of recent but also of historical and palaeo- earthquakes. The ESI 2007 scale has been already applied in historical earthquakes in various tectonic environments around the world, not only in individual events in order to enrich the existing database for countries, e.g. Greece (Papanikolaou and Melaki 2017), but also in a set of selected historical events occurring in the same region, e.g. southern Apennines in Italy (Serva et al. 2007) in order to reassess the historical events in the region and to contribute to the reduction of the seismic risk. Although some efforts have been made to record the EEE of individual recent earthquakes in Greece and evaluate their ESI 2007 seismic intensity (e.g. Fountoulis and Mavroulis 2013; Mavroulis et al. 2013; Lekkas and Mavroulis 2015; Papanikolaou and Melaki 2017; Lekkas et al. 2018), no one has focused on the complete seismic history of an area and the respective intensities based on the induced EEE. The southern and southwestern Peloponnese (Fig. 1) was considered appropriate for the development of this approach.

This study comprises the presentation of a catalogue of all known destructive historical earthquakes covering the time period extending from 550 BC to 1899, and generated in the southern and southwestern Peloponnese (Fig. 1), which is one of the most seismically active areas of Greece. Furthermore, the study includes a detailed and accurate description of the available EEE induced by the earthquakes listed in the catalogue and the application of the ESI 2007 scale for the characterization of their EEE.

The detailed knowledge of the historical earthquakes and their EEE as well as the respective seismic intensities serves as a valuable tool for revealing and highlighting subareas of significant earthquake-related hazards where no macroseismic damage data are available. Such a study contributes to test the susceptibility and the vulnerability of the affected area to the same EEE and improving preparedness and land-use planning to cope with and overcome the changes that an earthquake induces on the natural environment of the affected area.

2. Seismotectonic Setting

Onshore and offshore studies conducted by various researchers (Mariolakos et al. 1986; Papanikolaou et al. 1988; Papanikolaou et al. 2007) revealed that the southern and the southwestern part of Peloponnese is composed of major neotectonic macrostructures bounded by N-S and E-W trending fault zones (Fig. 1). These onshore macrostructures are from E to W the following: (a) the NW-SE striking Sparta basin, (b) the N-S striking Mt Taygetos mega-horst, (c) the Kalamata-Kyparissia mega-graben striking N-S in its southern part and E-W further to the north, (d) the very complex morphotectonic mega-structure of Mts Kyparissia - Mt Lykodimo striking N-S and (e) the Gargalliani-Pylos mega-horst located along the western coast of Messinia (Mariolakos et al. 1986; Fountoulis and Mavroulis 2013) comprising smaller fault blocks (Fig. 1). These onshore structures are bounded by active fault zones and seismic faults (Fig. 1, e.g. the eastern marginal fault of Kato Messinia basin ruptured in 1986 Kalamata earthquake, the Sparta fault ruptured in 464 B.C. devastating Sparta). Offshore fieldwork in the Gulfs of Messinia (Papanikolaou et al. 1988) and Kyparissia (Papanikolaou et al. 2007) demonstrated that in several cases active faults observed onshore continue offshore in the study area (Fig. 1).

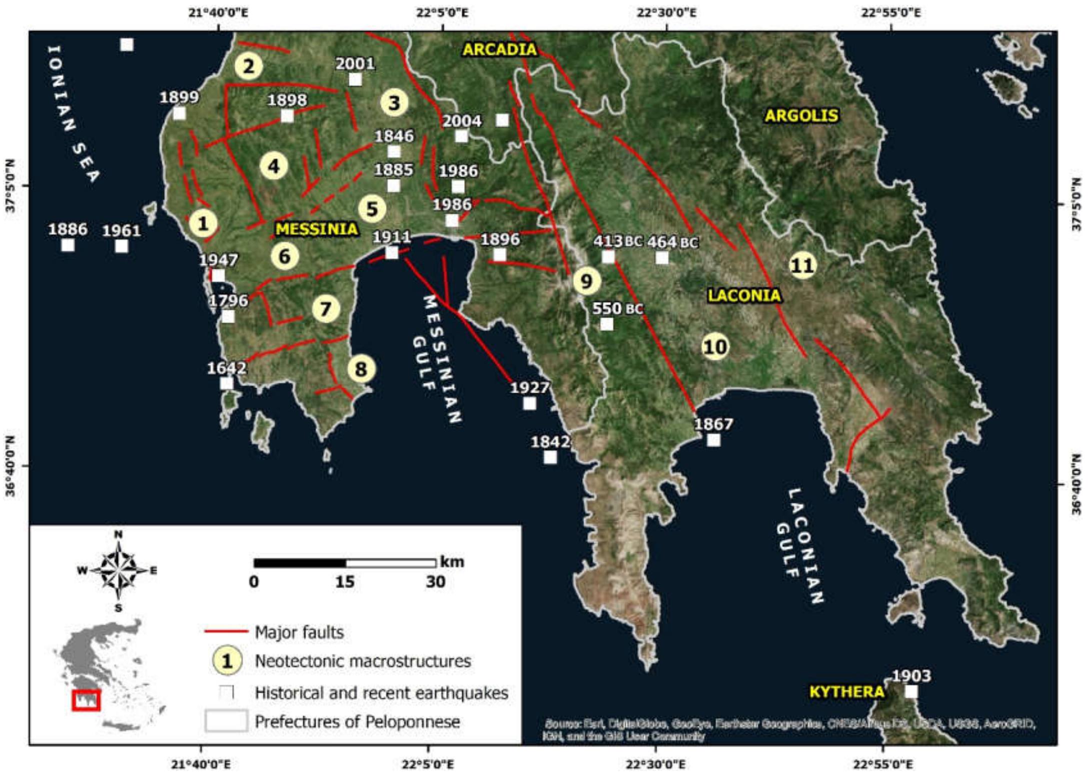

Figure 1: The southern Peloponnese along with the historical and recent earthquakes with impact on human, natural and built environment of the study area as well as the major onshore and offshore faults and the major neotectonic macrostructures: (1) Gargalliani-Pylos mega-horst, (2) Kyparissia basin, (3) Ano Messinia basin, (4) Kyparissia Mts, (5) Kalamata (Kato Messinia) basin, (6) Vlahopoulo graben, (7) Mt Lykodimo horst, (8) Falanthi basin, (9) Mt Taygetos, (10) Sparta (Evrotas) basin, (11) Mt Parnon based on Mariolakos et al. (1986), Papanikolaou et al. (1988) and Fountoulis (1994). The seismological parameters of the presented earthquakes can be found at AUTH (2019).

3. Methodology

For the present study, data and information on historical and recent earthquakes and their EEE in the southern and southwestern Peloponnese were obtained from the following sources: (a) All major academic databases, search engines and sources for scientific research including GeoRef, Sciencedirect, Scopus, Springer, JSTOR etc, (b) Official earthquake catalogues from universities, seismological institutes and observatories (AUTH, UOA, NOA, EMSC), (c) Books and scientific articles containing catalogues or information of earthquakes and their EEEs in the study area (e.g. Shebalin et al. 1974; Papazachos and Papazachou 1989, 1997, 2003; Soloviev et al. 2000; Ambraseys 2009; Galanopoulos 1940, 1941a, 1941b, 1949, 1960; Pirli et al. 2007; Ganas et al. 2012; Fountoulis and Mavroulis 2013; Sakellariou and Kouskouna 2014; Kouskouna and Kaviris 2014), (e) Official reports of applied scientific research projects (e.g. Mariolakos et al. 1986; Plessa and Ganas 2014).

4. Historical Earthquakes, EEE & ESI 2007 Intensities

4.1. The 550 BC and 464 BC Sparta earthquakes

The data referred to earthquakes from 550 BC to 1838 are limited to occurrence date and the most affected areas as well as limited information of secondary EEE comprising only slope movements including mainly landslides and rockfalls without any further quantitative information. The listed earthquakes occurred in (a) 550 BC causing the destruction of Sparta and the collapse of the Mt Taygetos summit indicating rockfalls and landslides and (b) in 464 BC, when the most destructive earthquake of Sparta took place resulting in 20000 fatalities. The 464 BC Sparta earthquake triggered ground cracks and slope failures along the eastern slopes of Mt Taygetos. The precise geographic locations of the triggered effects are not available. Consequently, the areal distribution of the secondary effects cannot be extracted neither directly nor indirectly. Moreover, further quantitative information including either the volume of the mobilized materials or dimensions (length, width and frequency) of ground cracks are not available.

4.2. The 1842 April 18 earthquake

This earthquake generated ground cracks, slope failures, hydrological anomalies and tsunami waves were generated in and affected various sites. In Eva [previous name (p.n.) Naziri], located within the Pamisos River valley, ground cracks with width of 40 cm and depth of 7 m ($VIII_{ESI\ 2007}$) were observed close to geotechnically unstable areas and were related to coseismic landslide phenomena (Ambraseys, 2009). Detachment of large rock masses and rockfalls occurred in Eva resulted in building damage and related fatalities. In Evrotas River valley, the earthquake caused detachment and fall of large rock masses in the archaeological site of Menelaion. Hydrological anomalies included water turbidity within the Pamisos River valley and more specifically water turbidity in Pamisos springs in Agios Floros ($VIII_{ESI\ 2007}$) and overflowing of wells. The flow of Pamisos River was disturbed and the river was locally overflowed (Ambraseys, 2009). Liquefaction phenomena were reported in Analipsi (p.n. Tsitsori) ($VII_{ESI\ 2007}$). The coast close to Koroni was inundated and ships were washed on the shore by the earthquake-induced tsunami ($VIII\text{-}IX_{ESI\ 2007}$).

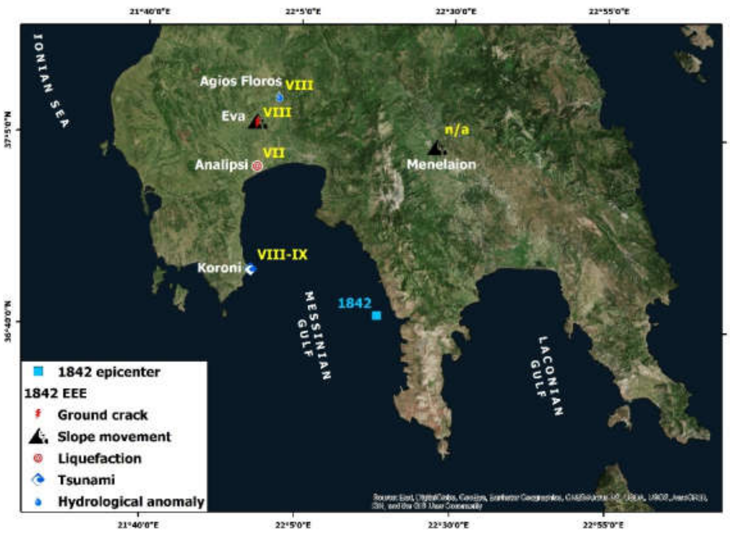

Figure 2: EEE induced by the 1842 earthquake and ESI 2007 intensities assigned in southern and southwestern Peloponnese.

4.3. The 1846 June 11 Messinia earthquake

Liquefaction phenomena occurred in several sites in the form of ground cracks accompanied by ejection and flowing of sand-water mixture that covered large parts of fields ($VII_{ESI\ 2007}$). A large lake made of silt-water mixture was formed in Ammos (p.n. Mpaliaga) and sulphureous gas emissions was noticeable ($VIII_{ESI\ 2007}$). Ground cracks were observed in Mikromani within the post-alpine formations of Pamisos River valley with width varying from 5 to 8 cm along with the formation of craters with diameter of 10 cm with surging liquid material ($VII_{ESI\ 2007}$). Ground cracks with large width and partially filled with silt were also reported in the Pamisos River estuary ($VII_{ESI\ 2007}$). Hydrological anomalies were also observed in Messese area ($VII_{ESI\ 2007}$) and caused the outbreak of infectious diseases.

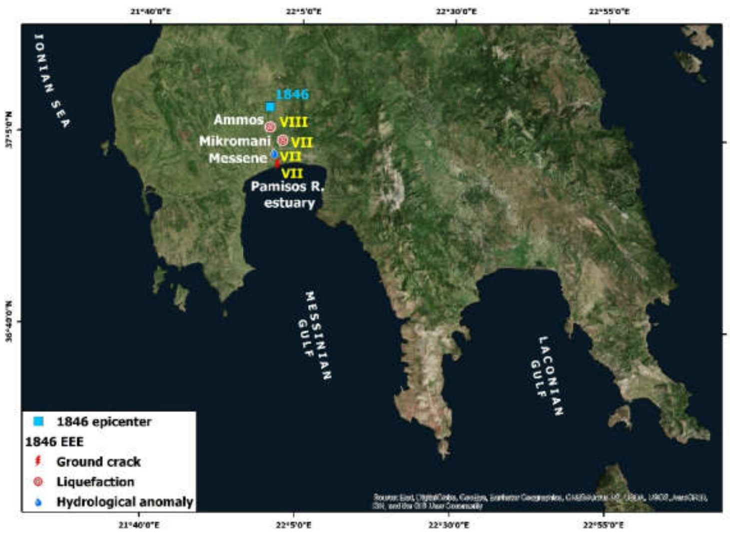

Figure 3: EEE induced by the 1846 earthquake and ESI 2007 intensities assigned in southern and southwestern Peloponnese.

4.4. The 1867 September 20 earthquake

The earthquake generated tidal waves which affected the southern and western part of Peloponnese, the Ionian Islands, the Cyclades complex in the Aegean Sea and reached also the eastern Italian coasts (Soloviev et al., 2000; Papazachos and Papazachou, 1989, 1997, 2003; Papadopoulos et al., 2014 and references therein).

The waves rolled onto the southern and western shores of Peloponnese and had considerable impact on the funnel - shaped gulfs and bays opened towards the earthquake epicenter (Soloviev et al., 2000; Papazachos and Papazachou, 1989, 1997, 2003). Thus, they severely affected the coastal areas of Gytheion and Messinian Gulfs. They also affected the coast of Cephalonia Island (Ionian Sea) causing damage to Lyxouri port and the Cyclades complex in the Aegean Sea and especially Syros and Serifos Islands. They also reached the Italian coasts and affected Brindisi, Messina, Sicily and Catania coastal areas (Soloviev et al., 2000). In Brindisi, the sea receded from the shore comparatively far, while in Sicily, Messina and Catania low sea water was observed and reported. Oscillations of the sea level within the focal zone of the waves presented a long duration ranging from 5.5 up to 10 hours before the sea calmed down again.

Gytheion was destroyed by the waves, which had a significant impact on the Cape Pagania, on the western shore of the Laconian Gulf and on the Messinian Gulf. In Gytheion, changes to sea level were observed. The sea initially receded from the shore and the sea bed was dried up. Afterwards, the sea rose for 6 m above its usual level and it looked like boiling ($X_{ESI\ 2007}$).

In Kalamata located in the northern part of the Messinian Gulf, low and high water were similarly observed with the sea receding slowly from the coast approximately for 15 m ($IX_{ESI\ 2007}$). Lower values of sea level fall were observed in Petalidi coastal area, where then the sea water level rose up to 2m and caused inundation of the coastal area ($VIII_{ESI\ 2007}$). In Neapoli, the sea bed was also dried up causing boats touching the sea bed more than once ($VII_{ESI\ 2007}$).

In Ionian Islands, similar phenomena were induced by the earthquake and perceived by the local population of the coastal areas. In Zakynthos, the sea was rough for 10 hours, the sea bed was dried up in its shallow parts close to the shore, a part of a small river flowing into the sea close to Zakynthos was also dried up and a lot of fish and eels coming not only from the sea but also from the river were exposed. The sea rose for 1 m above its usual level ($VII_{ESI\ 2007}$). In Cephalonia and more specifically in Argostoli, the sea was rough for 4.5 hours ($VI_{ESI\ 2007}$). In Lefkas, located north of Cephalonia, sea level change was also observed comprising fall and rise ($VI_{ESI\ 2007}$). The arrival of the wave swept boats from the harbor to the quay resulting crush damage. In Kerkyra, the arriving waves resulting in inundation of an about 20m wide coastal zone ($VI_{ESI\ 2007}$). In all cases, a lot of fish were thrown out onto the shores or remained exposed on the sea bed for a long time till the sea level rise. In Kythera Island, the sea rose for 2-3 m above its usual level in Kythera town resulting in inundation of the coastal area and flooding of the port facilities ($VIII\text{-}IX_{ESI\ 2007}$). Boats were also swept from the harbor to the quay.

In Chania (Crete), short-term and periodic (10-15 minutes) sea level variations of 1 m occurred ($VI_{ESI\ 2007}$), while turbulent flows were generated and were perceived in Chania port. The oscillations of the level lasted with a gradually increasing period and decreasing height till 14h (Perrey, 1870; Schmidt, 1881; Fuchs, 1886; Sieberg, 1932b; Galanopoulos, 1960; Ambraseys, 1962; Karnik, 1971; Antonopoulos, 1980a; Caputo and Faita, 1984; Papadopoulos and Chalkis, 1984; Papazachos et al., 1986).

By applying the ESI 2007 scale to the September 20, 1867 earthquake, the following intensity values are summarized as follows: (a) $X_{ESI\ 2007}$ in Gytheion port (Laconia, southern Peloponnese), (b) $IX_{ESI\ 2007}$ in Kalamata port (Messinian Gulf, southwestern Peloponnese), (c) $VIII\text{-}IX_{ESI\ 2007}$ in Kythera town (Kythera Isl., Ionian Islands), (d) VIIIESI 2007 in Petalidi coastal area (Messinia Gulf, southwestern Peloponnese), (e) $VII_{ESI\ 2007}$ in Zakynthos town (Zakynthos Isl., Ionian Islands), (f) $VI_{ESI\ 2007}$ in Argostoli town (Cephalonia Isl., Ionian Islands), in Lefkas town (Lefkas Isl., Ionian Islands), in Kerkyra town (Kerkyra Isl., Ionian Islands) and in Chania port (Crete Isl.)

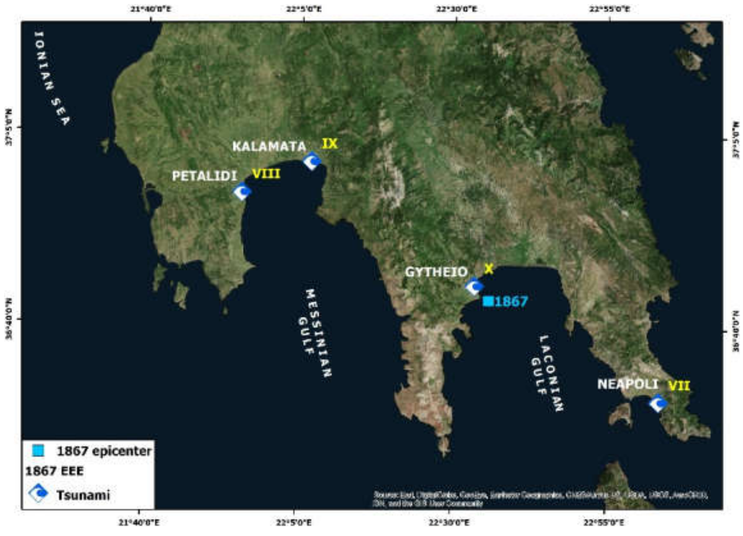

Figure 4: EEE induced by the 1867 earthquake and ESI 2007 intensities assigned in southern and southwestern Peloponnese.

4.5. The 1885 March 28 Messene earthquake

Rockfalls were triggered by the earthquake (Papazachos and Papazachou, 1989, 1997, 2003). No further information and details on the precise location and the areal distribution of the induced rockfalls and the volume of the mobilized geological material are available. Thus, the epicentral intensities and the local intensities cannot be estimated due to the absence of the exact location and the quantitative characteristics of the earthquake-induced rockfalls.

4.6. The 1886 August 27 Filiatra earthquake

The EEE include ground cracks, liquefaction phenomena, submarine landslides, tsunami waves and hydrological anomalies (Chiotis, 1886; Galanopoulos, 1941a; Papadopoulos et al., 2014). Ground cracks were observed in the area between Katakolo and Gargalianoi (V-VI$_{ESI\ 2007}$). Ground cracks along with liquefaction phenomena (ejection of ground water) were observed in Marathopolis area (Chiotis, 1886; Galanopoulos, 1941a) (VII$_{ESI\ 2007}$). Submarine landslides resulted in disruption of submarine cables connecting Zakynthos and Crete. Tsunami waves were generated and affected a 35km long N-S coastal segment extending from Agrilos located north of Filiatra to the Pylos bay. The waves swept several boats onto the coast of Gialova (VII-VIII$_{ESI\ 2007}$) located north of Pylos, the sea close to Argilos, located to the north of Filiatra, advanced resulting in coastal inundation ranging from 10 to 15 m for a short time period (Soloviev et al., 2000) (VII-VIII$_{ESI\ 2007}$). It was reported that the tsunami was observed up to Izmir (Marshall, 1887; Forster, 1890; Baratta, 1901; Galanopoulos, 1960; Ambraseys, 1962; Karnik, 1971; Caputo and Faita, 1984; Papazachos and Papazachou, 1997; Soloviev et al., 2000). Hydrological anomalies comprised water turbidity in Evinos River, whose estuary is located north of Patras Gulf, in a distance of 120 km north of Filiatra. These hydrological anomalies in Evinos River were considered as an isolated effect of the 1886 earthquake generated in the far field. Thus, it has not been taken into account in the assessment of the environmetal seismic intensities.

The hydrological anomalies observed in Evinos River, in a distance of 120 km north of Filiatra, is considered as an effect of the 1886 earthquake generated in the far field. Thus, it was not taken into account in the assessment of the environmetal seismic intensities.

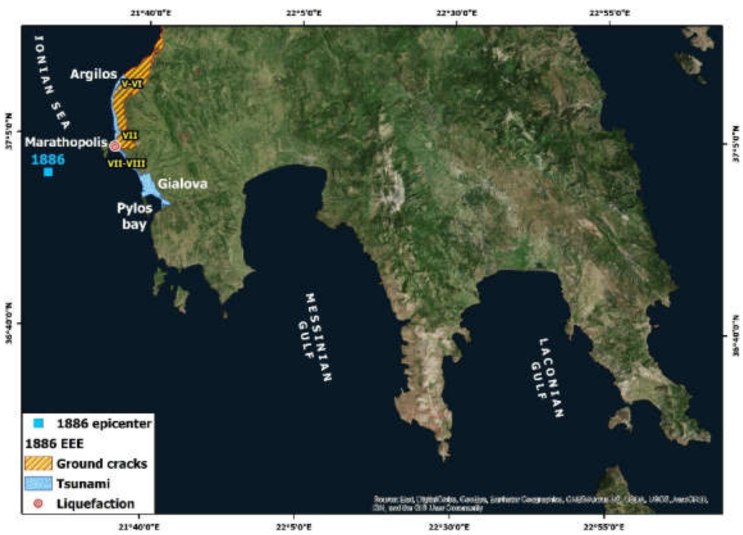

Figure 5: EEE induced by the 1886 earthquake and ESI 2007 intensities assigned in southern and southwestern Peloponnese.

4.7. The 1898 November 9 Kyparissia earthquake

Hydrological anomalies were observed in Aetos village located in Tryfillia province and included increased discharge and water turbidity (muddy water) in a spring (VII$_{ESI\ 2007}$).

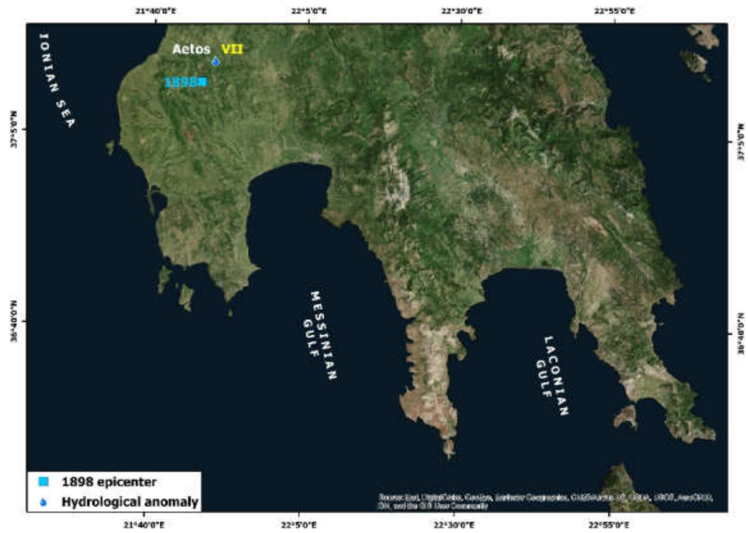

Figure 6: EEE induced by the 1898 earthquake and ESI 2007 intensities assigned in southern and southwestern Peloponnese.

4.8. The 1899 January 22 Kyparissia earthquake

As regards the secondary EEEs, this earthquake induced ground oscillation of long-period at distant localities, ground cracks, subsidence, liquefaction phenomena and slumping of the coastal material, slope movements, hydrological anomalies and tsunami waves (Papazachos and Papazachou, 1989, 1997, 2003; Ambraseys and Jackson, 1990; Ambraseys 2009). No evidence of primary EEEs including evidence of permanent ground dislocation of tectonic origin was observed (Ambraseys and Jackson, 1990; Ambraseys 2009).

Slope movements included mainly landslides and rockfalls located south of Kyparissia and east of Filiatra, more specifically in Perdikoneri and Rouzaki villages (Ambraseys and Jackson, 1990; Ambraseys 2009). Hydrological anomalies included water discharge variations in springs as far as Kalamata town ($VII_{ESI\ 2007}$), Varvitsa and Dimitsana villages (Ambraseys and Jackson, 1990; Ambraseys 2009). Liquefaction and slumping of geological material was induced along the Ionian coast of Messinia ($VII_{ESI\ 2007}$). In Messene marshes located west of Kalamata, extensive liquefaction phenomena occurred resulting in damage to railway embankments and telegraph lines (Ambraseys and Jackson, 1990; Ambraseys 2009) ($VII_{ESI\ 2007}$). The subsequent earthquake-induced tsunami was about 1m high and resulting in inundation of Marathopolis coastal area ($VIII_{ESI\ 2007}$), while in Zakynthos Island was about 20-40 cm (Galanopoulos, 1941b; Papazachos and Papazachou, 1989, 1997, 2003; Ambraseys and Jackson, 1990; Ambraseys 2009) ($VII_{ESI\ 2007}$). The tsunami was possibly triggered by submarine slumps (Galanopoulos, 1941b), but no damage occurred to the submarine cables between Zakynthos and Western Peloponnese. The hydrological anomalies observed in Varvitsa and Dimitsana villages located in Laconia and Arcadia prefectures respectively were also considered as far field effects of the earthquake and were not considered in the intensity assessment.

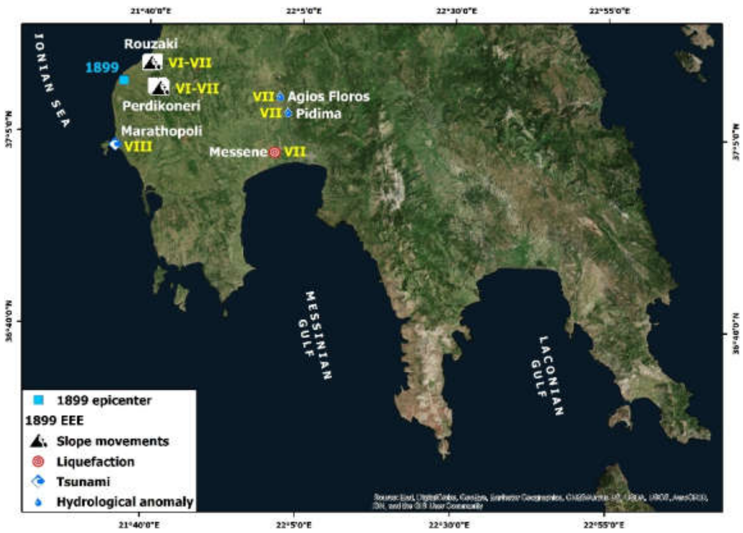

Figure 7: EEE induced by the 1899 earthquake and ESI 2007 intensities assigned in southern and southwestern Peloponnese.

5. Conclusions

Based on the aforementioned data, slope movements were the most frequently reported EEE reported in 5 historical earthquakes followed by liquefaction phenomena, tsunami waves and hydrological anomalies reported in 4 historical earthquakes and ground cracks in 3 historical earthquakes. The most susceptible areas to the generation of EEE are the Kalamata (Kato Messinia) basin, which has been affected by EEE during 4 historical earthquakes, followed by Sparta (Evrotas) basin with EEE during 2 historical earthquakes, the eastern slopes of Mt Taygetos affected by slope movements during 2 historical earthquakes, the Ionian coast of Messinia suffered by EEE during 2 historical earthquakes, and the Mts Kyparissia also suffered by EEE during a historical event respectively. The maximum local environmental seismic intensities assigned are $X_{ESI\ 2007}$ for Sparta (Evrotas) basin, $VIII\text{-}IX_{ESI\ 2007}$ for Kalamata (Kato Messinia) basin, $VIII_{ESI\ 2007}$ for Ionian coast of Messinia and $VII_{ESI\ 2007}$ for Mts Kyparissia. These analysis is not only of historical interest, but significantly contribute to the completeness of the earthquake and the induced EEE catalogue, which is the very important for seismic hazard analysis and as such benefits all scientists and agencies competent to the prevention and management of natural disasters.

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A DATABASE DEVELOPMENT IN NOVA FRIBURGO TOWN FOR ANALYSIS AND COMPLEMENTATION OF THE MAPPING METHODOLOGY PROPOSED IN THE GIDES'S PROJECT

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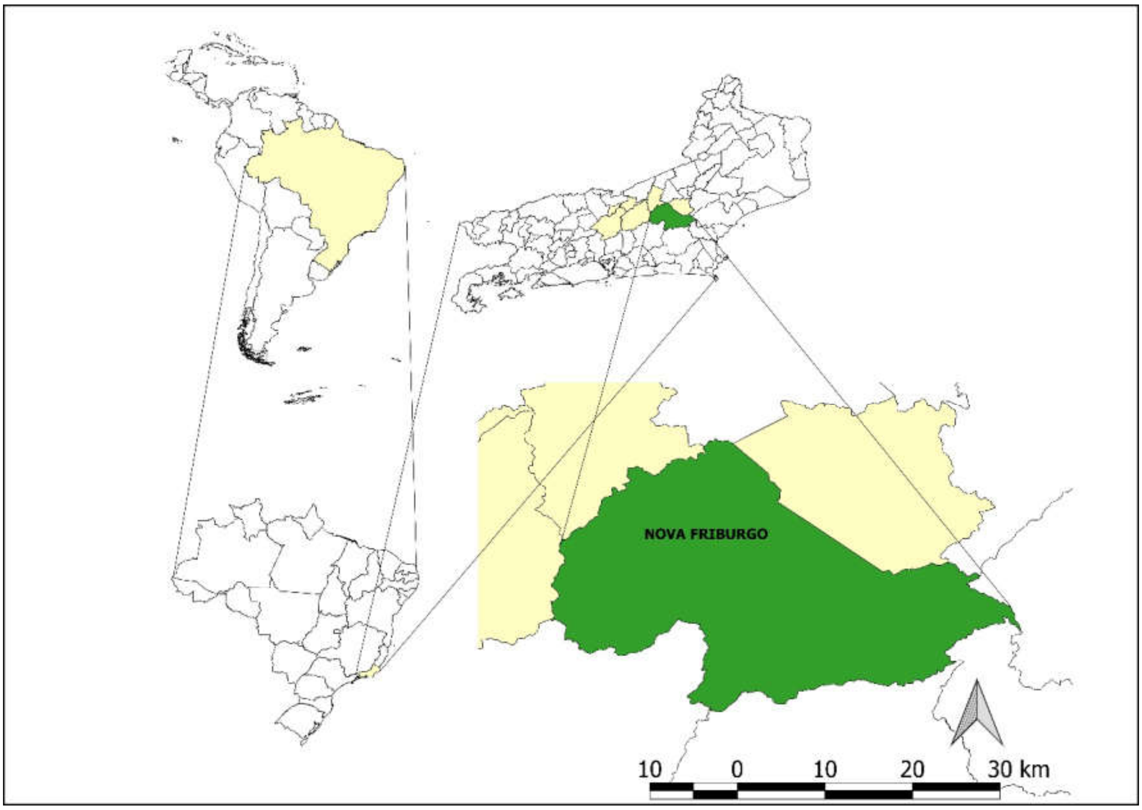
Abstract

The Project for Strengthening National Strategy of Integrated Natural Disaster Risk Management (GIDES) was developed from July 2013 to November 2017 with the objective of promoting technical communication between the japanese and brazilian programs for mass risk management. The municipality of Nova Friburgo (map 01) was inserted in this project and in this context the Geomatics Management sector received a technical recognition letter from Brazilian Geological Service (CPRM) to apply and disseminate the GIDES' Project methodology. During this project a lack of Brazil about gravitational mass movements (GMM) quantifications and statistical analyzes was evident linked to past events. In order to complement the mapping methodology proposed in the GIDES from the Manual of Mapping of Hazard and Risk to Mass Gravitational Movements the sector through this work extracted data from 125 slope fractures of planar landslides that destroyed about 54% of the lost buildings in Nova Friburgo reporting 455 cases of civil construction destruction in 2011 (map 02).

Keywords: GIDES; Brazil; Nova Friburgo; Planar Landslides

1 – Introduction

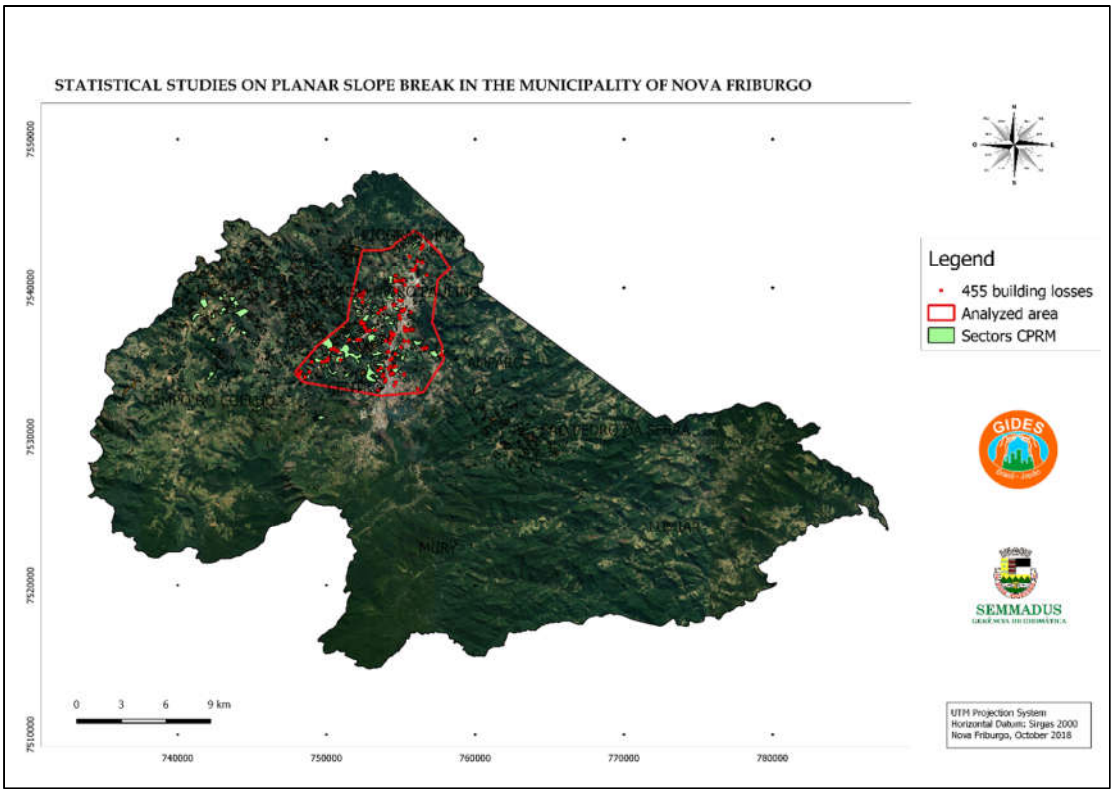
On May 25, 2017, the Project Project for Strengthening National Strategy of Integrated Natural Disaster Risk Management (GIDES) was awarded a prize in the city of Cancun in Sasakawa Prize. This award is given biannually by the UN Office for the Reduction of Disaster Risk Management (UNISDR) and the Japan Nippon Foundation. Technical and scientific the GIDES project resulted in complementary studies by the pilot municipality of Nova Friburgo in the Brazil (Map-01). The Management of Geomatics, an area belonging to the Secretariat for the Development of the Municipality of Nova Friburgo developed this bank data on gravitational mass movements occurring in the geoclimatic event The main objective of this work is to expose this survey of data extracted in a of 68 km² with more than 70% of the civilian buildings lost by planar landslides and debrisflow. The planar landslide is the focus of this work and in the area in question destroyed 54% of real estate lost in the municipality of Nova Friburgo representing 455 cases (Map-02)



Map 1 – Nova Friburgo's Localization Map

From the satellite image in image 1 it is possible to see the proximity of one of the fires with Nova Friburgo's downton.

The study area has 68Km² contained in the 11% of the coverage in which the municipality has a more detailed topographic database being made by Embraero Company in scale 1: 5000 in the year 2015. This area presents 87% of the landslides previously surveyed (graph 01) in field analyzes carried out by the CPRM in the three months that followed the event in order to verify the remaining risk sectors of adjacent civil buildings the occurrences of the mass movements of January 11 and 12, 2011. The information generated for the development of the data was: height, width, length, plateau, average slope, maximum inclination and destruction downstream due to rupture of occurrences as well as type of material moved, movement direction azimuth, relief form and verification of exposure of rocky outcrop after landslides. The methodological reliability of planar sliding of this Manual was made with confirmations made in the office and some field checks with the use of high resolution aerial images pre and post the event of January 2011. Taking into account that for each of the 125 analyzes was produced 20 information the final result of this survey are 2,500 raw data processed in the form of statistical graphs of the main catastrophic geoclimatic event occurred in Brazil..



Map2 - Area analyzed with 597 civilian buildings destroyed being 455 by planar landslide.

2 – Methods

The initial preliminary data acquisition method consisted of producing KML files with Google Earth Pro software in areas that had mass gravitational movements and simultaneously destroyed civil constructions in the 2011 geoclimatic event (Image 01). Subsequently with Quantum GIS software, the topographic base (SHP) 1: 5000 is crossed with mass gravitational movements (KML) and lost constructions (KML). In this crossing step, the intersection of the KMLs and SHP files is selected, producing an area of 68 Km² that corresponds to this study area.

At the municipal boundary of Nova Friburgo, 1: 25.000 scale is extracted from IBGE (Brazilian Institute of Geography and Statistics), the civilian buildings destroyed up to 20 meters from drainage, plus the cases of buildings destroyed up to 5 meters high from the bottoms of channels represented by curves marked by a 30 ° or greater slope lock.This procedure is redone in a scale of 1: 5.000 for the 68 km² and the cases with destruction of civil constructions associated to drains classified as debrisflow.The other cases not associated with drainage are the landslides that will be detailed in the study area.

In the 68 Km² of the study area, the slope ruptures that generate the destruction of the civil buildings are initially delimited. The criterion to define a rupture was minimum of 5 meters of height from the crest of the area of occurrence defined in this way only ruptures with civil destructions. From the top of the ruptures, lines perpendicular to the contour lines are drawn to the bottom of 25 ° incline contained in the area of movement. From the landslide crest points to the base of 25°, the azimuthal measurement is extracted with the plug-in CadTools. This azimuthal orientation is the main slide axis being used as reference to the extraction and measurements of the other data. In the civil buildings destruction location classification, the spacing used is 10,7 in meters in level contours of 5 meters to measure with the QGIS's ruler the slope areas with more than

25° of inclination. The baseline is the measurement above this value between slopes with more than 25 ° being this and the maximum inclination performed by the main slide axis. Destroyed buildings in danger zones defined as critical, dispersion and low risk are produced taking into account the hill plus the distance of 30 meters from the slope baseline in an azimuthal orientation. In the area of danger of dispersion the measurement variation also follows the azimuth, but in the interval of 30 and 50 meters from the base of 25 °. The area outside the danger zone has azimuth distances from the base of the hill above 50 meters. In verifying the applicability of the GIDES methodology is defined as not applicable when the distance from a civil destruction is greater than 50 meters as well as when that distance is greater than once the height in the critical danger area and twice the height in the area of danger of dispersal. The shape of the contour lines is also characterized in this study to define the relief shape most susceptible to planar landslides. In this analysis, it is verified the direction of bending of the three level curves of the base of the hill using preferably the 15 meters of height of the base of the mountain with slope equal or superior to 25°.

Image 01 - Visual analysis and delimitation of areas of occurrence and destroyed civil constructions

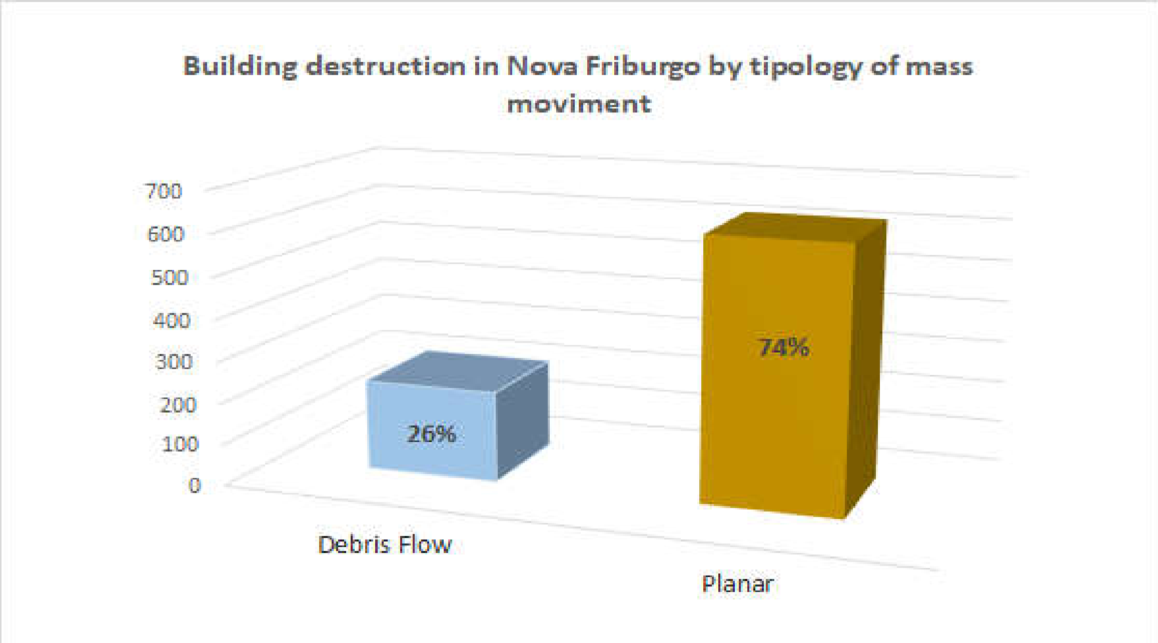
Source: Google Earth Pro, 2010 - 2011

In the planar slip method proposed in the Manual of Mapping of Hazard and Risk to Mass Gravitational Movements developed in the GIDES project, three zones are defined as two danger zones and one out of danger zone. The technique proposed in this manual uses slopes of hills with an average slope greater than or equal to 25 ° and height equal to or greater than 5 meters and this topographic configuration is a prerequisite of hazard mapping. Once the slope has been defined with potentially dangerous conditions, a horizontal line perpendicular to the contour lines is projected downstream and equivalent to once the height of this slope, but not exceeding 30 meters. This area makes up the reach of the critical area (CA) which also includes every area of the slope as well as the horizontal 10 meters projected upstream from the top 25 ° of slope. The second hazard area with a minus degree of risk is defined as yellow or dispersioan area (DA). This danger area is an extension downstream of the critical area and follows the ratio of 2 times the height of the slope to a maximum of 50 meters. The area of potential danger to planar slip includes both the critical and dispersion area. Therefore, to verify if the method in question is functional, the analysis of this mapping technique is carried out by quantifying civil constructions destroyed by mass gravitational movements. Using these criteria, the technique of mapping was developed at sites not associated to drainage channels as well as attached to surface water flows. From the topography the planar slip technique was also used in two other ways: one as established by the manual, projecting the attainment with the variation of top height to the base of the 25° slope of the slope and, other than the height of the slope associated with the 2011 event as a reference to project the hits in CA and DA. These checks add up to 500 additional data to the 2500 data by quantifying in Excel table thus composing a numerical quantity of 3000 cells with statistical data from Nova Friburgo. The area presents 87% of the landslides previously surveyed in field analyzes carried out by the CPRM in the three months that followed the event in order to verify the remaining risk sectors of the adjacent civil constructions the occurrences of mass gravitational movements of 11 and 12 January 2011. These field surveys inform by description and photographic collection a set of information of the landslides that in turn was the main focus of this analysis. The statistical data generated by the CPRM technical material were: the type of material moved (residual or colluvium), the presence of rock blocks associated to the sliding soil, the characterization of the soil rupture surface on soil with soil exposure at the end of motion or soil on rocky rocky outcropping exposure after the slides. The database of other information such as the azimuth of the direction of movement, height, width, length, slope, mean slope, maximum slope, relief shape and destruction analysis related to slope of the terrain were extracted with reference to the topographic base in a scale of 1: 5.000 Embraero company made and delivered to the municipality of Nova Friburgo in 2015. The data dfprocessing was performed in Excel using the functions: SOMA and CONT.SE and the results of the analyzes were made in pie and column charts. The azimuth, mean slope, maximum slope, length, width and height of the ruptures were previously grouped by comparable measurement intervals. The SUM function was used for the quantification of the destroyed civil constructions in the slope, base or top of this being also useful function to quantify the destructions occurred in the danger areas. The function COUNTIF was used to verify the slope rupture levels as well as to analyze the quantification of the distance of attainment with destructive energy in planar landslides. The Quantum Gis software raster calculator was used to quantify the utilization of the non-hazard areas mapped using the planar glide technique of the Manual of Hazard and Risk to Gravitational Mass Movements and the ruler of this software was used in the various analysis related to topography site and footage of destroyed civilian buildings. This analysis was carried out in approximately 4.256,459 m² related to the pilot areas of the GIDES project mapped in the years 2016 and 2017. The Brazilian municipalities pilot of the GIDES project were adequately equipped to fulfill the mission of mapping high detail of the territory in scales of analysis equal to or greater than 1: 2000. From November 2017 the municipality of Nova Friburgo received the training and life license to use the software Pix4D being the program in question suitable for producing horticultural images, topographic bases and 3D model of relief. This work has been carried out by the Geomatics Management Department of the Municipality of Nova Friburgo. This sector uses images from Drone Phantom 4 for civil defense and defense from aerial surveys with routes and areas of coverage and height programmed in the office. In the year of 2010 the municipality hired the company Engemap for the aerial survey of the territory mainly of the urban area of the city. This survey resulted in orthophotos georeferenced with 0.2 meters of pixel referring to this year that in turn precedes the event 2011. Geomatics Management currently delimits the destroyed civilian buildings polygons with aerial images of high spatial resolution of before and after occurrence of landslides in addition to conferring local topography with the TruPulse 200B model laser hypsometer with accuracy +/- 0.3m (Borrowed from CPRM to Geomatics Management / SEMMADUS / PMNF).Os 3.000 dados estatísticos referente ao evento geohidrológico de 2011 produz mais de 20 gráficos e mapas expostos neste trabalho. This data is available in excel tables as well as SHP files (shapefiles) that can be verified in geoprocessing software such as QuantumGIS and ArcGIS. The work scales were 1: 25.000, 1:5.000 and local scale with field studies and high resolution images pre and post event of 2011.

3 – Results

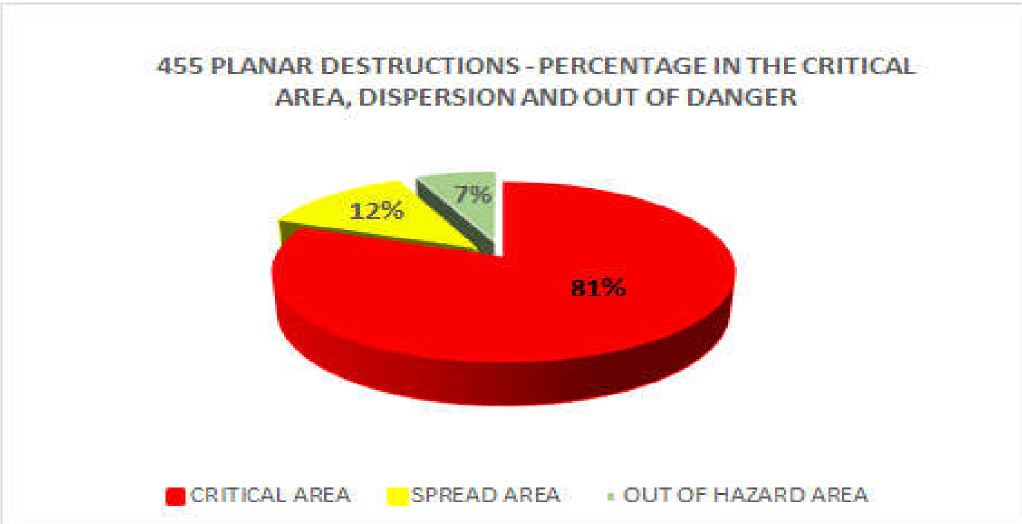
The analysis based on IBGE's 1:25.000 base with equidistance level curves of 10 meters and hydrographic networks also on this scale shows that of the 842 civil constructions lost in Nova Friburgo most of them were by planar landslide, which justifies the further study of this typology of mass gravitational movement that in turn represented 74% of the losses occurred in the municipality (graphic 01).

In the method adopted in GIDES mapping there are three zones: critical area, dispersion area and out of danger. The initial analytical form of the method uses the quantification of destroyed civil constructions in each of these zones. This count was carried out under different physical conditions, as well as in a general and specific way. The use of the planar glide technique for cases of mass gravitational movements not associated with drainage channels using slope height greater or equal to 25° slope results in the percentages of 81% in the critical area, 12% in the dispersion area and 7% out of danger (graphic 02). This analysis constitutes a 93% accuracy in relation to the applied methodology and uses the natural configuration of the relief to define the danger zones. In this analysis all the slopes up to 50 meters of the lost buildings are taken into account to project mass gravitational mass hits.



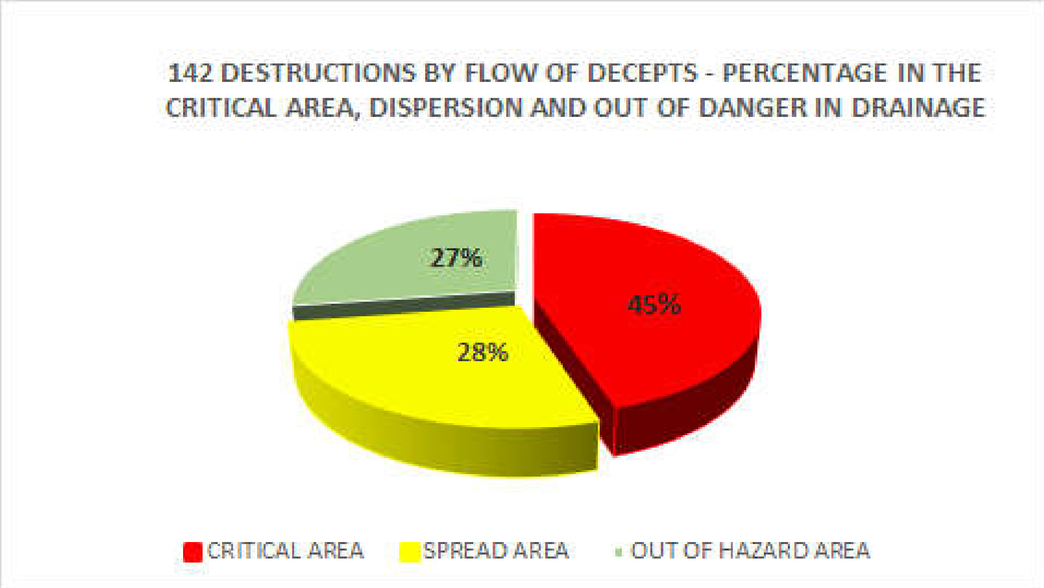
Graphic 1 –Predominance of planar landslides in the municipality of Nova Friburgo

In the method adopted in GIDES mapping there are three zones: critical area, dispersion area and out of danger. The initial analytical form of the method uses the quantification of destroyed civil constructions in each of these zones. This count was carried out under different physical conditions, as well as in a general and specific way. The use of the planar glide technique for cases of mass gravitational movements not associated with drainage channels using slope height greater or equal to 25° slope results in the percentages of 81% in the critical area, 12% in the dispersion area and 7% out of danger (graphic 02). This analysis constitutes a 93% accuracy in relation to the applied methodology and uses the natural configuration of the relief to define the danger zones. In this analysis all the slopes up to 50 meters of the lost buildings are taken into account to project mass gravitational mass hits



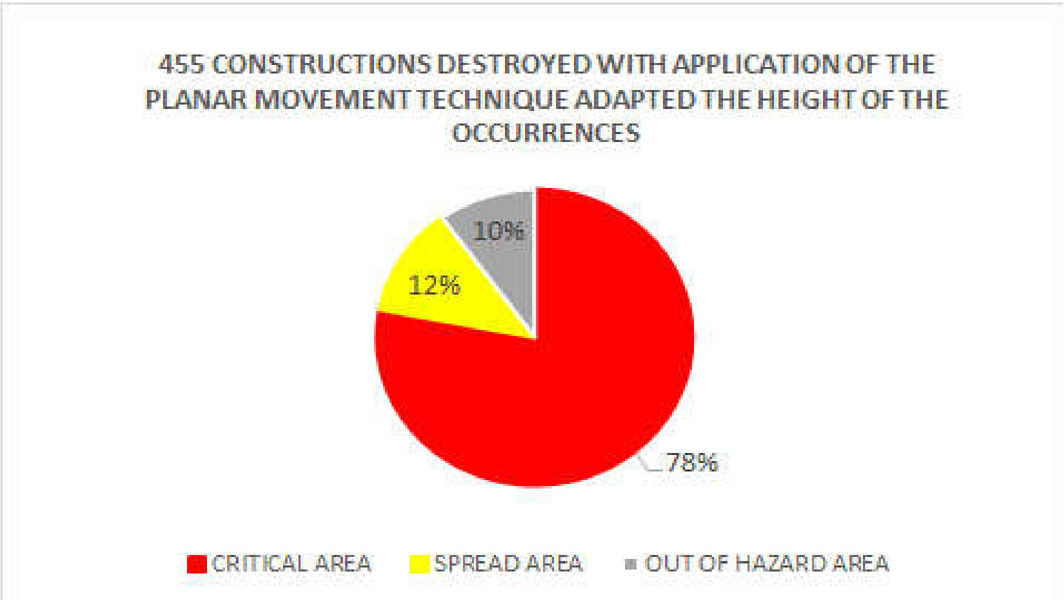
Graphic 2 – Graphical representation of 93% methodological accuracy (CA + DA)

In a second verification, only cases associated with drainage channels are analyzed. The planar slip technique in this case is applied to another typology of mass gravitational movement defined as a flow of debris in which the mobilized material is more fluid. The result makes it clear that the method is less efficient with 20% less accuracy, but it is understood that even if it is not ideal the planar slip method for flow of debris is applicable since the statistic shows a sum of the danger areas critical and dispersion of more than 70% (Graphic 03)



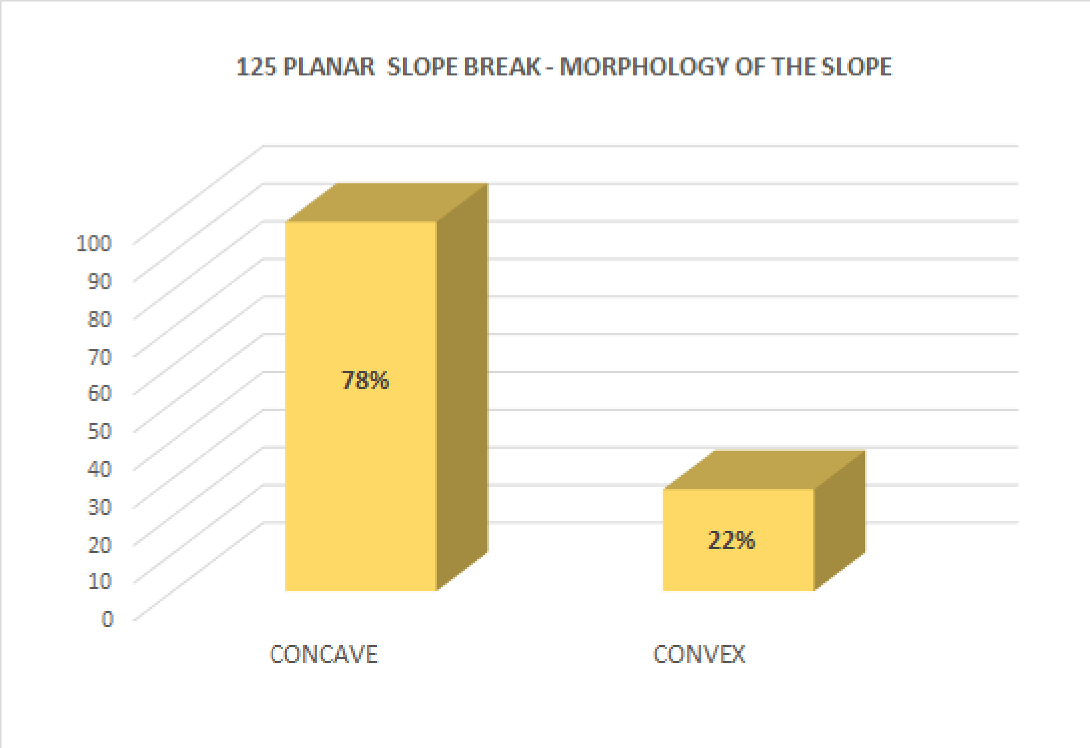
Graphic 3 – Graphical representation of 73% methodological accuracy (CA + DA)

The final analysis is more specific because it considers only a slope without drainage channel and uses the heights of the planar landslide rupture to project areas of attainment from the azimuth direction of the main axis of the movement. The results are: 78% in the critical area, 12% in the dispersion area and 10% in the non-hazardous area (graphic 04). This analysis constitutes a 90% accuracy proving that in a more specific analysis the GIDES methodology the planar slip is applicable and highly reliable.



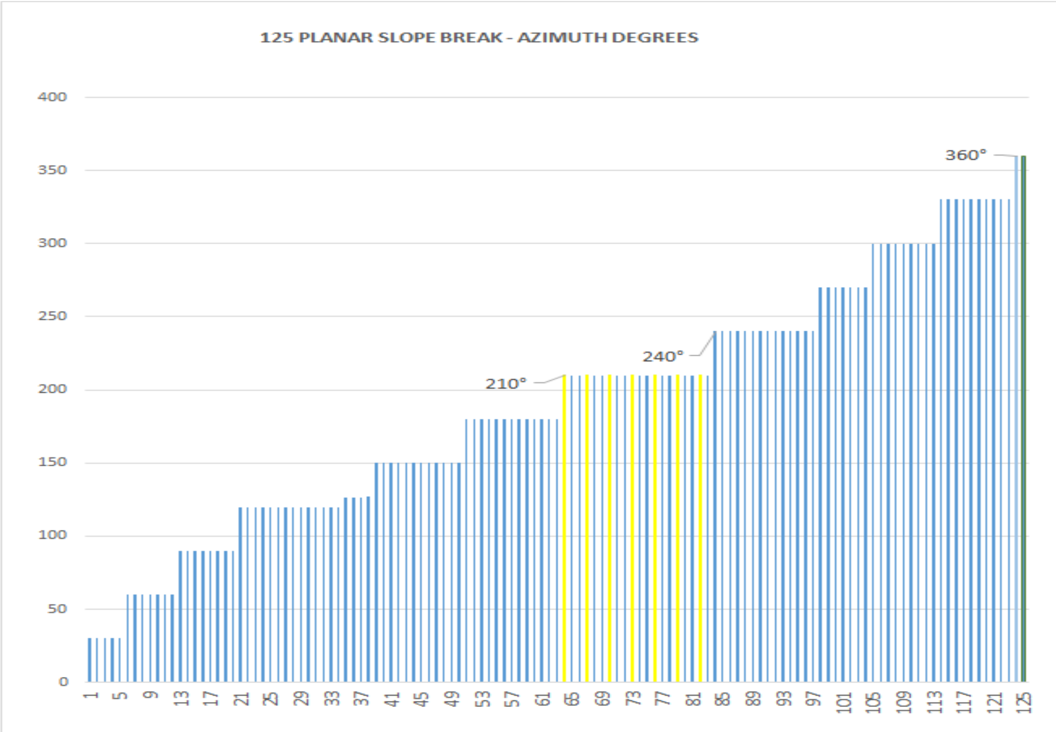
Graphic 04 - Graphic representation of 90% methodological accuracy (CA + DA)

The concave relief as shown in graphic 05 composes 78% of the cases, giving a greater pre-arrangement to planar landslides. In this relief this occurs because this feature facilitates the concentration of surface and groundwater that in turn promote movement. The convex relief works as a water divider, dispersing the superficial and subterranean flow, which results in a lower probability of massive gravitational movements.

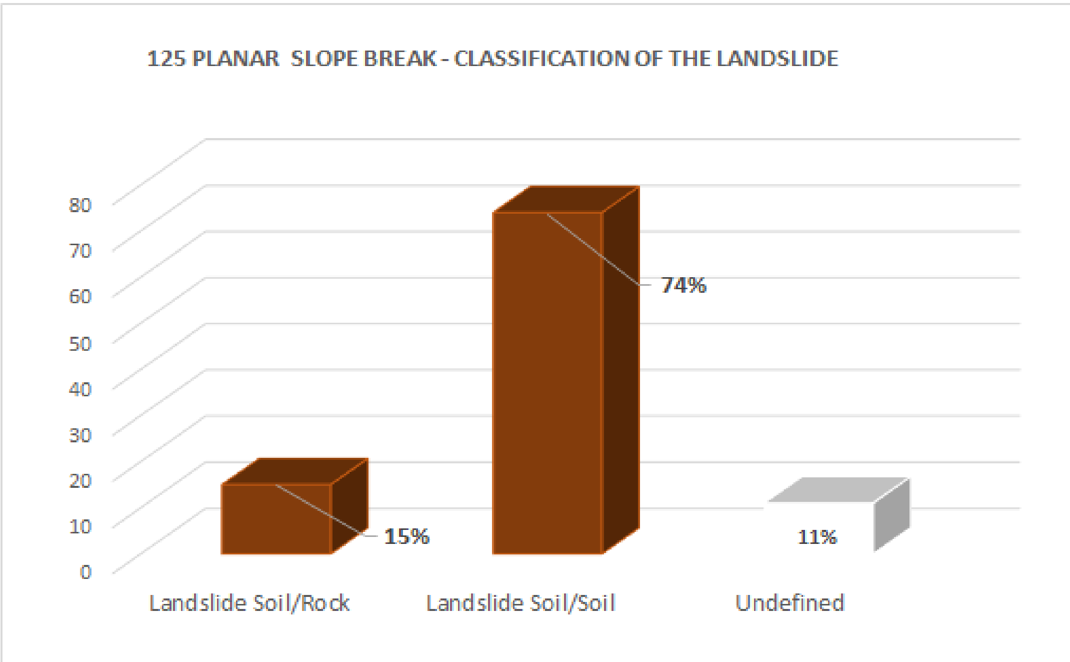


Graphic 05 - Greater Susceptibility to Concave Reliefs.

The result of the azimuthal (graphic 06) data points to a dispersion of values in the way of occurrence of the 125 ruptures analyzed. Therefore, the azimuth data calculated by the main axis of the planar landslides show that the occurrences associated with civil buildings destroyed in 2011 occurred in more circular hills. However, there is a predominance in azimuthal variation from 210 to 240 ° that is not very expressive in 6% of the cases. In the planar soil / rock landslides there is a predominance of the way of movement to the southeast between the azimuthal variation of 120 to 150° in 32% of the cases. The verification of the classification of the movement process shows 74% of the cases are planar landslides soi/soil (graphic 07). Probably these analyzed cases refer to the alteration of plutonic rocky bodies that promote deeper pedogenetic alterations in homogeneous textures of magmatic origin with circular shape. In the verification of the average slope, it was verified that 35% of the cases of soil / soil landslide had more than 35° of inclination, but the ground / rock planar movements make up 47% of these cases. The rocky slopes of Nova Friburgo that have resulted in planar soil / rock slides are also more difficult to occupy since they are more oriented and steep.



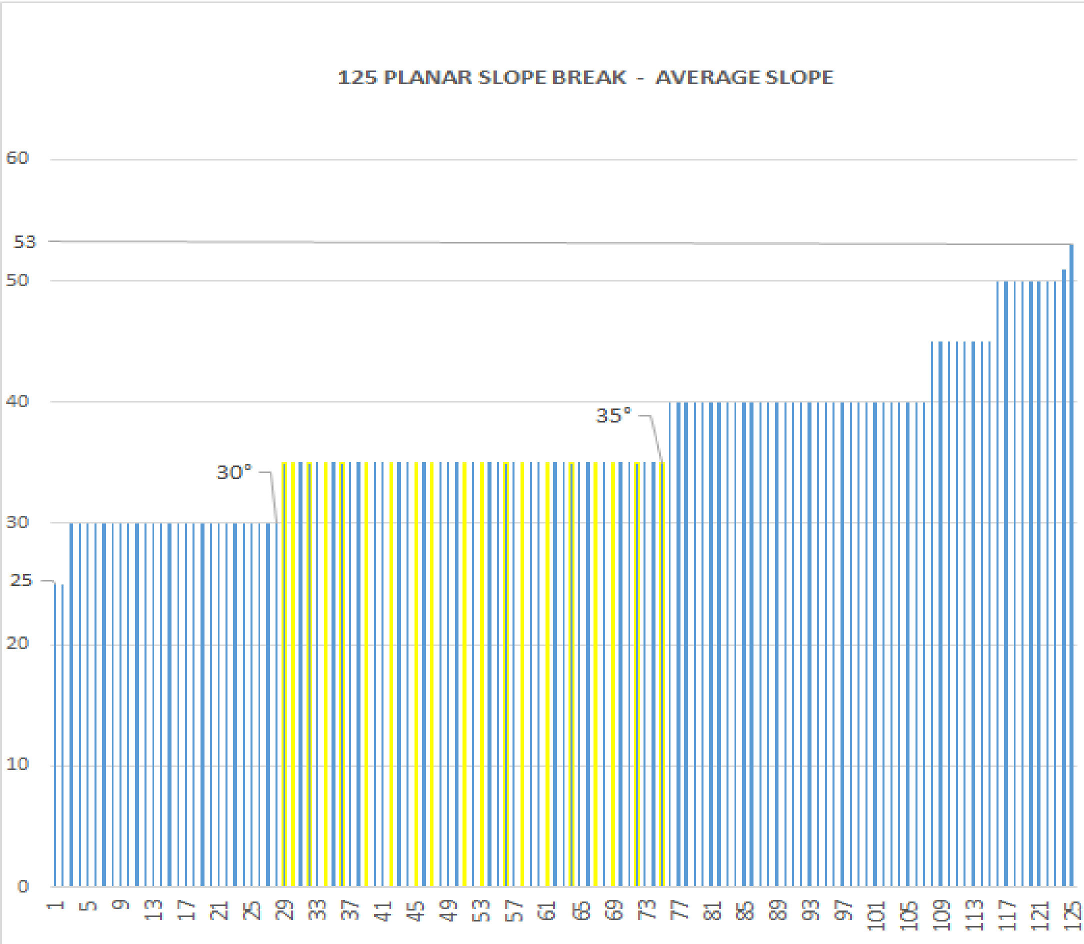
Graphic 06 - Alternate azimuths representing planar landslides on circular hills



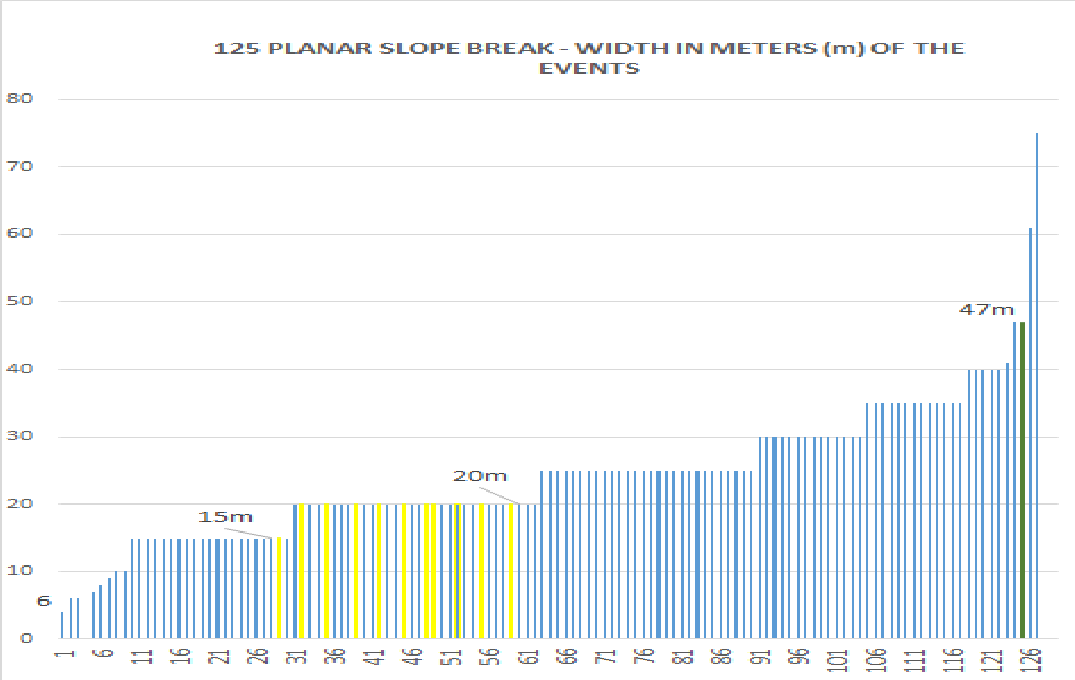
Graphic 07 - Predominance of planar soil/soil landslides in sites with civilian destruction

The results of the average slope clearly show that a significant number of cases range from 30 to 35° of slope with extremes ranging from 25 to 53° (graphic 08). The width of the slides in general presents measures between 15 to 25 meters (graphic 09). These results can be used to verify remaining risks in the adjacent lateral areas the occurrences being consistent the adoption of 25° of medium slope for hazard mapping as well as the measure of 25 meters minimum distance to infer lateral risk to past landslides.

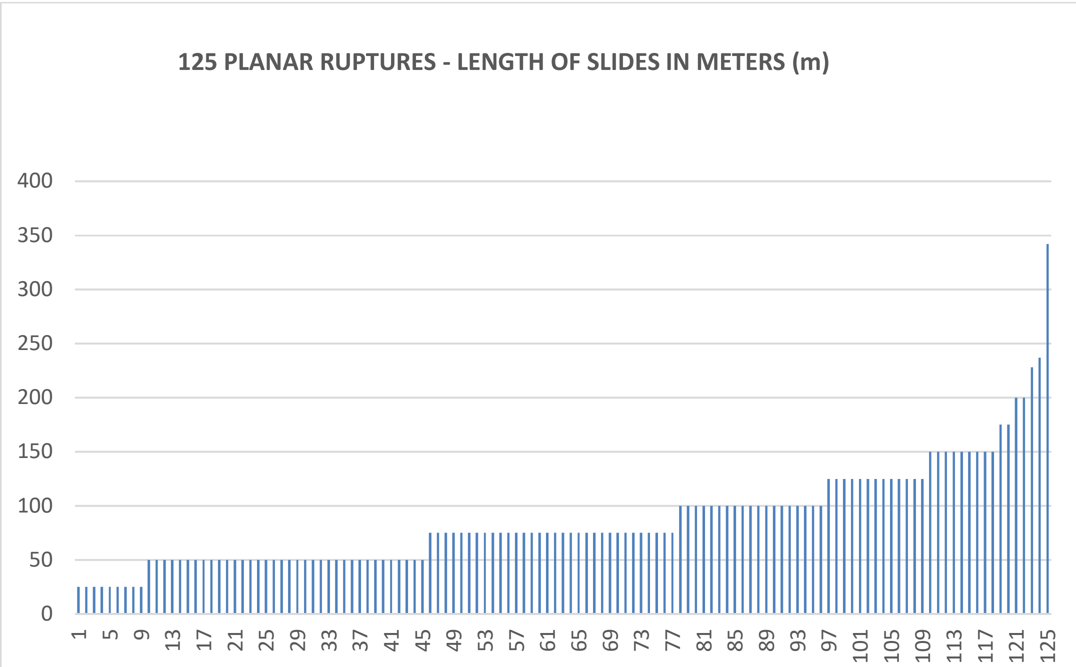
The length of landslides in the vast majority of cases ranges from 25 to 150 meters (graphic 10), with only 7% of cases measuring below 25 meters. The height data of the area greater than or equal to 25 ° inclination show that in general the heights reach 60 meters (graphic 11). These cross-heights with the destructive attainment distance data demonstrate that the ratio of 1.5 times the height of the slope to project hits contains 96% of the cases of ruptures associated with destroyed civilian constructions (graphic 12). In the 125 cases of ruptures, the mean of 45 to 50 ° show the predominance of the maximum inclinations.



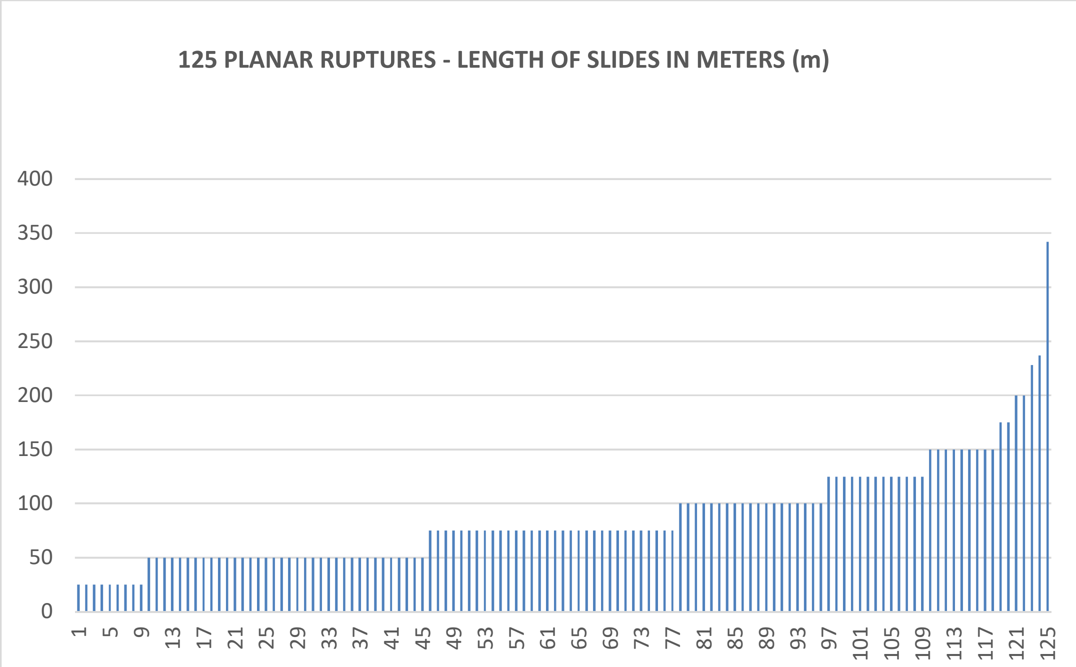
Graphic 08 - Average slopes in general varying from 25 to 40° with predominance of measures between 30 to 35°



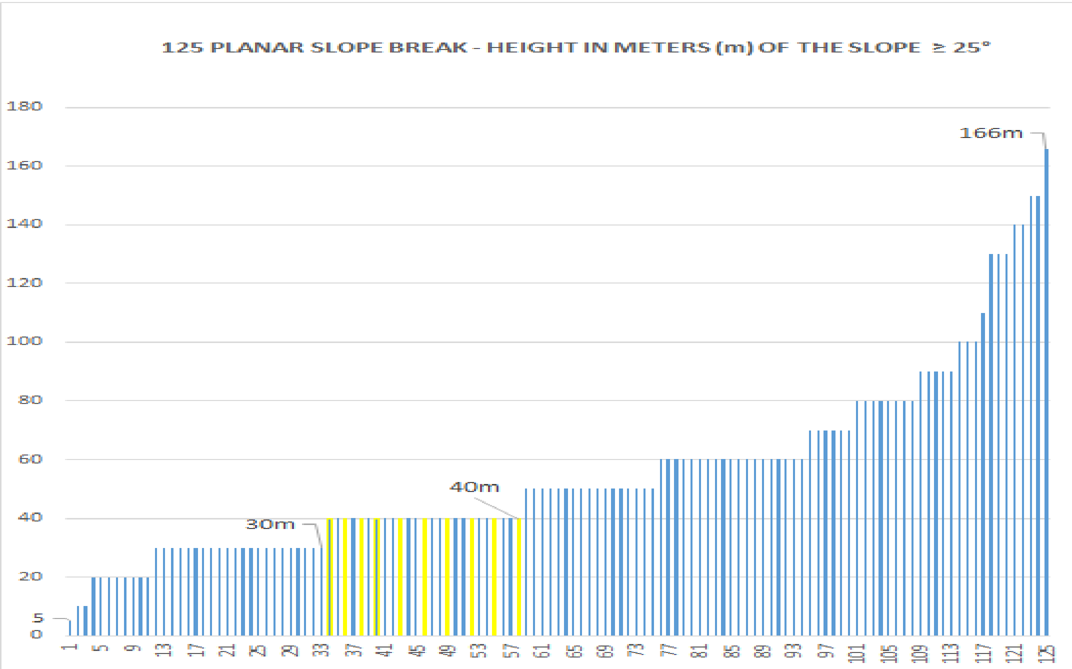
Graphic 09 - Statistics representing the width of occurrences at 5m downstream from the top of the slide



Graphic 10 - Graphical representation with minority of slides less than 25 meters



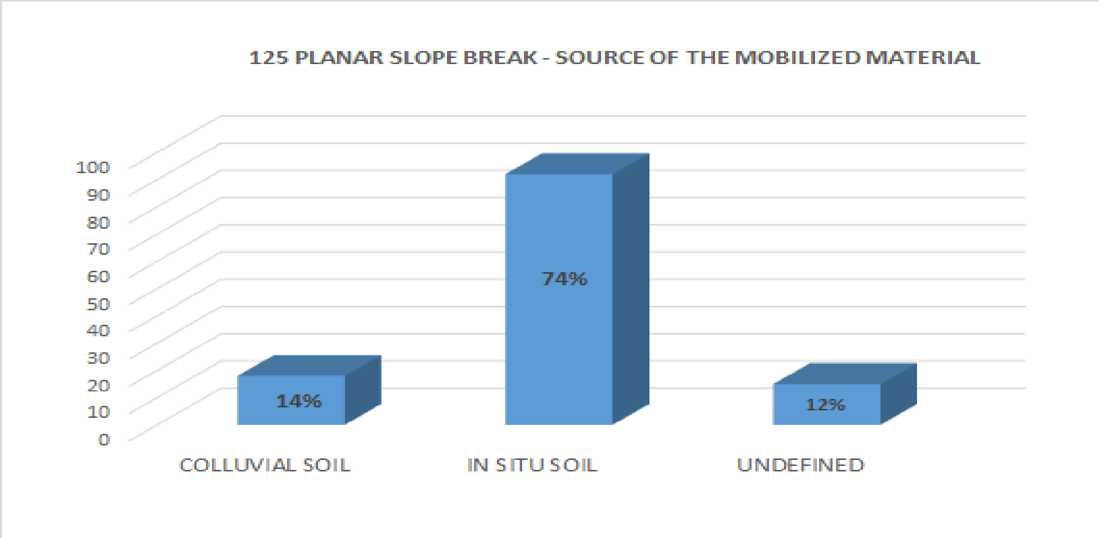
Graphic 11 - Greater variation of measures between 25 and 60 m of height with predominance between 30 and 40 meters



Graphic 12 - Horizontal projection of 1.5 times the height of the slope composing 96% of the cases of ruptures

The statistical analysis of landslides shows that in the great majority of cases occurred in 2011 there was in situ soil mobilization (graphic 13). This material of more cohesive nature was displaced in the landslides of the event and in a significant part of the cases it was deposited in the phase and the base of the slope conferring today a greater local susceptibility with colluvium (more inconsistente material) combined with slopes prone to mass dispersion as highlighted by sectors 29, 34, 35, 39, 67, 83 and 141 of the CPRM. From the field analyzes carried out in September 2018 the Geomatics Management / PMNF verified under UTM coordinates: X = 754523 and

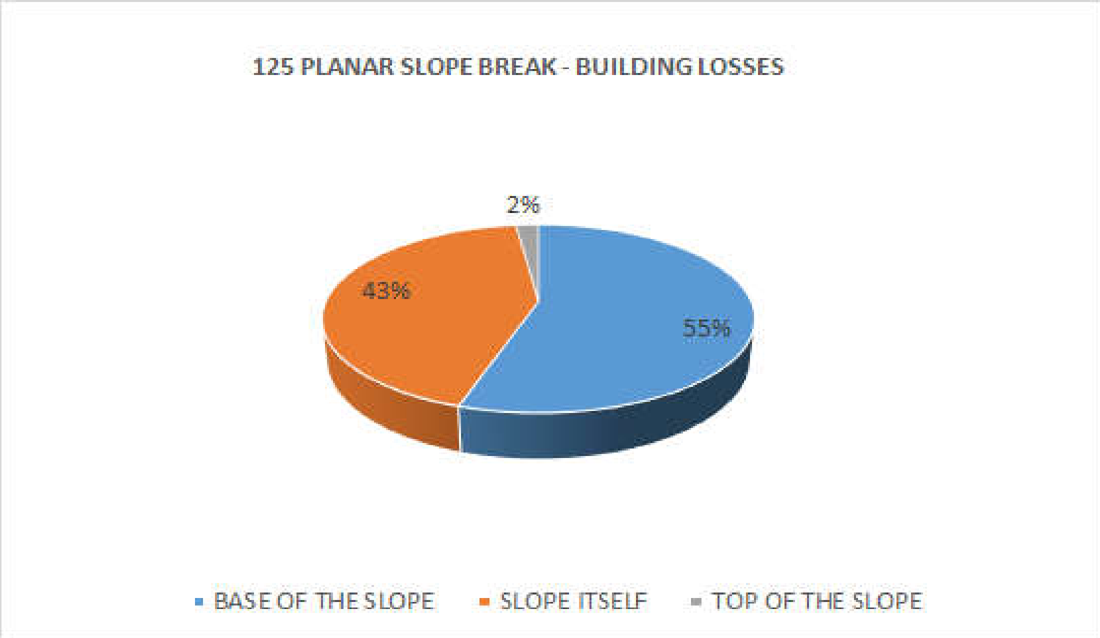
Y = 7533458, zone 23 K transported soil (colluvium) deposited on a steep slope in a remnant area of mass movements occurred in 2011 (Image 02).



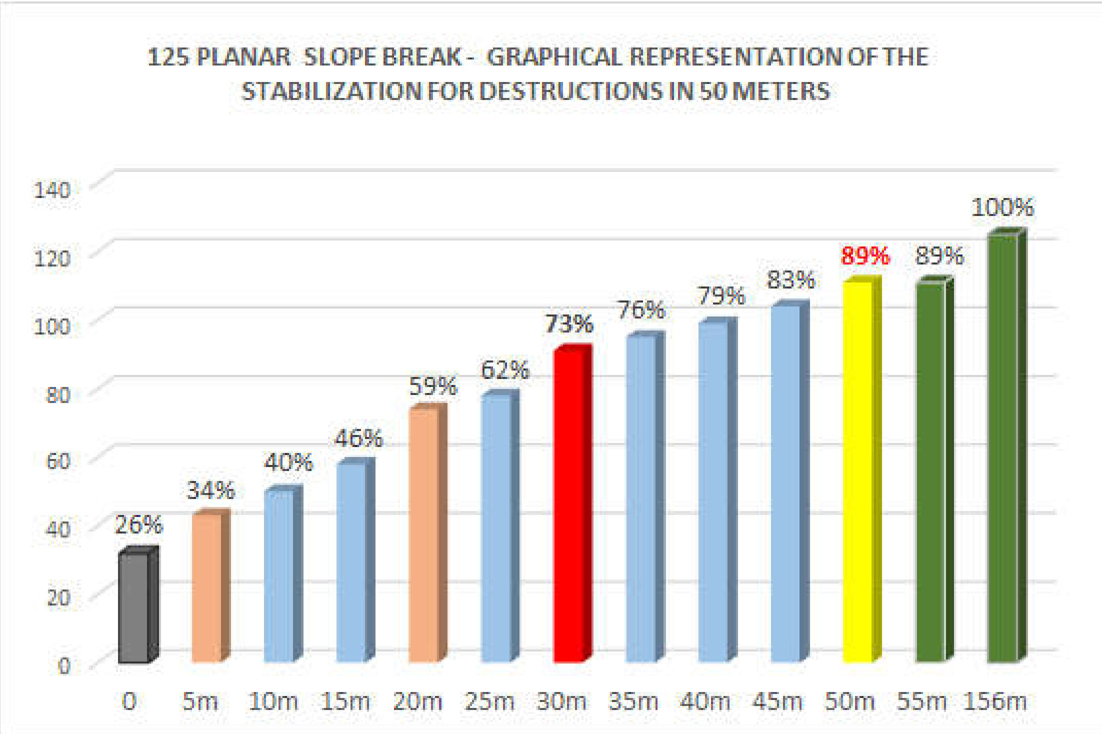
Graphic 13 - Predominance of soil slides in situ (residual)

Image 02 - Soil of colluvium deposited in the base and the face of the slope in past events

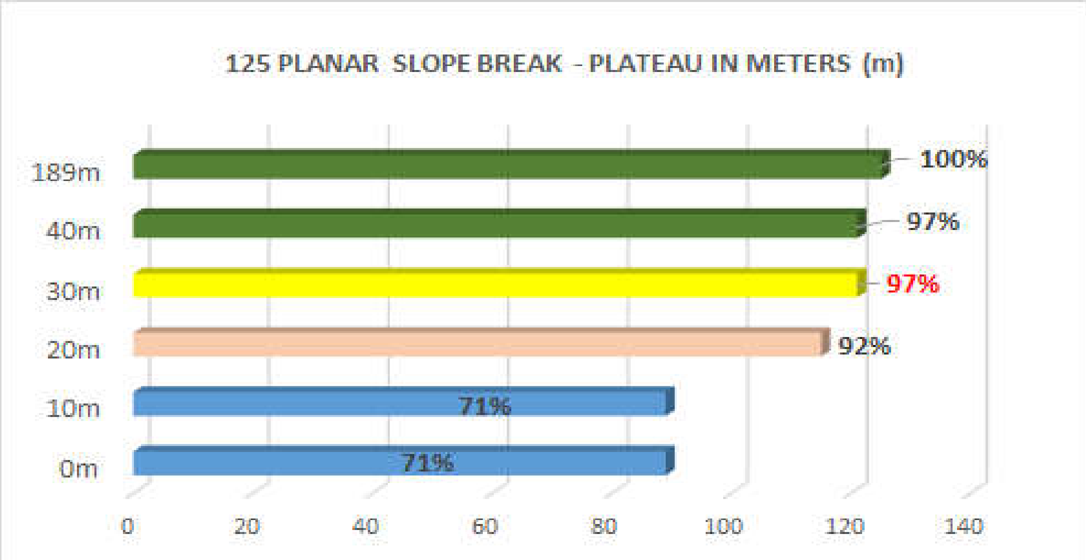
The understanding that inclined areas are more dangerous than locations of smooth topography seems to make great sense when dealing with areas of danger to mass gravitational movements. However, statistical data indicate that the highest concentration of destroyed civilian buildings was in areas with little inclination (graphic 14). This is because areas close to the slopes of the slopes are susceptible to receiving the material mobilized by the landslide and in general slope areas greater than or equal to 25 ° are subject to losses of soil and / or rock. To understand the behavior of nature and how far the masses dispersed in planar landslides has the potential to destroy buildings, a study was carried out with the houses destroyed further downstream of the slopes of average slopes equal to or greater than 25 ° and the final result of this analysis shows that the distance of 50 meters of this is clearly the most adequate because even increasing to 55 meters the percentage of hits does not change remaining at 89% (graphic 15). This verification takes into account that the slopes (areas of soft topography between slope sites) are part of the slope even if slopes lower than 25 ° because the calculated average that is taken into account and in the analysis of levels 97% of landslides have up to 30 meters (graphic 16) measured perpendicular to the contours.



Graphic 14 - The graph represents a higher concentration of losses of civil constructions downstream of the end of the topographic condition of 25° of slope and lower percentage within the slope area

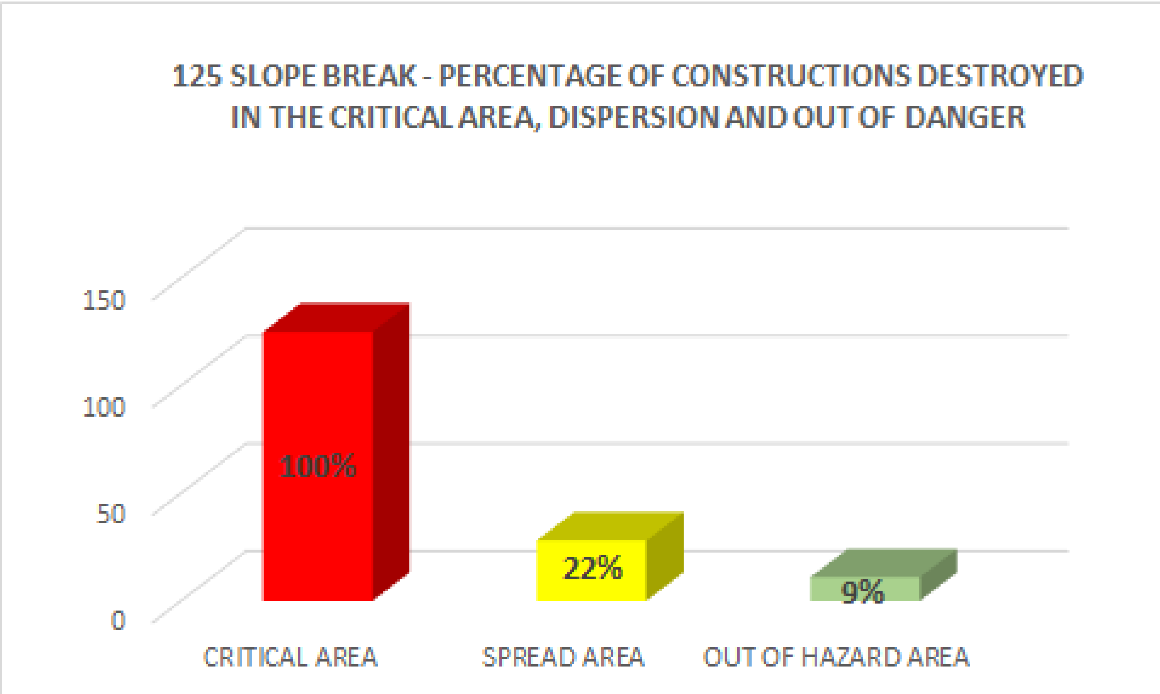


Graphic 15 - Quantification of hits for danger areas with each increase in 5 meters of slope clearance from the slope with an average slope equal to or greater than 25 °



Graphic 16 - The films on the main axis of the gravitational mass movement measured in topography flattened between slope sites with inclination greater than or equal to 25°

The analyzes carried out are applicable in 88% of the 125 ruptures studied, but these percentages counted by number of slides that are in agreement with the technique of planar as well as by the quantitative of the 455 destructions by mapped zones always take into account the sum found in the area of critical danger and dispersal. However, these areas of danger can be differentiated otherwise there would be no need for separation and the statistical verification shows precisely that the critical danger zone has at least one civil construction destroyed in all 125 cases of planar landslides analyzed. In the area of dispersion this value reduces from 100% to 22% and the cases of ruptures with at least one destruction out of danger are at 9% (graphic 17).



Graphic 17 - The graph shows that the danger in the critical area is considerably greater than in the dispersion area

The verification of the methodological correctness is not enough to classify a map as being the ideal because it is of great importance that the geological / geotechnical mapping in question take advantage of a more expressive percentage of area when comparing it with other materials of aptitude the occupation in place safe. The Municipality of Nova Friburgo has more than one cartographic material in an area of 4.256,459 m². The Geotechnical Chart of Urban Aptitude developed by DRM-RJ (Geological Service of the State of Rio de Janeiro) covers the entire municipal territory and more recently the map of the GIDES project developed by the municipality of Nova Friburgo in conjunction with CPRM and JICA (International Cooperation Agency of Japan).

The image 03 expresses the Danger Map of the GIDES project in planar gliding with a light blue color representing slope areas greater than or equal to 25 ° of medium slope and in dark blue the projection of areas of critical attainment and dispersion in a distance up to 50 meters downstream from this slope. Correctness is expressed by the quantitative percentage of red dots that characterize civilian destruction by landslides in areas pre-defined as hazard (in the case of this map the blue-colored areas). Finally, the orange color represents places defined as non-hazardous areas and characterized as low risk, that is, occupable areas that represent 58% of the area that can be used in GIDES mapping with the planar technique. Image 04 expresses the Geotechnical Letter of Urban Aptitude with the color in blue representing the areas that can not be occupied without interventions of works of risk mitigation and the color in orange represents the areas apt to the occupation defined as low risk. The accuracy of this letter is equated with the GIDES hazard map in 94 and 95% however it only has a 6% area utilization.

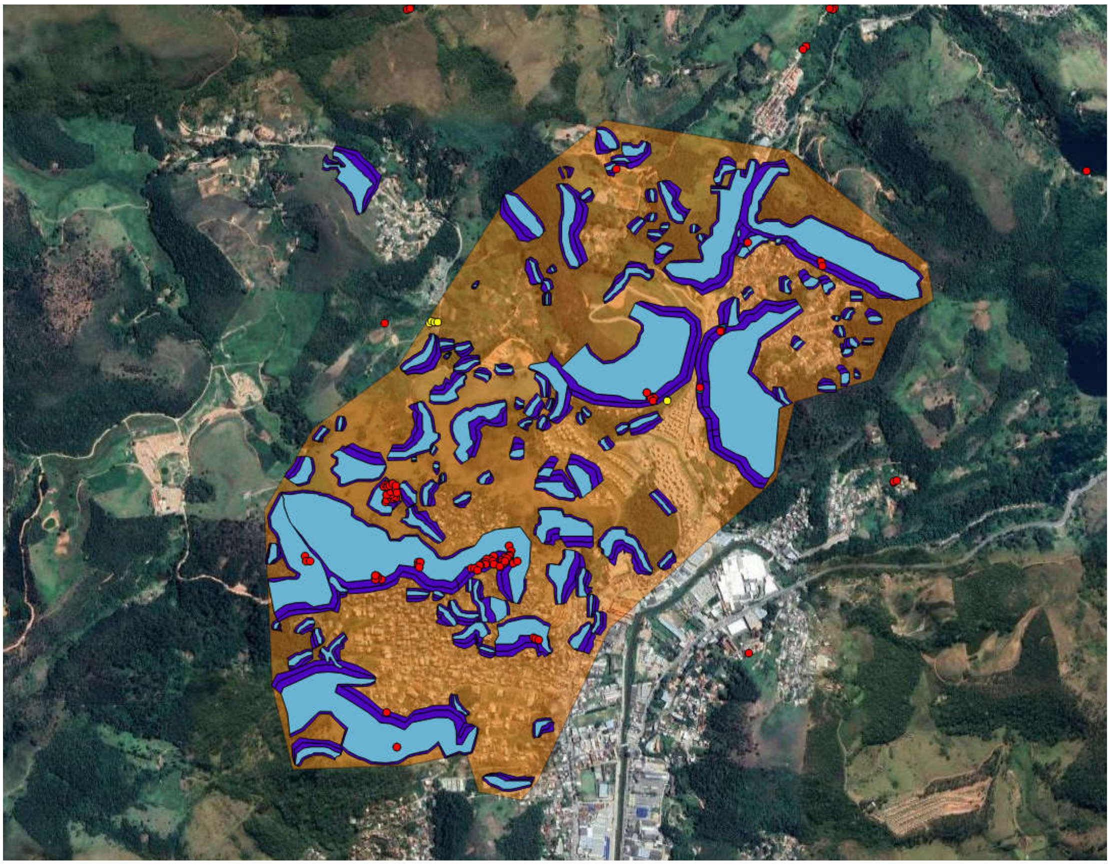


Image 03 - The application of the planar slip technique developed during the GIDES project in the pilot area represented in this Hazard Map 94% of correctness and 58% of use of safe areas

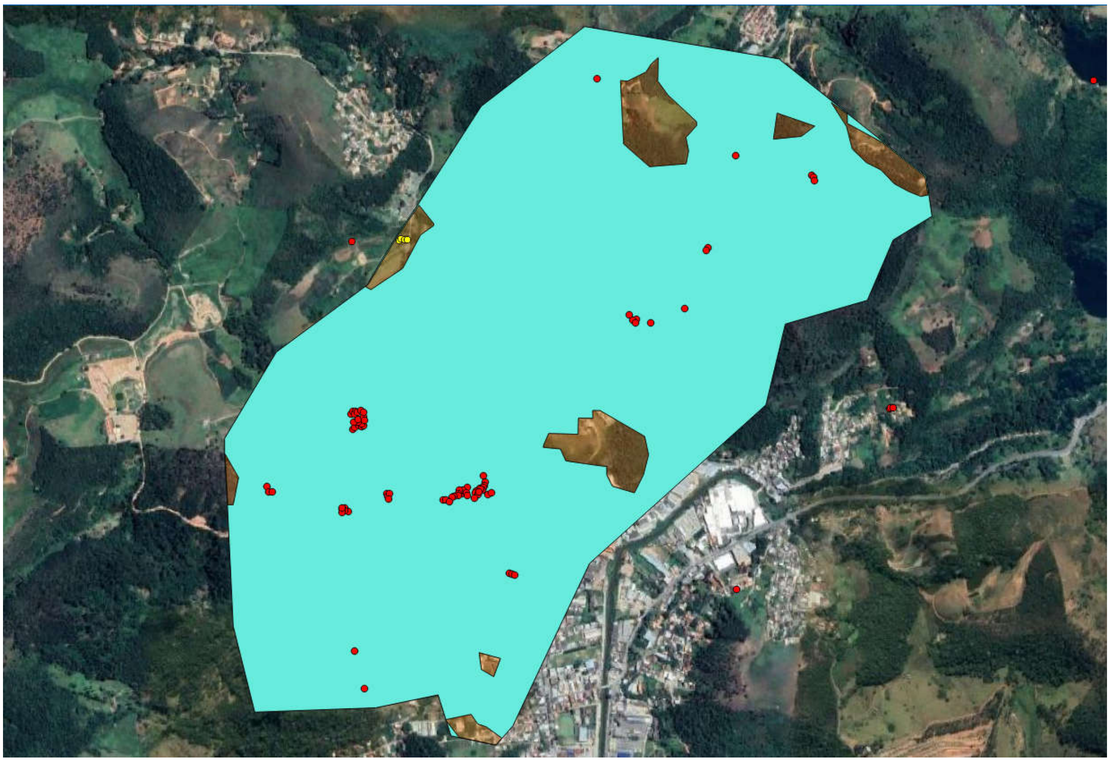


Image 04 - The Geotechnical Chart of Urban Aptitude elaborated by the DRM-RJ presents a low risk in the areas of the orange polygons - This presents 95% of accuracy and 6% of exploitation

The result of the mapping performed by the Geomatics Management / PMNF sector started after the end of the GIDES project with the use of a laser hypsometer for topographic corrections and verification in high resolution images of the before (ENGEMAP Company) and after (DJI Phantom 4) of the event geoclimatic model of 2011 shows that of the 45 civilian buildings lost (image 05 and 06) by mass gravitational movements 78% would be in the critical area, 15% in the dispersion and 7% outside the danger area, with a methodological accuracy of 42/45 equivalent to 93%. This quantification takes into account lost constructions in the form of georeferenced polygons and in the case of destructions that occupy more than one danger area one always takes into account the greater degree of danger in the case the critical area is classified preferentially and also in limits the area of dispersion is prioritized in counting the zone out of danger. In this check of aerial photos of the DJI Phantom 4 obtained in 2016, 2017 and 2018 are evident slips remaining / 2011 (Image 07).

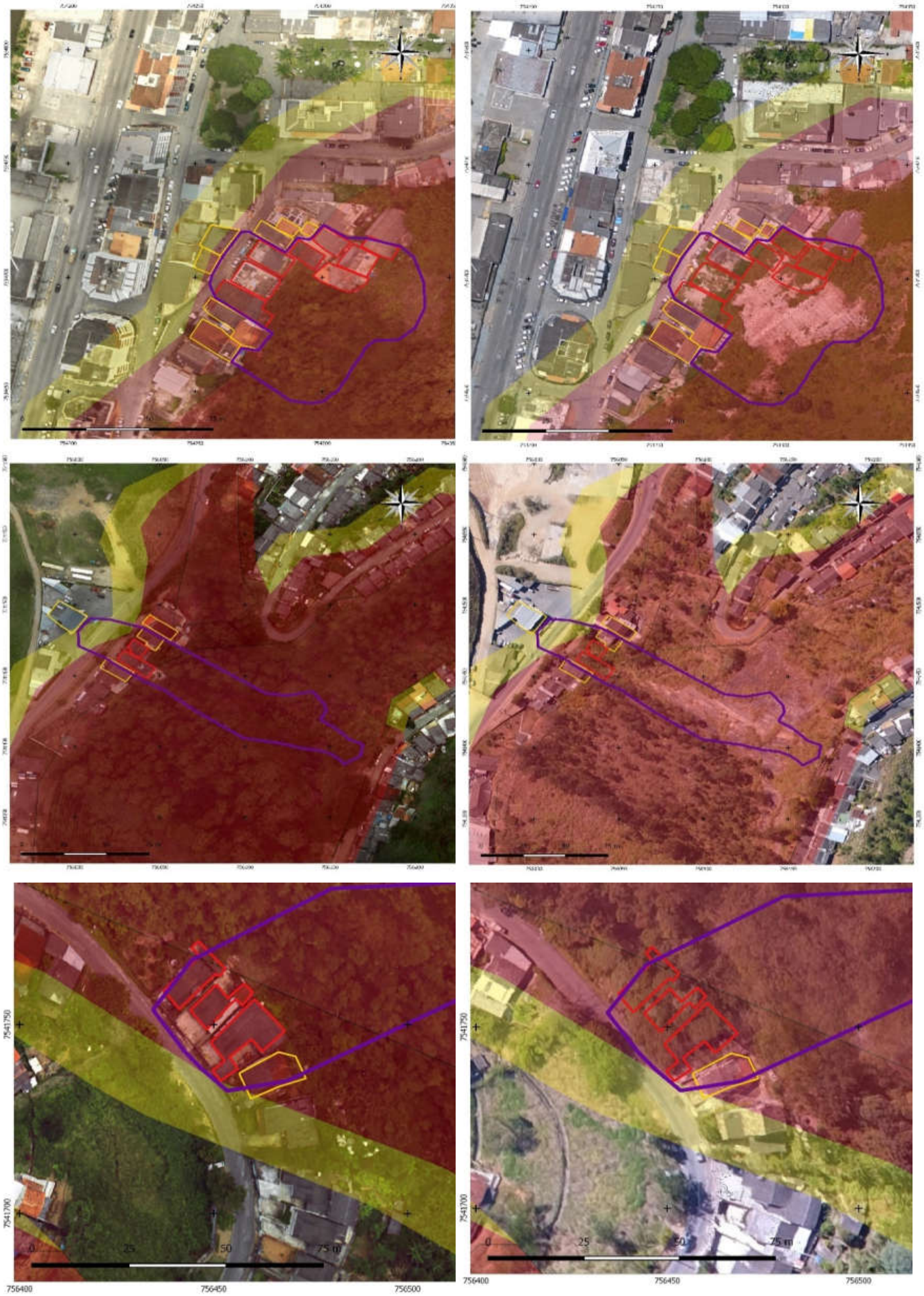


Image 05 - Comparison of the affected area before and after the landslides highlighting in the red polygons the buildings lost in 2011 in the critical area

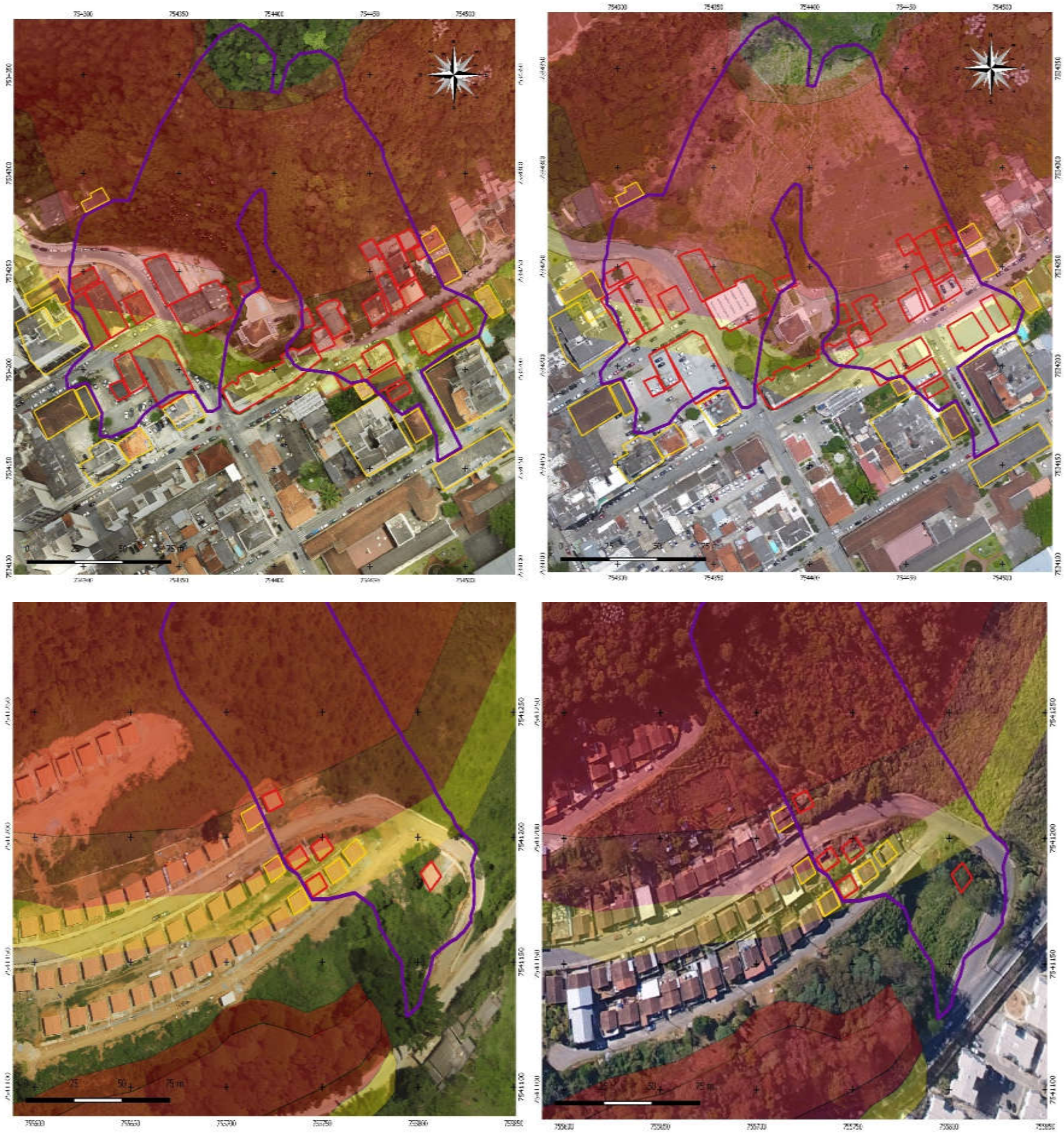


Image 06 - Comparison of the affected area before and after the landslides highlighting in the red polygons the buildings lost in 2011 in the critical areas, dispersion and out of danger

Image 07 - Aerial photo of remaining landslides ruptures of 2011

4 Conclusions

The 125 cases of planar landslides associated with losses of civil constructions are linked to 25 ° or more average inclination and critical danger areas associated with planar movements present at least a destruction in 100% of the analyzed cases as well as the 50 meters projected downstream of the hillside is the best distance that represents a stable limit with regard to statistical percentages adapted to the use of safe areas. It is soon understood that these definitions already adopted in the Technical Manual of Mapping to Gravitational Mass Movements defined in the GIDES project are functional in practical case study analyzes.

Statistical data show by the geoclimatic event of 2011 that more widespread destruction is occurring in softer relief areas downstream of the slopes than in the slope and also demonstrates that upstream of the 25 ° topographic condition the top or crest slope had a low percentage of destruction cases by only 2%. The area of potential danger to planar landslide gravitational movements follows the ratio of twice the slope height with projection down to a maximum of 50 meters and 10 meters fixed upstream of the slope with an average slope greater than or equal to 25 °, however, it is noticed that the 50 meters combined to 1,5 times the height of the slope to project the attainment generates results very close to 2 times the height. The GIDES methodology for planar slip on original topographic scale 1: 5000 has a hit rate (percentage obtained by the sum of destruction in the critical area and dispersion) of 93%. According to the local scale analysis with high resolution images and topographic adjustments with hypsometer, the hit ratio was also 93%. The quantitative of ruptures shows that in 88% of cases the planar slip method is applicable.

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THE ECOLOGICAL PRINCIPLES OF THE RESTORATION OF THE MEDITERRANEAN FOREST ECOSYSTEMS.

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Abstract

Worldwide natural disasters are becoming increasingly frequent and that is verified, especially in the Mediterranean region, by many recent severe forest fires and floods. When the primary stages of preventing and tackling the natural disasters fail, the restoration's strategic planning is significant for the ecosystem's recovery and for resilience to climate change. Thus, the present study presents restoration's ecological principles of the Mediterranean forest ecosystems. Particularly, it emphasizes on the key principle of soil preservation. Through practices' review, erosion and flood control techniques in the field are presented. Some of them are conventional and temporal while others are modern and more innovative. All types of techniques with pros and cons are discussed. Therefore, the study shows a significant interdisciplinary approach through the two goals of Ecological Engineering, that of the disturbed ecosystems' restoration and that of the new sustainable ecosystems' development including both ecological and human values. As forest fires have major impacts on the forest floor and soil, the avoidance of the soil erosion and floods, knowledge of post-fire ecology and ecosystems' capacity of self-design are key issues for shaping the framework of ecosystem's restoration, climate resilience and sustainable development..

Keywords: Ecological engineering, Restoration, Forest fires, Forest ecology, Mediterranean ecosystems.

Introduction

The restoration of the disturbed areas has many purposes, such as the enhancement of their natural functions and their recovery into the initial stages before the disturbance (Karetsos et al., 2012). The appropriate management of such complex situations requires a specialized scientific knowledge as well as an interdisciplinary approach in order the best results to be achieved.

Ecological engineering includes the creation and restoration of sustainable ecosystems which have values both for the nature and the humans too (Mitsch and Jørgensen, 2004). The scientific research shapes over time serious framework of sustainable solutions and suggestions in order further degradations to be predicted and limited (Karetsos et al., 2012). In particular, there are specific works which could implemented by a specialized scientist. There is a high soil erosion risk when the soil, after the forest fire, has steep slopes, it has low capability of rainwater absorption and the organic matter has been burnt (Bourletsikas and Baloutsos, 2014).

The smooth coexistence between the nature and the human is dominant element in the modern environmental notion. The humans can contribute with appropriate restoration measures in the degraded ecosystems to the preservation of these natural systems and also to the improvement of the quality of life. The restoration of the processes and the mechanisms which contributed to the vegetation's creation is in the scope of the restoration nowadays (Karetsos, 2009).

The present study brings to the foreground through a holistic approach and according to the scientific literature review, the ecological principles of the restoration of the Mediterranean ecosystems focusing on soil conservation. Particularly, it focuses on measures for the soil conservation and flood control by exploring several techniques.

Materials and Methods

Through an interdisciplinary and cross-thematic approach over the key issues according to the literature review but also from past and current research experience the current study aims to emerge the ecological principles of the restoration, such the soil preservation focusing in Mediterranean forest ecosystems. Pros and cons are also explored and supported by an extensive photographic archive from the field work.

Results and Discussion

The restoration's two basic Ecological Principles are that of Soil Conservation and that of Natural Regeneration (Karetsos et al., 2012). In Greece, two natural disasters have close connection in a very short time period. Just after the summer forest fires, severe floods are an upcoming event. The limited time for preventing floods and soil erosion as well as the restoration according to ecological principles are key issues. After forest fires there are many ecological consequences, depending also on their severity degree, according to the vegetation's destruction and the soil properties' alterations. Due to Organic Matter burning it is created into the soil an hydrophobic layer, which increases the surface flow. Also, due to vegetation loss is decreasing the water restraint. In addition, it is reduced the rainwater infiltration speed into the soil, due to the soil's closing pores. Also, the soil's resistance is reduced due to vegetation loss. Furthermore, the sediments are transported downstream creating extensive floods. The soil's surface moisture is reduced because of the soil's surface burning residues (foliage, soil humus). Finally, the soil's agglomerates are fragmented due to the higher rainwater's energy (Bourletsikas and Baloutsos, 2014).
According to the ecological Principles the restoration planning process of the Mediterranean forest ecosystems, except from the grazing prohibition, the monitoring of the natural regeneration and the appropriate reforestations, emergency projects (Fig. 1,2,3) should be implemented in the burned area in order to control floods, erosion and further soil loss.

Fig. 1,2,3. The hill of Cronus in the Ancient Olympia a World's Heritage Site (UNESCO) in Peloponnesus, Greece. A combination of emergency measures after the devastating forest fires (2007) and finally the ecological restoration (2013). A combination of log erosion barriers, wooden dams, jute geotextiles and hydroseeding. (Photo archive: Hellenic Agricultural Organization 'Demeter', Institute of Mediterranean Forest Ecosystems, Athens, Greece).

Firstly, immediate actions should take place on the burned slopes (Fig.4,5).

Fig. 4,5. Emergency measures in the Monument Pierre de Coubertin in Ancient Olympia after the lethal forest fires (August 2007) and also five years later. The time is pressing as soon here in the Ancient Olympia is taking place the global event of the Lightining Ceremony of the Olympic Flame (March 2008). This Ceremony would start the Olympic torch relay for the upcoming Olympic Games (Beijing, August 2008). (Photo archive: Hellenic Agricultural Organization 'Demeter', Institute of Mediterranean Forest Ecosystems, Athens, Greece).

Secondly, instantly measures should take place in the hydrographic network. These projects called also front and second line measures because of their emergency character for direct soil conservation and flood control. These are explored analytically in the present study. After these projects specific works are following on the road network and on the lowlands, which are called as third and fourth line measures.

Conclusions

Front line measures on the burned slopes improve also the soil conditions for seed germination. A conventional technique is the branch barriers. That is thin branches from the burned vegetation, that are well pressed-in cohesion between them, also placed in parallel with the contour lines and in excellent connection with the soil surface. The branch barriers are used for soil erosion avoidance but there are also disadvantages. The branch barriers could be a future fuel source for fire repetition and spread. Also, this technique is not so effective due to very quick construction. Finally, it needs expert staff.

A more effective and widespread technique is the log erosion barriers. That is laying and full adapting on the ground and in parallel with the contour lines, the logs of burnt trees after their branches removal. Their stability is ensured by wooden piles. For an excellent adaptation on the ground, the logs should be short. The log diameter should not exceed the 20-30 cm in order to avoid any distortion. Also, in each log extra logs could be placed one above the other. The log erosion barriers last for 4-5 years and as time goes by, their effectiveness is reducing.

Other techniques are the gabion baskets or even gabion walls, sandbags, always depending on effectiveness, on local area's materials but also on landscape's aesthetics and on economic parameters.

Another one technique is the dispersion of materials like straw (straw mulch). Except for the erosion and surface runoff control, the straw creates appropriate moisture, temperature and soil conditions for further seed germination and development. However, the straw drifts away on windy areas with steep slopes. Particularly, in Greece during the hill of Cronus' restoration in Peloponnesus, the combination of sawdust dispersal behind of the log erosion barriers was a successful method as a significant retention for both the seeds and the soil was achieved.

Finally, modern and innovative techniques for soil protection such as the soil overlap with jute geotextile. In addition, hydroseeding could also be implemented. Hydroseeding is applied by hydraulic pressure of aqueous solution with adhesive substances, fertilizer and a mix of seeds from various species. This technique requires the appropriate technical equipment and a careful choice of the seeds' mixture.

Second line measures in the hydrographic network aim to the stabilization of the slope and river bed. The construction material of the dams should be ecological friendly. Particularly, the wooden dams (dams constructed from burnt tree logs) which are placed on appropriate locations of the watercourses. Also, the dry stone dams and the gabion dams is another category of projects depending and on local area's materials. Another category are also the dams of sandbags or gravel.

Third line measures are implemented on the road network such the maintenance of the drainage network as well as the protection of the bridges.

Fourth line measures are appropriate projects which are implemented on the lowlands and valleys such as the concrete dams, adapting them carefully to the environment and landscape's aesthetics

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RENEWABLE ENERGY AND DRONES IN SEARCH AND RESCUE: AUTOMATED NETWORK FOR AIR-SEA ACTIONS

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Abstract

Human migration has become a major concern for the experts in search and rescue. In 2018 alone, almost 80,000 migrants entered Europe by sea (Mediterranean Sea), while more than 2100 others died trying. These numbers highlight that the early detection of the migrant boats and sea survivors is essential in order to minimize casualties, especially during extreme weather events. For that reason, unmanned aerial vehicles (UAVs) are widely used in air-sea rescue (ASR) missions. The UAVs surveil large areas in short periods of time; however, their power dependency limits their potential. The in situ recharge of the UAVs that surveil remote sea areas could be a possible solution to this problem. Tidal energy generators and wave energy converters (TWCs) combined with solar collectors could recharge them. Moreover, pre-installed navigation systems could reduce the needs in recourses and overall costs. This research investigates these scenarios by introducing an automated network of multifunctional buoys and UAVs. Specifically, it presents the concept of TWC buoys capable of recharging one or more UAVs depending on the available energy generation. They are also equipped with mini solar collectors, meteorological sensors, warning systems and survival kits. The UAVs are equipped with thermal and color sensors in order to detect disturbances on the sea surface. By establishing this network in remote sea areas that include migrant sea routes, this study aims to provide the coast guard with a reliable, automated and self-powered tool that could detect sea survivors or threats within sufficient given time.

Keywords: tidal energy, wave energy, air-sea rescue, automated surveillance, first-aid buoy

1. Introduction

Science and technology have undoubtedly improved the crucial mechanisms for the protection of human life in every phase of disaster management. Specifically, in disaster response, the robotic systems, such as the unmanned aerial vehicles (UAVs), also known as drones are often enhanced with artificial intelligence (AI), as well as scientific and other types of instruments, allowing them to inform their operators in sufficient lead-time or even self-act directly. In addition to that, the recent innovations in renewable energy generation and their application in robotics, open new horizons to such an extent that they further upgrade AI-based devices and provide reliable power efficiency. Tidal power that is a form of hydropower, as well as wave power are two noteworthy examples, as they have turned out to be very promising energy sources due to their emerging technology and increasing demand. It is estimated that the annual tidal energy generation can reach up to 800 TWh (terawatt-hours); whereas, the annual wave energy generation from 8,000 TWh to 80,000TWh (Tidal Energy, 2015). A portion of this energy could be sufficient for powering marine and coastal infrastructures or to be used in coast guard operations.

The “self-response” and power autonomy of automated mechanical tools are critical factors, as they may determine the success of an action, especially in the search and rescue missions that occur under extreme conditions. Specifically, in air-sea rescue (ASR), the use of UAVs often results in the “early-detection” of marine accidents and threats. Mounted sensors on the UAVs collect valuable data that are sent to their operators in time. In order to minimize or even prevent completely unpleasant outcomes, efforts are made so the emergency rescue UAVs to behave more independently and respond immediately once an anomaly is observed, at least until the first responders reach the disaster area (Marques et al., 2016). However, despite the potential of the present achievements, deficiencies in both technical aspects and operation techniques remain a major unsolved issue for the authorized personnel.

In several marine countries around the world, the coast guard uses the UAVs for the detection of migrant boats, sea survivors and sharks during or after extreme weather events. These missions are operated from either the shore or rescue vehicles. Nevertheless, these scenarios require a satisfying number manpower and resources, including the continuous power charging for all the available UAVs in order for them to be effective. This increases the cost, as well as the time of such operations, especially if they occur often and far from the coast (e.g. the 24/7 surveillance of Mediterranean Sea for migrant presence). In order to minimize such problems, this study introduces the Automated Network for Air-Sea Actions (ANASA) that emphasizes the combined use of “smart” buoys and UAVs established perimetrically of a selected distant sea area. This innovative concept is based on technologies and products that are currently available but not linked with each other, especially in disaster response mechanisms. The continuation of this study can help improving the aerial surveillance in sea with a minimum number of manpower and resources. Furthermore, it can increase the survival rate of sea survivors, especially those migrating through the Mediterranean routes to Europe.

2. General Understanding of Tidal and Wave Energy

The tidal power is a unique method that derives directly from the tides that are generated by the relative motions of Earth and Moon. Tides can also be generated by the influence of the Earth and Sun or a combination of all these systems; however, this is not a frequent phenomenon. The tidal power is usually classified into the following generating methods:

- **Tidal Stream Generators:** Similar logic to wind turbines (except that they use water). The impeller of the turbine is pushed by the tide flows.
- **Tidal Barrage:** This is a dam-like structure that “traps” water from high tides and releases it through channels. The channels will carry it through the turbine.
- **Dynamic Tidal Power:** This scheme uses protruded walls that will “trap” a tide in such a way so to create a head. The tide will be directed though channels to the turbine.
- **Tidal Lagoon:** Similar logic to the Tidal Barrage. Instead of a dam-like structure, it uses an enclosure in order to create a pool.

Despite its high cost and needs in resources, tidal energy is a very reliable renewable energy source. First of all, it can be predictable; it is not influenced by the weather conditions unlike other renewable energy types. Secondly, the energy density of the tides can be extremely high, compared to solar and wind energy. Lastly, most of its schemes can assist in flood control scenarios and protect coastal populations and infrastructures. Table 1 shows the advantages and disadvantages of each tidal power type. It should be noted that the amount of generated energy depends on several factors, such as the size and the tidal conditions (Kanemoto et al., 2001; Tidal Power, 2015).

Table 1. Advantages and Disadvantages of Tidal Power Types		
Classification	**Advantages**	**Disadvantages**
Tidal Stream Generator	- Moderate power generation capability - Modular scheme - Low-cost scheme - Environmental-friendly scheme (least impacts in marine ecosystems)	- High maintenance - Corrosion - The spinning blades may harm marine wildlife
Tidal Barrage	- High power generation capability - Proven design - Long life span - Low maintenance - Suitable for flood control	- Limited sites for installation - High tidal flows are required - High environmental impacts - High-cost scheme
Dynamic Tidal Power	- Very high power generation capability - Single installation	- Unproven design - Very high-cost scheme - Alternations in coastal environments - Limited sites for installation
Tidal Lagoon	- High power generation capacity (less compared to the tidal barrage) - Proven design - Environmental-friendly scheme (less compared to the tidal barrage) - Low maintenance	- High tidal flows are required - High-cost scheme - Generates less power than barrage

The wave power is the result of the waves that are generated by the wind (depended on weather conditions). Wave power can be generated when there is a motion of objects that float in the ocean. The wave crest can lift an object against gravity endowing it with energy. When it passes, the object falls into the wave trough; this kinetic power can be used to generate electricity. Image 1 shows the concept of wave power generation. This renewable energy type is relatively old, as it first started in 1799 but it quickly lost popularity due to the difficulties in producing large quantities of energy at a low-cost price. Nowadays wave power is getting popular again and wave farms in USA, Australia and other countries, are testing its capabilities. It should be noted that related studies focus on wave power applications in buoys but mainly for light or GPS tracking purposes (Tidal Power, 2015; Marine Energy, 2018).

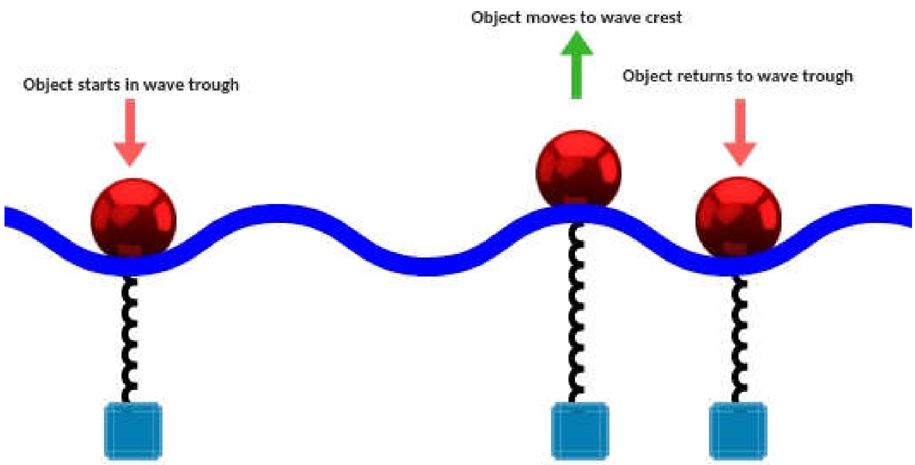

Figure 1. Concept of Wave Power Generation

Air-Sea Rescue and Migration Routes: The case of Mediterranean Sea

From 2014 to date, most European citizens and governments have been in engaged in an ongoing discussion about migration and the protection and surveillance of the Mediterranean borders. This matter increased significantly when refugees and other migrants from Africa and Middle East (especially Syria), fled from their countries due to civil conflicts, terrorism (Islamic State), poverty and corruption to Europe in order to find a better living conditions for them and their families. The migration problem reached its zenith in 2015 when more than one million people arrived in Europe through Turkey, Greece and the Balkans. This event resulted in a great influence in local economies and societies that in turn lead to changes in the European political field (Eurosceptic parties gained more power and supporters). According to United Nations High Commissioner for Refugees, the routes migrants use to come to Europe are not standard; however, the Mediterranean routes are the most frequent. Table 2 shows the number of refugees and migrants that used or died while using the Mediterranean routes from 2014 to 2018.

Table 2. Mediterranean Routes and Number of Refugees and Migrants*

Year	Western Route (Spain)	Southern Route (Italy)	Eastern Route (Greece)	Deaths
2014	4,632	170,100	41,038	3,184
2015	5,238	153,842	856,723	3,558
2016	8,162	181,436	173,450	4,757
2017	22,103	119,369	29,710	3,079
2018**	35,653	21,024	22,821	2,119

***sources and more information at: https://missingmigrants.iom.int/, https://openmigration.org/, https://www.ecfr.eu/**

****January 1st – November 28th**

In 2013, European Union (EU) established the European Border Surveillance System (Eurosur). The main purposes of the Eurosur are the information exchange and the operational cooperation between the Member States and Frontex Border Agency (Seiffarth, 2011). When the migration issue arose, EU focused on their interests in more restricted safety measures, including sea border control and security surveillance in order to limit the migratory flows. Specifically, the plan included the establishment of hotspots in third countries that are neighbored to Europe (e.g. Turkey, Libya) and the increased surveillance in both the Mediterranean and externalized borders in Africa and Middle East. However, due to the current policies and conditions, this strategy highlighted many legal and ethical dilemmas. Several decisions could not be fully implemented mainly due to the lack of personnel and resources, civil rights and cross-country political disputes (Gabrielsen, 2013). Figure 3 shows the concept of southern border surveillance for restricting the migration flows (Torelli, and Ugolini, 2018).

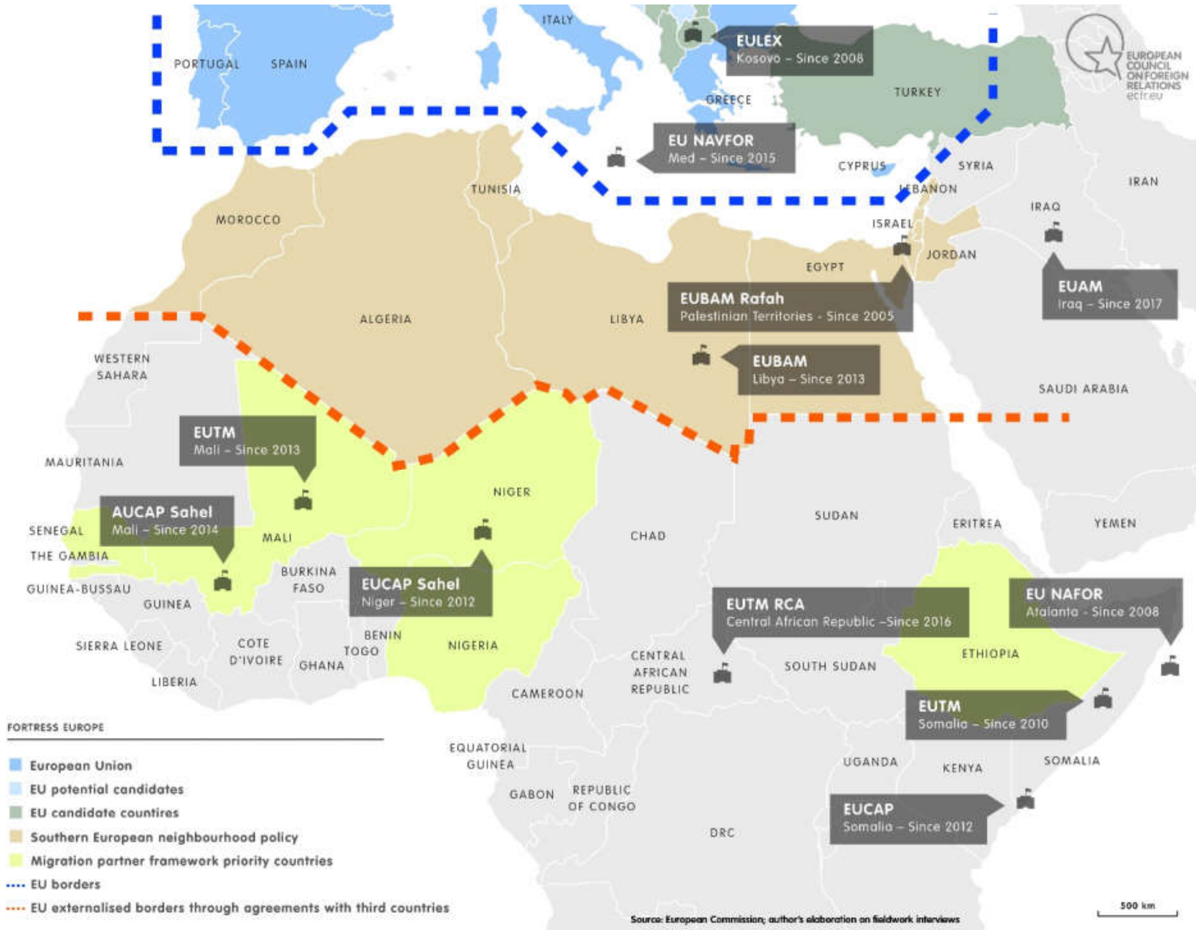

Figure 2. Security plan in Mediterranean and externalized boards for migration flow reduction

Despite the efforts of EU to alleviate this problem, the flows exist (Table 2) and they are estimated to continue or even to increase, depending on the geopolitical stability in Africa and Middle East. Even though in 2018, the migrants arriving to Europe through the Mediterranean Sea have been reduces in numbers, the fatalities are still at a concerning rate. More than 15,000 confirmed deaths have been recorded since 2014; among those several infants and children. The efficient and integrated model for surveilling sea zones can be the key for minimizing the fatalities.

3. Concept of Automated Network for Air-Sea Actions

Since tidal energy generators and wave energy converters (TWCs) mainly apply in the sea, their applications in ASR missions and sea surveillance should be further investigated, especially if the use of UAVs is required. The ARS that is the coordinated search and rescue of emergency water landing survivors or those who have survived the loss of their seagoing vessel, usually involves a variety of resources including rescue boats, helicopters, seaplanes and of course UAVs. The UAV is a type of aircraft that operates without a human pilot on board and it flies autonomously using pre-programmed flight path data or remotely, if it is controlled by an operator from a ground station (Yeong, King, and Dol, 2015). Due to their advantages in agility, portability, cost-effectiveness (compared to conventional manned aircrafts), and aerial access, the UAVs are often used in search and rescue missions or in the aftermath of a natural disaster. Their main purpose is to detect and identify possible rescue targets (Matos et al., 2013).

Furthermore, in ARS missions, various sensors and devices are added on them while they fly over large areas in short periods of time. If they detect a disturbance, they send the collected information to their operators for further action (Lin, Roscheck, Goodrich, and Morse, 2010; Waharte, and Trigoni, 2010). However, based on the current technology development, the UAVs are not highly effective under extreme weather conditions. Their resistance level to disasters is corresponded to their design and cost. What is more, due to their power limitations, they are not fully efficient when they must operate far away from the shore. An average flight time of a common battery-powered UAV is usually 10 to 30 minutes (similar to its recharge time); therefore, it is still difficult to deploy UAVs far from their base, especially in emergency incidents, such as the sudden occurrence of heavy rainstorms or migrants' ship failures (Yeong et al., 2015).

When extreme events occur at sea, accidents are almost inevitable if the floating vessels are not designed for such conditions (Wagenaar & Groeneweg, 1987). In these cases, the corresponding ASR personnel is not always capable of detecting survivors in time and as a result, fatalities are inevitable (Fargues & Bonfanti, 2014). Another problem with the current UAV usage in many ARS missions is that each drone inspects selected areas in a specific duration of time. Therefore, it is possible for an incident to occur in an area that the UAV has already inspected. The chances of such scenarios increase when a low number of UAVs operates in large sea areas (e.g. Mediterranean Sea). This, in combination with the power limitations perplex the procedures and reduce the efficiency of the ASR missions. To alleviate these issues, the ANASA concept suggest the development of a network of automated UAVs that operate in large sea zones and recharge in situ. The TWC buoys will charge the UAVs that operate in frequent time periods. Additionally, the buoys will provide emergency assistance to survivors, as well as weather information to their operators. Figure 2 shows how this network operates.

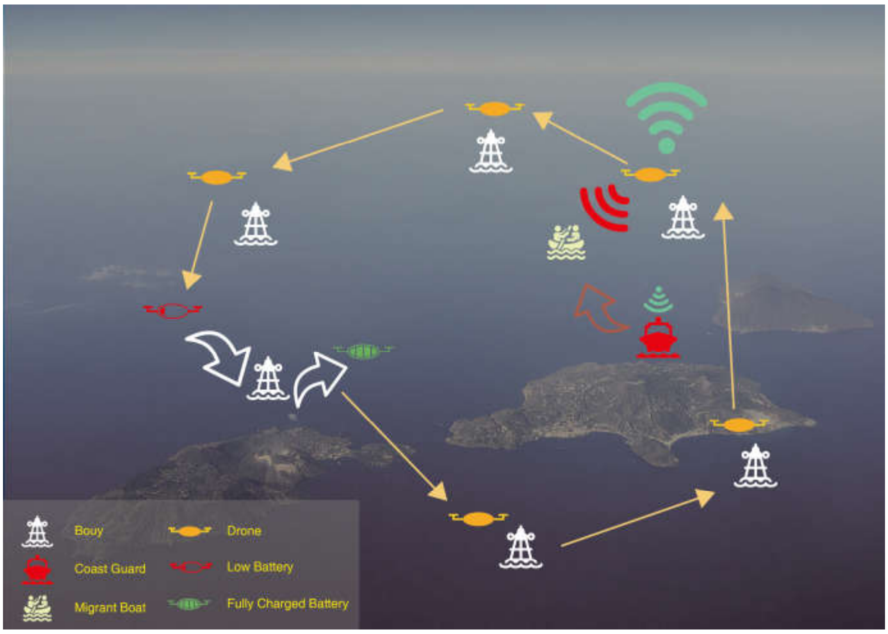

Figure 3. Visual description of the Automated Network for Air-Sea Actions: Each buoy charges one UAV per time. The aerial surveillance is divided into 2 sets. The UAVs of each set are activated simultaneously and move to their following buoy (clockwise order). When a set is operating, the UAVS of the other set are recharging. This loop continues throughout the day and provides a 24/7 surveillance.

To further increase the efficiency of the network, the buoys must be placed in appropriate distances, so to be able to recharge the UAVs before they run out of power. As the buoys cover large areas, their meteorological systems can detect weather changes at the local level and when necessary, warn the coast guard accordingly. The alarm systems can activate lights and other warning alerts during the night-time or extreme weather events in order to guide survivors and other boats towards them in case of emergency. As it can be observed in Figure 3, the ANASA Unit is a combination of:

1. a TWC that provides energy, at least for the installed instruments. For that reason, the systems for emergency signals and first aid are prioritized
2. a mini lighthouse (light signal) that is activated during the night-time and extreme weather events
3. an emergency signal transmission connected to an SOS button (it also includes an emergency kit)
4. a meteorological system for weather changes at the local level
5. battery charging space(s) for UAVs (wireless charging). Once the UAV is attached, it automatically locks into its position. If the UAV is violently dislocated from its position while charging, a relevant signal is sent to the operator.

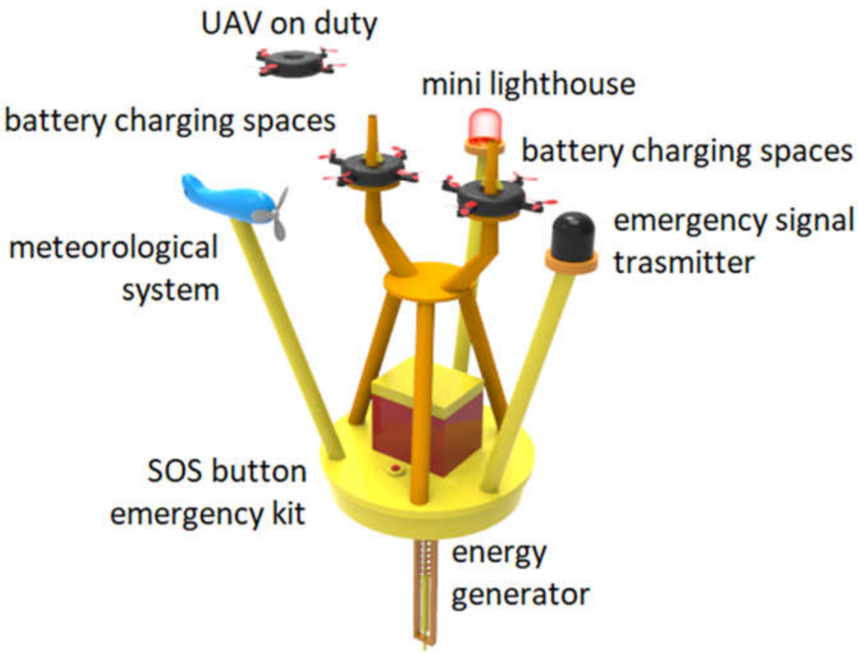

Figure 3. Part description of the ANASA Unit (design is still under development)

3. Conclusions

The investigation of tidal and wave energy can be very promising as they present many advantages over other renewable. Following this approach, the ANASA focuses in marine disaster response mechanisms and more specifically, the automated ASR missions. The buoys that are TWCs, are capable of recharging one of more UAVs depending on the available amount of generated energy. Moreover, they are equipped with meteorological sensors, warning systems and emergency transmitters. Sets of UAVs operate subsequently so to inspect large sea areas non-stop. To further maximize the energy generation of the buoys, the study suggests the investigation of small solar thermal collectors mount on the buoys as an additional renewable energy resource. It should be noted that the conceptual idea of the ANASA is based on technological features and AI-based applications that currently exist but not used combined. Future studies could evaluate the suggested system under realistic conditions and verify its feasibility, cost to benefit analysis, and its impact, contribution and alternative use in marine ecosystems. By establishing the ANASA in sea areas with high disaster risk probability, this research aims to provide the coast guard a reliable, automated and self-powered tool that can detect sea survivors or threats under a sufficient given time. Furthermore, it aims to provide an alternative solution for surveilling sea migration routes that can potentially detect shipwrecks on time and increase the survival rate.

4. Acknowledgement

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ROLE OF THE RADIO STATION IN CRISIS MANAGEMENT

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Abstract

So far, by going through the radio stations, they are trying, when it comes to a crisis, to provide as realistic and realistic as possible information that will be useful for listeners. According to previous research, it has been found that these instruments are fully in harmony with the crisis environment and serve the public in the face of the crisis. While they are vulnerable to disasters, at the same time they know how to maneuver in the situations of the crisis. Paradoxically, it would be the fact that the stations that have bigger revenues, more resonance, are targeting bigger and bigger markets are not so willing to provide accurate information to the public. This, of course, causes a climate of confusion in the news. The media have always been present at any time since the beginning of their creation. More specifically, the radio, whether in times of war or crisis, was the rock of human trust. Besides, the radio has the ability to provide timely information and psychological comfort. It was commonplace that stations in smaller markets were better prepared to cope with a crisis, perceived a higher level of civil responsibility for crises and were more likely to say that citizens would respond to a pre-social emergency, in contrast with those in large markets, who may be less equipped or willing to serve in these possibilities.6. The case for 2008

1. Introduction

1.1 Radio as a crisis mitigation tool

Under circumstances such as these, past research would suggest that radio should play a pivotal role in the management of the event and subsequent community responses. When a community is threatened, radio will typically help to galvanize citizens and motivate community leaders and social groups to work together to achieve common recovery goals.

These recovery efforts may involve the distribution of resources, such as food, clean water, fuel, sandbags and equipment. In addition to logistical needs, serious flooding is likely to produce a unique set of psychological needs among those affected, notably a need for uncertainty reduction.

Regarding these needs, local radio may act a means of community surveillance, allowing individuals seeking needed information to access it with simple, widely available and robust technology. This utility and resiliency makes radio technology better suited for emergency communication than other media. Radios are standard on vehicles, making them readily available and convenient for seeking information regarding road conditions in a rapidly changing environment.

Battery powered radios are typically used for someone in the home and doing various activities there. They have a handle from which someone can catch and move to where they are. They are constructed for emergencies such as floods or earthquakes. That is, there is communication between radio stations and people when there is an emergency or a crisis.

They are often next to the citizen when extreme weather events occur. Newsletters of radio stations provide timely and accurate information about the state of the country and whether there are people in need because of problems.

Given this mutilation, the following research questions are proposed:

RQ1: How do radio stations perceive their ability to respond to wear and tear?

RQ2: To what extent do radio stations perceive civil liability during wear?

1.2 Preparation of training and coordination

Disaster preparedness planning among SME organizations is often limited and of poor quality. After seeing whether radio stations believe that response to the crisis is part of their political duty and whether or not they have autonomy to act, it seems crucial to assess the extent to which they have been trained to respond to such contingencies. While handling an event such as a flight requires some degree of technical expertise, the media is involved in this type of training with a worrying discontinuity.

Undoubtedly, the efficiency of the radio stations is judged by the fact that the stations maintain good relations and interconnections with state institutions and local authorities and services. The common goal, ie the cooperation of all actors to collect data and cover reports on informing listeners, should be served.

Another function of the radio stations is that they constitute a board and a channel of communication between the citizens of a community and the coordination of various projects in a time of crisis. Frequent news interference during radio programs indicates that radio stations want to fulfill their mission as best and as they can. They are very close to the citizens, since they can make bills from listeners, reports from affected areas, instructions and statements from civil servants. Radio can also be used as a mechanism for recruiting volunteers and helping with inventory and relief activities.

For instance, Spence et al. found that over 64% of radio stations sampled indicated they had not participated in any drills related to local emergencies. In the same study, a little over half reported that they had no staff trained in reporting on biological or radiological terrorist events, and 78% reported that they had not participated in any training related to the handling of these types of emergencies.

Further, inter-organizational coordination is closely related to these preparation efforts. In order to be as effective as possible, it is likely that radio stations will have to coordinate with state and local authorities, police, and first responders. Coordination has been defined as 'collaborative processes through which multiple organizations interact to achieve common objectives'. In other words, activities such as emergency drills, simulations and exercises can aid in multi-organizational coordination

Radio stations are expected to aid in the communication and coordination needs of a community during a crisis and at times even go above this expectation. In their mission to serve the public, local stations will often replace regular programming with continuous live coverage of a crisis. Such coverage is likely to include accounts from listeners, reports from affected areas, instructions and statements from public officials. Radio can also be used as a mechanism for recruiting volunteers and for assisting in disaster logistics and relief activities.

Research has shown that outcomes associated with both level of preparation for disasters and emergencies and the perceptions of civic responsibility held by radio stations may vary across market size. At the same time, this research demonstrates that smaller stations, seeing themselves as more central to the needs of their communities, are less likely to have had appropriate training for these circumstances. To replicate or refute those findings under the conditions of an active crisis, the following research question is proposed:

RQ6: To what extent do crisis preparedness and perceptions of civic responsibility vary across market size?

2. Methodology

A list of all broadcast AM and FM radio stations in the United States was obtained from the Federal Communications Commission (FCC). A list of the flooded counties in the Midwest along the Mississippi River was obtained from the National Oceanic and Atmospheric Administration National Weather Service. Using these two lists, a determination was made regarding which radio stations would have broadcast directly to affected communities during the flood. To be selected, a radio station had to possess a current FCC licence and be licensed in a county that was categorized as in a state of emergency, or that received a Federal Disaster Declaration. This produced a total of 124 radio stations.

Each of the 124 stations were first sent a post-card providing advance notification about the study and informing them that the survey would be mailed in the next few days. The advanced mailing was sent out 5 days after the peak of the flooding and the survey was mailed out three days later. The survey was mailed along with a cover sheet indicating the purpose of the study, and an assurance of confidentiality. A self- addressed, stamped envelope was also enclosed with the survey. Sixty-two surveys were returned, providing a response rate of 49%. The 62 responses reported for a total of 76 stations, which provides an adjusted response rate of 60%.

3. Conclusion

This study, along with previous investigations, indicates that local radio can play a particularly critical role in a community-based response to a crisis. Disaster researchers often note that all disasters are local in their impact, and that the first response to a crisis comes from the community itself. Local radio stations, given their resilience, flexibility and accessibility, play a critical role in informing the public, coordinating response and recon-stituting community connections. In a somewhat alarming turn, the replication of previous findings in the current investigation suggests that smaller-market stations more fully understand and embrace that role.

It also suggests that in larger markets, radio stations may over-look this role, leaving much larger communities without the information necessary to protect life, health and property, as well as information related to the reduction of psychological stress and the empowerment of community resiliency efforts.

While a fuller picture of the role of radio in crisis response is emerging, additional investigations are needed. For example, different types of crises, such as fires, infectious disease outbreaks, large-scale power outages or transportation accidents, may create specific kinds of communication requirements and associated roles for radio. Although stations often report suspending regular programming during a crisis in favour of 24-hour crisis coverage, little is known about the content of crisis coverage.

Attitudes of the public towards the crisis role of local radio are not clearly understood. Finally, the impact of media convergence on the post-crisis management role of radio has not been explored. What is clear, however, is that radio is a major component of community based crisis response infrastructure. Mismanagement of this critical information resource will likely have dire implications for those affected by major crises and disasters.

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BIG DATA ANALYSIS FOR NATURAL DISASTER MANAGEMENT THROUGH SOCIAL MEDIA

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Abstract

Social media information collected by individuals can provide useful information when dealing with specific natural disaster situations. Unfortunately, this data is hard to find and evaluate within the wide pool of social media postings related to the disaster. From the perspective of public authorities, the main challenge for using social media is the lack of control over the lineage of the information, and thereby an unknown reliability and trustworthiness. This article presents an approach towards the effective and accurate enhancement of decision support tools for natural disaster management with social media. A 'big data' - oriented approach is proposed, in order to cope with challenges of huge amounts of data, in a variety of formats and quality that must be processed quickly. The methodology is based on the enrichment of geospatial content retrieved from Geographic Information Systems (GIS) modeling outcomes with real-time disaster-related information from social media during an emergency incident. Instead of solely relying on social media sources or 'a posteriori' analysis through classification or machine learning approaches, the applied methodology is based on the combination of spatial danger rating models with geo-social tweet messages. The findings show that social media content encloses potentially useful information and can act as an additional communication channel for citizens who have been affected by a disaster. The article aims to highlight the role of geospatial big data such as geo-located tweet messages in the effective confrontation of natural disasters.

Keywords: Big Data, Social media, civil protection

1. Introduction

Social media has been used to disseminate a wide range of public safety information before, during and after natural disasters by providing assistance towards the establishment of situational awareness (Herfort *et al.* 2014). At the same time, the growing use of electronic devices equipped with Global Positioning System (GPS) receivers has increased the amount of geoinformation available in social media platforms (e.g. blogs, chat rooms, discussion forums, wikis, YouTube Channels, LinkedIn, Facebook and Twitter) and transformed them into location-based social networks (Beigi et al., 2016). Social media messages with a geographic reference can be described by the terms of Volunteered Geographic Information (VGI) (Stefanidis *et al.* 2013), Neogeography (Goodchild and Glennon 2010) and Crowdsourcing (Gao *et al.* 2011).

Despite the intensive research activities regarding the contribution of social media in natural disasters management, many challenges are still open. The form of geo-social media is highly unstructured and thematically diverse, while valuable knowledge is often implicit and cannot be easily processed through automation (Sahito *et al.* 2011). Such data structure heterogeneity has a direct impact on the ability to store, manage or process effectively. Apart from data diversity, there is an enormous volume of social geospatial data – especially during emergencies – that must be analyzed as soon as possible. With all the high volume, high speed and varied structure of social media content, significant challenges emerge on how to deal with this 'big data' problem (Athanasis *et al.* 2017). Even though the amount of the available data is huge, reliable information is rare to find and difficult to locate within the enormous pool of social media postings (Landwehr and Carley

2014). It is easier than ever to search the web for information, but filtering out falsehood and off-topic discussions from the huge online content still remains difficult (Herfort *et al.* 2014). Thus, it is still an open research question how emergency management agencies and the public can capitalize on the abundance of geo-social media by reducing the volume to credible and relevant content (Spinsanti and Ostermann 2013).

This article presents a state-of-the-art approach towards an enhancement of decision support tools for natural disaster management with social media. Its novelty lies in the enrichment of geospatial content retrieved from Geographic Information Systems (GIS) modeling outcomes with real-time disaster-related information from social media during an emergency incident. Instead of solely relying on social media sources or ‘a posteriori’ analysis through classification (Lofi *et al.* 2012), or machine learning approaches (Terpstra *et al.* 2012), the applied methodology is based on the combination of spatial danger rating models with geo-social tweet messages. As a result, the volume of the underlying tweet messages that have to be processed is significantly reduced and the possibility to include erroneous messages is minimized. By using existing and well-studied geographical models for danger rating, the open problem of handling social media information during the occurrence of natural disasters can be tackled.

2. Methodology

The first pillar of the proposed methodology (Fig. 1) consists of the GIS modeling component that utilizes the HFire algorithm (Peterson *et al.* 2009), as a fire behavior prediction algorithm inside a web-based GIS system. HFire is a raster-based, spatially explicit model of surface fire spread. By running fire simulations through the HFIRE algorithm, parameters such as the speed and the direction of the fire can be calculated. The perimeter polygon of the simulated fire restricts the area where the tweet messages will be filtered before shown in the web-based GIS system.

By the time a new fire is ignited and the perimeter has been calculated, tweet messages that consist of up to 140 Unicode characters are steadily analyzed by the geo-social component. The geographic location of any tweet message is described in the metadata field ‘coordinates’, which is also known as geo-tag. In general, users can geo-reference messages in Twitter either manually (e.g. by entering the name of a city in the field ‘location’) or automatically when a client application has access to the coordinates of a GPS receiver. Because in most situations only a small fraction of tweets are geo-referenced by users, an external geocoding gazetteer component is used. The component searches the tweet messages for place names (toponyms) and assigns coordinates if a toponym is found.

For identifying messages containing relevant to the incident information, Twitter messages are filtered based on specific keywords that are common practice in the analysis of Twitter messages. Tweets containing the Greek keywords ‘photia’ or ‘pyrkaya (meaning ‘fire’), ‘sismos’ (meaning ‘earthquake’) are retained. By following the aforementioned approach, tweet messages can be visualized on top of a Web-GIS system.

In the core of the proposed architecture lies the Apache Kafka component, an open source stream processing platform (Fig. 2). It is a high scalable message queue storage, capable of process streaming data such as tweet messages. Apache Kafka works together with the Apache Hadoop framework. The Hadoop open-source work framework provides tools for organizing, managing and transforming large-scale data. On top of Hadoop runs the Hadoop Distributed File System (HDFS) that is a distributed file system designed to run on commodity hardware. Inside the big data cluster, virtual machines called workers receive the twitter messages and distribute them to the brokers, which are responsible for replicating the messages.

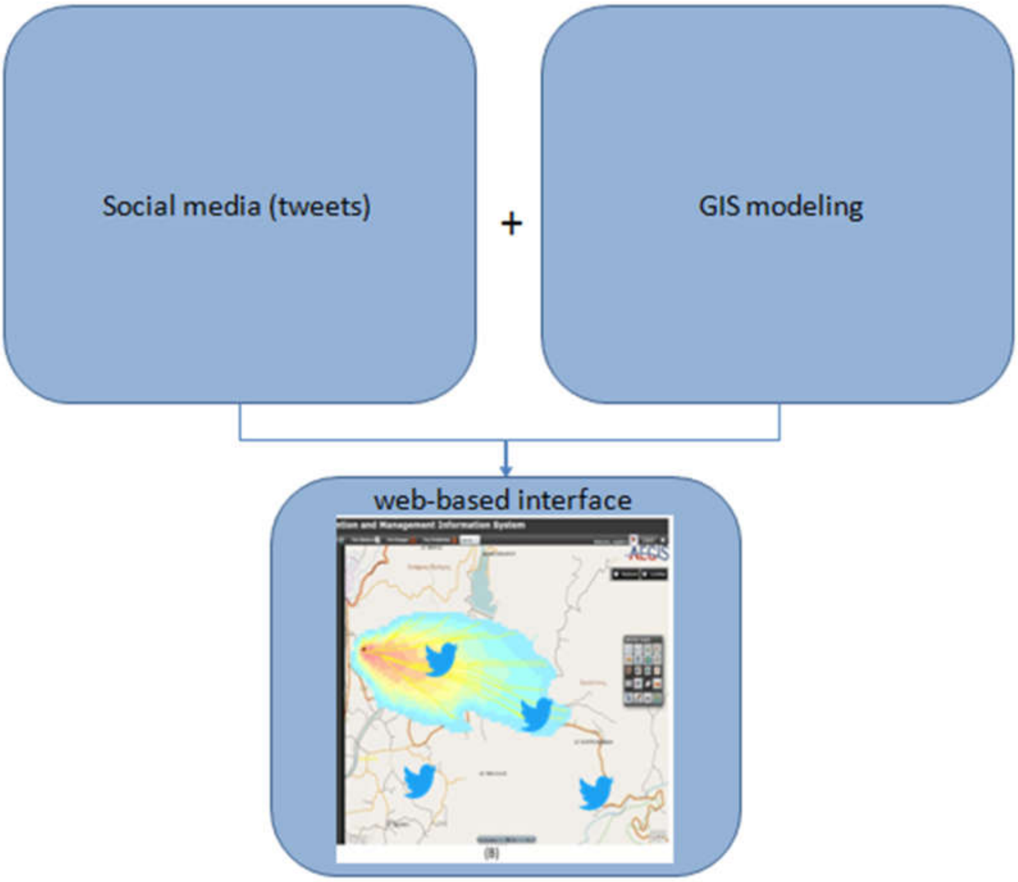

Fig. 1 – Conceptual design of the proposed methodology

Tweet messages are retrieved from the Twitter Source by utilizing the Twitter API and stored in Kafka topics. The Kafka Connect API is utilized that receives messages from any sources (such as Twitter) and redirects them into related sinks. In the proposed methodology, tweet messages are retrieved from the Twitter API (that is used as a source) and stored in a Kafka Topic. From the topic, the Producer API is used to connect the source (i.e. Twitter) to any Kafka topic as a stream of records for a specific category (i.e. a specific natural disaster event). From there, the consumer API is used to get out the tweeter messages from the Twitter topics into ElasticSearch, a distributed big data search and analytics engine capable of near real-time use cases.

Fig. 3 describes how ElasticSearch is used for filtering out the off-topic tweets. The area of interest for the specific wildfire (i.e. the arrival time based on the HFire fire behavior modeling) is retrieved in a JSON format from the ArcGIS Server that is used to store all output results of the fire simulations. This polygon about the area of interest is used as a GeoPolygon Query inside the ElasticSearch big data store, to exclude the off-topic messages and visualize the meaningful messages through the web-based GIS visualization platform

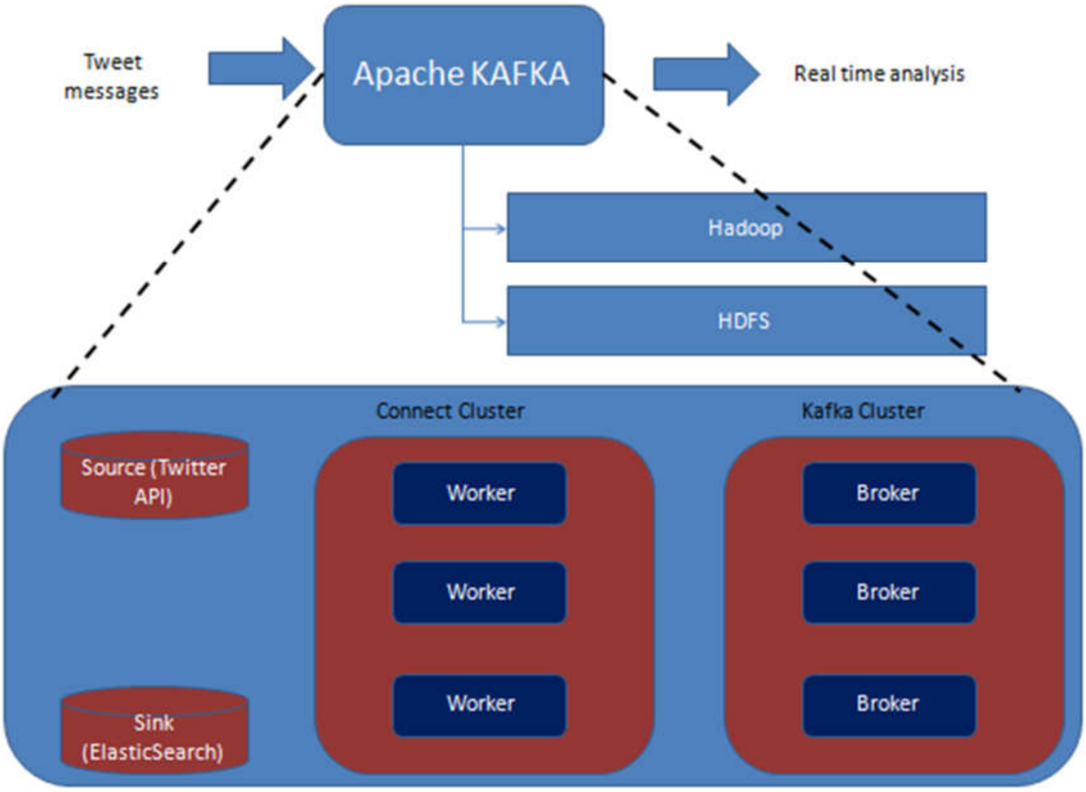

Fig. 2 – Architectural components of the proposed methodology

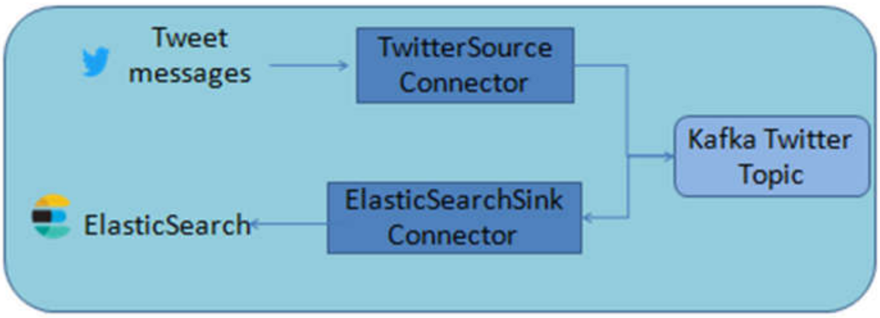

Fig. 3 – Architectural components of the proposed methodology

3. Results and Conclusion

The present work aims to highlight the role of the social big data, towards a more sophisticated transfer of knowledge among the civil protection authorities, emergency response crews, and the affected population. The results from our case studies show that social media content encloses potentially useful information and can act as an additional communication channel for citizens who have been affected by a disaster. Our approach follows a 'big data' architecture to cope with challenges of huge amounts of data, in different formats and varying quality that must be processed quickly. It is based on the enrichment of geospatial modeling results with real-time disaster-related information from social media during an emergency incident. Compared to similar studies, the added value is by combining wildfire behavior modeling outputs with tweet messages in order to increase the accuracy and efficiency of the tweets during an emergency.

Big Data technology emerges as a technology capable of successfully addressing contemporary digital challenges. The Big Data ecosystem provides high-volume, high-velocity, and/or high variety information assets that require new forms of processing to enable enhanced decision making, insight discovery, and process optimization.

The proposed highly scalable architecture relies exclusively on big data components. Thus, it can be applied to different geographical areas, to different types of social media and to a variety of natural disasters. Even though the Big Data ecosystem integrates many platforms and software components, it is mainly based on distributed storage and processing of very large datasets on computer clusters.

Our goal is to extend the proposed methodology and apply it first in a web-based system which will be tested by local authorities in Greece, throughout the next wildfire season. The fire prediction simulations of HFire were conducted for wildfire propagation, but the model did not take into consideration unpredictable factors such as the wind shift. The utilization of this system may potentially not only support civil protection and fire control services in the organization of effective wildfire management and control but also contribute to the immediate and massive alert of firefighters and/or people who are at risk during a fire outbreak.

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ZONATION FOR MITIGATION OF LANDSLIDE RISK AND RESPONSIBLE TOURISM DEVELOPMENT IN THE IONIAN ISLANDS' BEACHES (WESTERN GREECE)

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Abstract

The Ionian Islands comprise one of the most seismically active parts in the Mediterranean. Their evolution is defined by active faults and a dense net of joints, which form geotechnically unstable areas with high and steep slopes, highly fractured and brecciated formations as well as suitable geometry of beds and discontinuities. The synergy of endogenic and exogenic processes contribute to formations loosening resulting in frequent failures along steep coastal slopes.

This is the case in the western coastal part of the Ionian Islands, where slope failures are often generated along some of the most beautiful and visited beaches in the Mediterranean. The most characteristic events occurred in Myrtos beach (Cephalonia) during the 2014 earthquakes, in Egremnoi and Porto Katsiki beaches (Lefkada) during the 2015 earthquake and in Navagio beach (Zakynthos) in September 2018.

In similar cases worldwide, medium- and long-term approaches are adopted for landslide risk assessment and mitigation requiring no beach access until completion of protection measures with adverse effects in the economic activity of the affected areas.

Taking into account all the aforementioned, the most suitable approach for the study area is the beach zonation after landslide hazard identification and risk assessment based on morphological, geological and geotechnical data. Three zones of (a) high, (b) medium and (c) low risk are usually defined and correspond to (a) prohibited, (b) restricted and (c) free access. This approach can be valid for a short time period and may vary in time depending on the prevailing conditions affecting risk level.

Keywords: Ionian Islands, landslides, rockfalls, beach zonation, earthquakes

1. Introduction

The central part of the Ionian Islands is one of the most seismically active parts in the Mediterranean region (Makropoulos and Burton 1984) with high seismicity rate and earthquake magnitudes up to 7.4 (Papazachos 1990; Louvari et al. 1999). The Hellenic Trench represents an active plate boundary where the eastern Mediterranean lithosphere is being subducted beneath the Aegean one. This subduction zone terminates against the Cephalonia Transform Fault Zone (CTFZ in Fig. 1), which is located west of Lefkada and Cephalonia (Fig. 1). The CTFZ has been identified by numerous studies based on (a) marine geophysical data and offshore structural trends (Finetti and Morreli 1973; Finetti 1982; Kokinou et al. 2005, 2006), (b) the spatial distribution of epicenters and the fault plane solutions of strong earthquakes (McKenzie 1978; Scordilis et al. 1985; Anderson and Jackson 1987; Kiratzi and Langston 1991; Papazachos et al. 1991; Papadimitriou 1993; Louvari et al. 1999; Sachpazi et al. 2000) and (c) displacement rates determined from geodetic measurements and GPS observations (Kahle et al. 1995; Peter et al. 1998; Cocard et al. 1999; McClusky et al. 2000).

The CTFZ is composed by the Lefkada segment (LS) to the north and by the Cephalonia segment (CS) to the south. The LS starts from the northern part of Cephalonia, strikes in a NE-SW direction, has a length of about 40 km and is characterized by a dextral strike-slip motion (Fig. 2). The CS occurs west of Cephalonia, exhibits strike-slip motion with a thrust component, strikes in a NE–SW direction, dips to the SE and has a length of about 90 km (Fig. 1). The CTFZ connects the subduction boundary to the continental collision between the Apulian microplate and the Hellenic foreland and plays a key role in the region's geodynamic complexity. It also separates the slowly northward and northwestward moving (\5 mm/year with respect to Eurasia) northern Ionian Islands from the rapidly southwestward moving (6–30 mm/year) central Ionian Islands (Anzidei et al. 1996; Hollenstein et al. 2006, 2008) and, therefore, represents a major boundary of the kinematic field in Greece.

From the seismic point of view, the northwesternmost part of the western Hellenic Arc and particularly the central part of the Ionian Islands is the most seismically active regions of Greece due to its proximity to the offshore CTFZ and to the occurrence of onshore active faults mapped by Lekkas (1993, 1996) and Lekkas et al. (2001, 2016, 2018). These onshore active faults are also capable of generating moderate to strong earthquakes causing extensive earthquake environmental effects (EEE) and severe structural damage, thus posing additional significant seismic hazard to the Central Ionian Islands.

Based on the aforementioned data, it is concluded that the evolution of the Central Ionian Islands is defined by active faults and a dense net of joints, which form geotechnically unstable areas. These areas are characterized by high and steep slopes, highly fractured and brecciated formations as well as suitable geometry of beds and discontinuities. The synergy of endogenic and exogenic processes contribute to formations loosening resulting in frequent failures along steep coastal slopes. This is the case in the western coastal part of the Ionian Islands, where slope failures are often generated along some of the most beautiful and visited beaches in the Mediterranean. The most characteristic events occurred in Myrtos beach in Cephalonia Island during the early 2014 earthquakes, in Egremnoi and Porto Katsiki beaches in Lefkada Island during the 2015 earthquake and in Navagio beach in Zakynthos Island in September and October 2018.

In similar cases worldwide, medium- and long-term approaches are adopted for landslide risk assessment and mitigation requiring no beach access until completion of protection measures with adverse effects in the economic activity of the affected areas. In this paper, a different approach is proposed. The beach zonation for mitigation of landslide risk and responsible tourism development is presented herein along with two application examples in the Central Ionian Islands.

2. Geological Structure And Fault Blocks Of The Central Ionian Islands

The geological structure of the central Ionian Islands comprises alpine formations that belong to the Paxoi (Pre-Apulian) and Ionian geotectonic units and Plio-Quaternary post alpine deposits that lie unconformably on the alpine basement (Lekkas 1993, 1996, 2001; Lekkas and Mavroulis 2015, 2016; Lekkas et al. 2016, 2018).

In Cephalonia, the Paxoi unit prevails. The western part of the island is composed of Paxoi formations including Triassic-Middle Miocene carbonates and Middle Miocene-Early Pliocene clay-clastic sequence of flysch type comprising alternations of marls, clays and mudstones (Lekkas 1996; Lekkas et al. 2001; Lekkas and Mavroulis, 2015, 2016), while its eastern part comprises Triassic evaporitic series of gypsum beds and limestone breccia and Jurassic-Cretaceous thick-bedded limestones, red nodular limestones and slates without the flysch at the top of the sequence (Lekkas 1996; Lekkas et al. 2001) as known from mainland Greece. The western boundary of the Ionian unit is defined by the Ionian overthrust (Fig. 1), which is the most external Hellenide structure. The Paxoi and Ionian formations are dissected by major thrust faults (Underhill 1989; Fig. 1).

Cephalonia is composed of the following fault blocks: (a) the Aenos Mt located in the central and eastern part of the island and bounded to the SW by the Aenos fault zone (AFZ in Fig. 1), to the NW by the Kontogourata–Agonas fault (KAF in Fig. 1), to the ME by the Agia Efimia fault (AEF in Fig. 1) and to the SE by the Paliokastro fault (PF in Fig. 1), (b) the Erissos peninsula located in the northern part of the island and bounded to the south by the Agia Efimia fault (AEF in Fig. 1), (c) the Paliki peninsula located in the western part of the island (Fig. 1) and bounded to the west by the Cephalonia segment (CS in Fig. 1) of the CTFZ, (d) the Argostoli peninsula located southwest and south of the Aenos Mt (Fig. 1) and bounded to the east and north by the Aenos fault zone (Fig. 1).

Lefkada comprises (a) alpine formations that belong to Ionian and Paxoi (Pre-Apulian) geotectonic units, (b) molassic formations and (c) recent deposits that lie unconformably on the previous formations (Lekkas et al. 2016, 2018) (Fig. 2). The alpine formations cover the largest part of Lefkas and form its mountains and plateaus. The largest part of Lefkas belongs to the Ionian unit, while only the southwestern part of the island and more specifically Lefkata peninsula comprises Paxoi formations (Fig. 2). Many faults dissected the island (Rondoyanni 1997; Lekkas et al. 1999; 2001; Rondoyanni et al. 2012). They are mainly normal or strike-slip faults with a sinistral or dextral sense of shear (Fig. 2) and they are classified into active, probably active and inactive structures (Lekkas et al. 1999, 2001, 2016, 2018).

The main fault blocks of Lefkada are the following: (a) the fault block of Lefkas town, located in the northeastern part of the island, where Lefkas town is situated, and bounded to the south by the Frini-Apolpaena fault zone (FAFZ in Fig. 2) consisting of E–W and N–S striking faults. (b) Tsoukalades-Katouna fault block located south of the previous fault block of Lefkas town, composed of Ionian carbonates in its western part and molassic and post-alpine formations in its eastern part and bounded to the north by the Frini-Apolpaena fault zone, to the south by the Pigadisanoi-Fraxi fault zone (PFFZ in Fig. 2) and to the west by the Tsoukalades-Agios Nikitas fault zone (TANFZ in Fig. 2) along the western coastal margin of the unit. (c) Agios Nikitas fault block located in the northwestern part of the island and bounded to the east by the Agios Nikitas fault zone (ANFZ in Fig. 2) and to the west by an almost N–S striking fault zone parallel to the coast. (d) Drymonas fault block located east of Agios Nikitas fault block and bounded to the west by the Agios Nikitas fault zone, to the east by the N–S striking Drymonas fault zone (DFZ in Fig. 2) and to the south by the NW–SE striking Kalamitsi-Exantheia fault zone (KEFZ in Fig. 2). (e) Mega Oros-Skaroi fault block located east of Drymonas fault block and bounded to the north by the NW–SE striking Pigadisanoi-Fraxi fault zone and to the south by the NE–SW striking Sivros-Nidri fault zone (SNFZ in Fig. 2). (f) Vlicho-Poros fault block located in the southeastern part of the island and bounded to the northwest by the NE–SW striking Sivros-Nidri and Vassiliki fault zones (SNFZ and VAFZ respectively in Fig. 2) and to the southeast by the NW–SE striking Syvota-Sivros fault zone (SSFZ in Fig. 2).

In Zakynthos Island, alpine formations comprising limestones, dolomites and evaporites of the Ionian unit occurred in Vrachionas Mt and Skopos Mt located in the western half and the southeastern part of Zakynthos respectively (Lekkas 1993). In contrast, the post-alpine deposits are observed in the rest part of the island unconformably deposited over the alpine bedrock.

The Zakynthos Island can be divided into fault blocks bounded by major active faults or fault zones. They have different lithostratigraphic structure and they have suffered different tectonic deformation and consequently they have followed different tectonic and neotetctonic evolution. The main neotectonic fault blocks are the following from the northern to the southern part of Zakynthos Island:

(a) the Northern Zakynthos fault block, located in the northern part of the island and is extended from the area north of Volimes and Katastari Cape (Fig. 3) and bounded to the south by the Volimes fault zone, (b) the Central Zakynthos fault block occupying the largest part of the island and bounded to the north by the VFZ and to the south by the active Kamaroti fault zone, (c) the Keri bay fault block located in the southern part of the island and bounded to the north by the Kamaroti fault zone and to the south by the Keri bay fault zone, (d) the Southern Zakynthos fault block bounded to the north by the Keri fault zone, (e) the Skopos fault block in Skopos peninsula, with the Ionian thrust over the Paxoi unit as well as the fault of Zakynthos city being its western boundary.

3. Slope Failures Along The Most Visited Beaches In The Western Part Of The Central Ionian Islands

Slope failures are often generated along some of the most beautiful and visited beaches in the Mediterranean. The most characteristic events occurred in:

3.1. Myrtos beach (Cephalonia Island) during the 2014 earthquakes

Myrtos coastal area is located in the western part of the transition zone between the northern part of Aenos Mt (i.e., Agia Dinati Mt) located southwards and the southern part of Erissos peninsula (i.e., Kalon Mt) located northwards (Fig. 1). In this transition zone, the Triassic-Middle Miocene limestones of Paxoi unit thrust over the Middle Miocene-Early Pliocene clay-clastic sequence of the same unit (Fig. 1). This reverse fault is the NW-SE striking Agia Efimia fault (Fig. 1), which also presents strike-slip component and therefore is characterized as an oblique reverse fault (Lekkas et al. 2001). The Agia Efimia fault along with the presence of NE-SW and NW-SE striking active faults (Fig. 1) cut across Myrtos coastal area and form a geotechnically unstable region.

This region is characterized by fractured and brecciated rock mass, suitable geometry of beds and discontinuities, high and steep slopes and scarps. It is obvious that in Myrtos coastal area the intense tectonic uplift plays a decisive role in the development of instability conditions since it increases the inclination and the height (300 m) of slopes. This tectonic deformation combined with the lithological anisotropy of alpine formations, and the erosion and weathering processes contribute to decreased cohesion along the steep slopes. All these endogenic and exogenic processes make Myrtos coastal area highly susceptible to the generation of slope movements. The early 2014 Cephalonia earthquakes act as triggering mechanisms for many types of slope movements, which are classified as landslides, rockfalls, rock toppling failures, creep and debris flows. Some of them remained active for a long time after the second earthquake.

After the first earthquake, rockfalls occurred along the steep slopes over Myrtos beach (Fig. 1). Two limestone blocks with volume up to 500 m^3 were detached from the eastern steep slope, rolled downwards and stopped at the foot of the slope at a distance of 100 m from the shoreline (Fig. 1). During this movement, the blocks bounced and rolled over the road leading to the beach causing the total destruction of the road asphalt surface (Fig. 1).

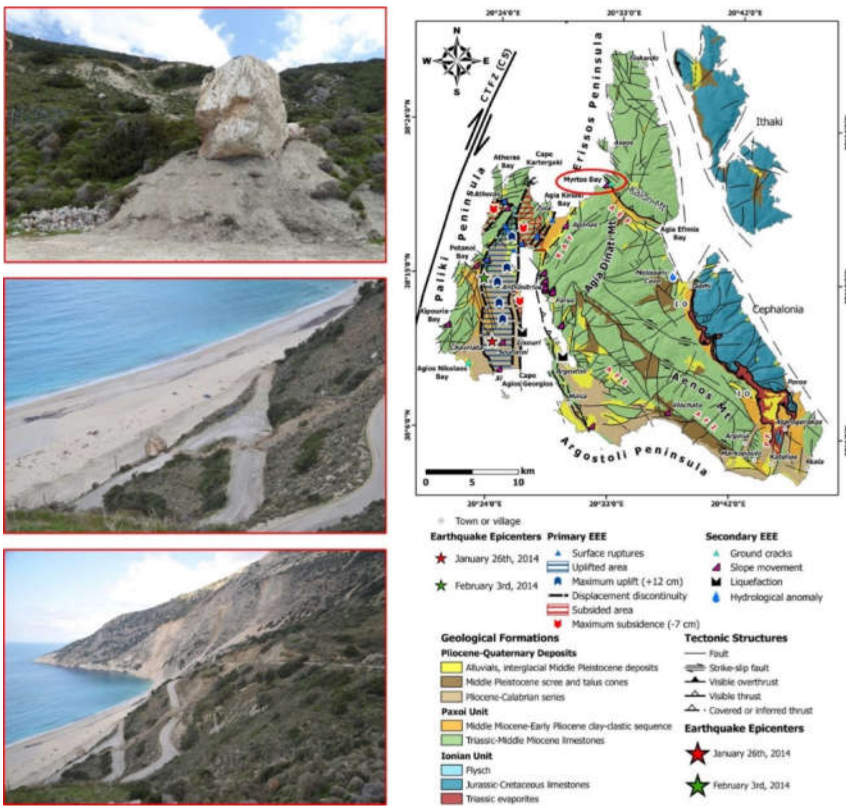

Figure 1: The neotectonic map of Cephalonia Island along with the epicenters of the early 2014 Cephalonia earthquakes, the primary and the secondary earthquake environmental effects induced by both earthquakes (Lekkas and Mavroulis 2015, 2016). Rockfalls were generated along the Myrtos beach (Lekkas and Mavroulis 2015).

3.2. Egremni and Porto Katsiki beaches (Lefkada Island) during the 2015 earthquake

Extensive slope movements were also generated during the earthquake in Porto Katsiki (Fig. 2) and Egremni (Fig. 2) coastal areas. Loose brecciated limestone blocks were detached from the steep limestone slopes of Porto Katsiki area and fell in the narrow beach (Fig. 2). It is significant to note that Porto Katsiki is one of the most beautiful and visited beaches in the Mediterranean with thousands of locals and tourists attracted by this naturally shaped beach during the summer season and staying close to the steep limestone cliffs or inside caves.

As regards Egremni area, unstable geological material comprising loose limestone blocks and semi-cohesive scree with limestone breccia and red clay were detached from the steep coastal slopes and rolled down towards the sea (Fig. 1). As a result, the Egremni beach was almost entirely covered by landslide material, the part of the road network leading to the beach was destroyed and some buildings were found on the edge of the slope and at risk of collapse. It is concluded that it is fortunate that the earthquake was generated during the winter season.

The coastal slopes of the western part of Lefkada suffered the most by the 2015 Lefkada earthquake due to the combination of the following parameters:

(a) The tectonic structure of the western coastal part of Lefkada is characterized by active faults (Lekkas et al. 1999, 2001; Rondoyanni et al. 2012) that play decisive role in the formation and the evolution of Lefkada. Along with a dense net of joints, they additionally form a geotechnically unstable region characterized by high and steep slopes and scarps, highly fractured, brecciated and almost powdered limestones with secondarily welding as well as extensive semi-cohesive scree with limestone breccia and red-clay filled fractures fractured as well as suitable geometry of beds and discontinuities. Thus, Porto Katsiki, Ergemni, Kalamitsi, Kathisma, Agios Nikitas and Pefkoulia areas are characterized by generation of slope movements. It is clearly evident that the tectonic activity in this area increased the inclination of the coastal slopes varying in height from 100 to 600 m. The combination of (ii) the endogenic processes including tectonic deformation of the crust and resulting in the lithological heterogeneity and the mechanical anisotropy of the alpine and post-alpine formations with (iii) the exogenic processes comprising repeated cycles of mechanical, chemical and organic weathering and fluvial, marine and aeolian erosion contribute to the decreased cohesion and formations loosening along the steep coastal slopes of the affected area. For example, sea waves erode the base of the almost vertical slopes forming steep limestone cliffs, caves and overhangs and creating conditions favorable for slope movements. The probability for the generation of slope movements increases during earthquakes.

(b) They are located within the core of the epicentral region, which is characterized, as already presented, by extremely severe horizontal and vertical components acting almost simultaneously.

(c) The LS of the CTFZ is characterized not only by strike-slip motion but also by a compressional component directed from west (sea-side) towards east (hill-side), perpendicular to the free surface of slopes. This function is schematically shown in Fig. 8e, where an indicative simplified schematic E-W cross section is presented. As a result, the strong initial inertia forces of the ground mass composing the slope, are directed from east towards west (e.g. towards the free slope surface). On the contrary, if the polarity of the initial strong horizontal motion was directed from east towards west, where is facing the free slope surfaces, the results could be quite different with the initial strong horizontal motion acting in favor of the slope stability. And this is of great significance for the seismic safety of slopes exposed to this kind of earthquake ground motions since the aforementioned motion was composed out of very few pulses during its strong phase.

(d) Due to the extremely strong vertical seismic component and especially during its downward motion, the following parameters are greatly reduced until their final extinction: (i) the weight of the ground particles acting perpendicularly to their interfaces, (ii) the friction among the particles and (iii) the final overall stability and earthquake resistance of the slope.

All above mentioned concerning the seismic response of the slopes, in the case under consideration, are present and combined together, resulting in a final collapse of the slopes and a great mobility and deformation of their top surface.

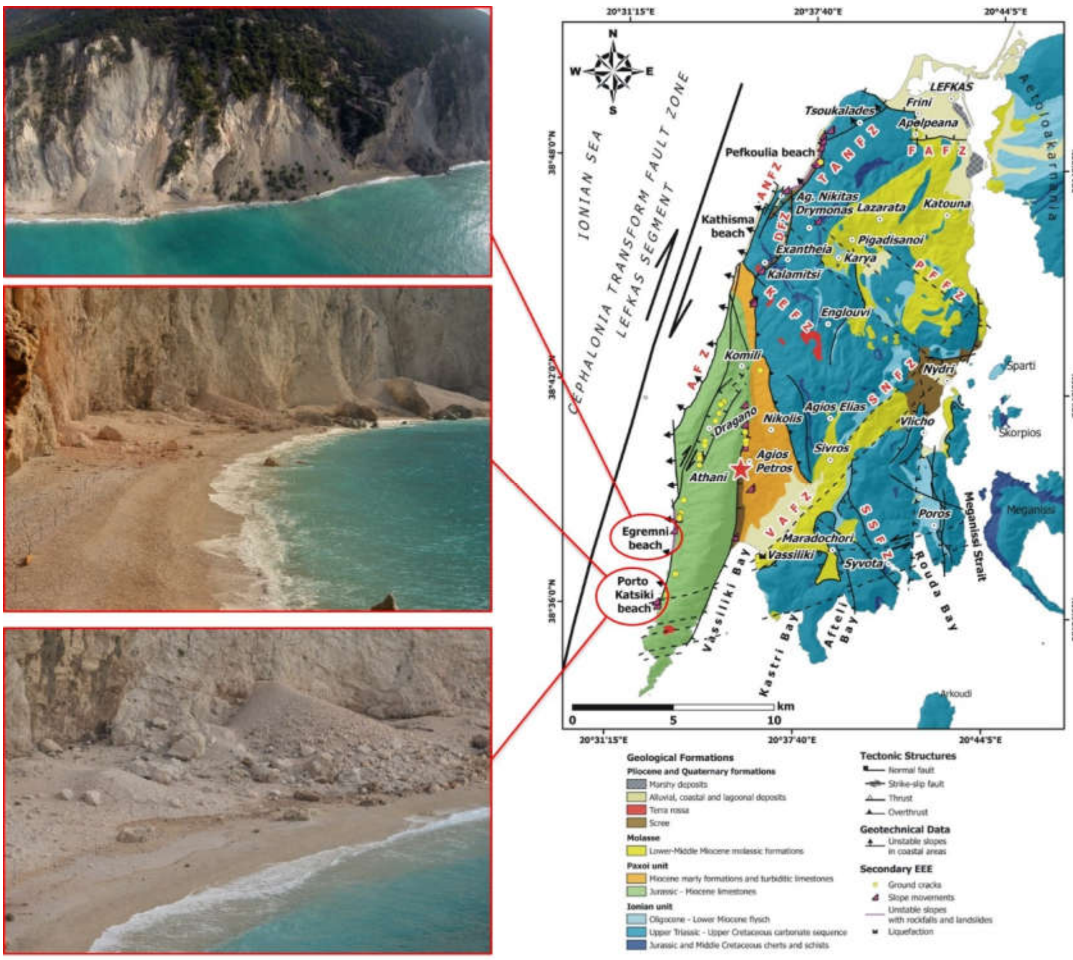

Figure 2: The neotectonic map of Lefkada Island along with the epicenter of the 2015 Lefkada earthquake and the secondary earthquake-induced environmental effects (Lekkas et al. 2016, 2018). Landslides and rockfalls were generated along the Egremnoi beach (up left) and in Porto Katsiki beach (Lekkas et al. 2016, 2018).

3.3. Navagio beach (Zakynthos) in autumn of 2018

Navagio beach is located along the isolated Agios Georgios coast and it is located in the northwestern part of Zakynthos (Fig. 3). This beach is considered as one of the most beautiful and most visited beach not only in Europe but worldwide.

The Navagio coastal area is composed of Vrachionas limestones of the Paxoi geotectonic unit (Fig. 3). This formation comprise white, usually massive and locally layered and rarely sub-lithographic Upper Cretaceous limestones with thickness more than 600 m composing the largest part of Vrachionas Mt in the western half of the island. They are usually chalky and are easily weathered. High and steep slopes and stunning sea caves are formed along the western steep limestone coast of Zakynthos. Their formation is attributed to the synergy of (a) endogenic processes resulting in the lithological heterogeneity and the mechanical anisotropy of Vrachionas limestones and (b) the exogenic processes comprising erosion at the base of the almost vertical slopes forming steep limestone cliffs, caves and overhangs and creating conditions favorable for slope failures, especially during earthquakes.

The first rockfalls occurred in September 18, 2018 after the first autumn rain. Loose limestone blocks were detached from the eastern steep limestone slopes and fell in the small beach and into the sea (Fig. 3)and triggered a small but strong wave that overturned 3 small boats. At the time of the generation of the rockfalls, many residents and tourists were already along the beach. Some of them were close to the unstable slope and consequently 7 were slightly injured and transferred to the closest hospital. As a result, the approach and disembarkation to the beach were prohibited for public security reasons.

The second rockfall phenomena were triggered by the October 26, 2018 Mw 6.8 earthquake generated offshore southwestern Zakynthos and it was predominantly felt on Zakynthos and throughout the Ionian Islands, Peloponnese and the mainland Greece fortunately with no casualties or injuries reported. Landslides and rockfalls were mainly generated along the steep coastal slopes and scarps in the western part of the island (Lekkas and Mavroulis 2018).

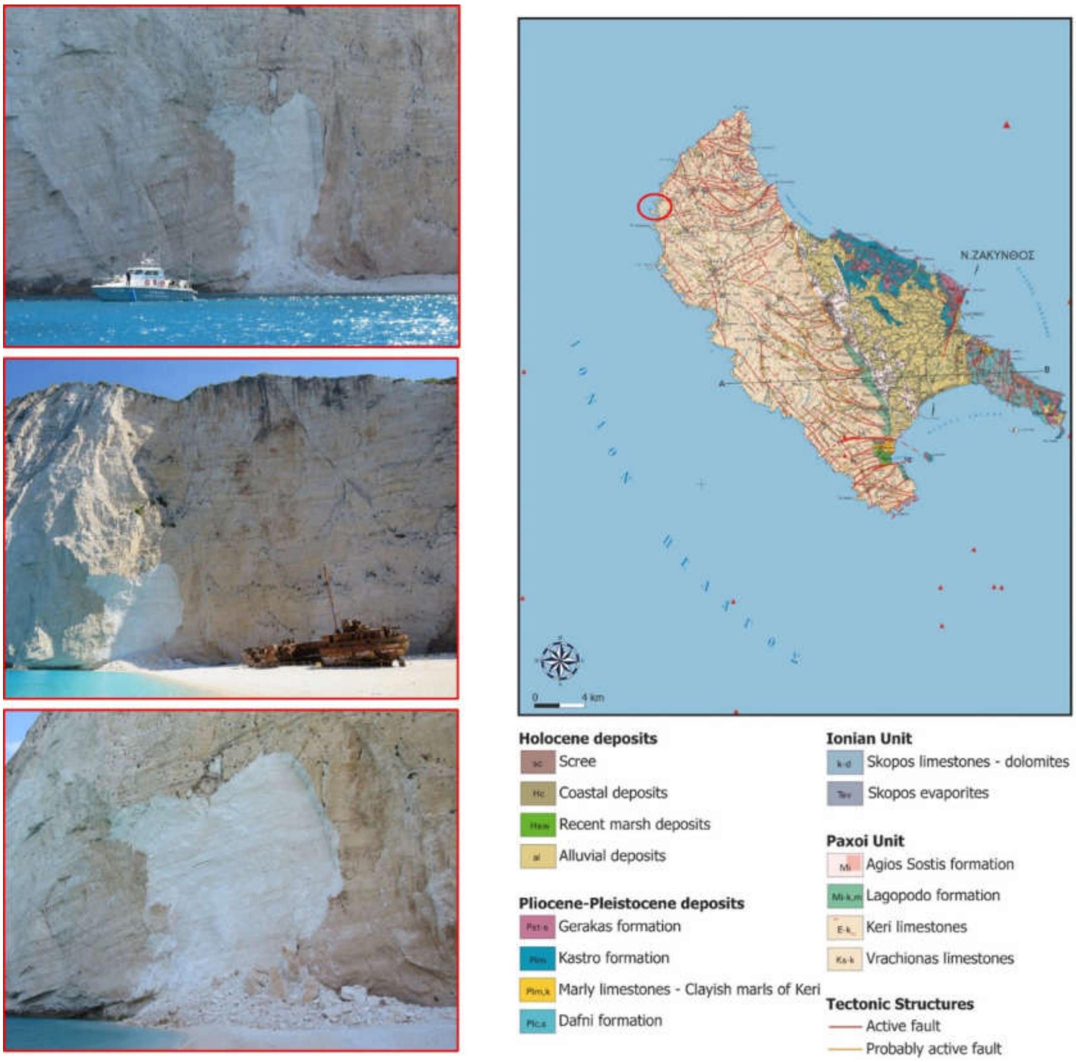

Figure 3: The neotectonic map of Zakynthos Island (modified from Lekkas 1993) along with the location of Navagio rockfalls.

4. Beach Zonation For Mitigation Of Landslide Risk And Responsible Tourism Development – Application To Porto Katsiki (Lefkada Island) And Navagio (Zakynthos Island)

Beach zonation is a widely used methodology that is applied for a limited time and needs to be differentiated in time according to the prevailing conditions that primarily affect the degree of risk.

Based on the aforementioned, the study beach is divided in three zones of risk, which are described below:

1. High Risk (Prohibited access)
2. Medium Risk (Restricted access)
3. Low Risk (Free access)

The delimitation of the zones is based on:

- the morphology and mainly the height of slopes
- the geotechnical characteristics of the rock mass and mainly in the presence of unstable blocks which are ready to fall
- the presence or absence of boulders or smaller blocks on the beach, which are originated from past events
- testimonies for past landslide sites and related phenomena
- the experience of rockfalls and similar phenomena in other beaches with the same or similar characteristics

Based on the following two assumptions:

- Landslides and rockfalls comprising small and large unstable blocks along the beaches of Porto Katsiki and Navagio are a frequent phenomenon and the risk is generally characterized as high,
- Measures must be proposed in order not to forbid the access to the beach in order to avoid large economic and social impacts until the implementation of the medium- and long- term projects,

the use of the beach have to be under strict conditions and restrictions that are associated with acceptable risk, a practice widely used in countries advanced in risk management. This is further suggested by the fact that there can be no risk in the studied coastal areas and more specifically in Myrtos, Porto Katsiki and Navagio beaches.

With this assumption, the proposed beach zonation could be implemented in short term without high cost and with positive results. This approach results from the determination of risk of even minor rockfalls along the beach and from restricting access to its affected parts.

This approach was applied to Porto Katsiki and Navagio beaches (Fig. 4). The resulted subareas and the proposed measures for the mitigation of landslide risk and responsible tourism development are the following:

(a) The high risk, prohibited access zone, marked as red in Fig. 4, starts from the steep and high limestone slopes of the beaches. Additionally, the access to existing caves should be banned.

(b) The medium risk, restricted access zone, marked as yellow in Fig. 4.

(c) The low risk, free access zone, marked as green in Fig. 4, extends from the yellow zone to the sea shore.

The first two zones of high and medium risk can be merged into one high risk, prohibited access zone when factors that can trigger or accelerate the generation of landslide phenomena exist, for example after the generation of an earthquake, during a prolonged aftershock sequence, during an extensive period of heavy and intense rainfalls.

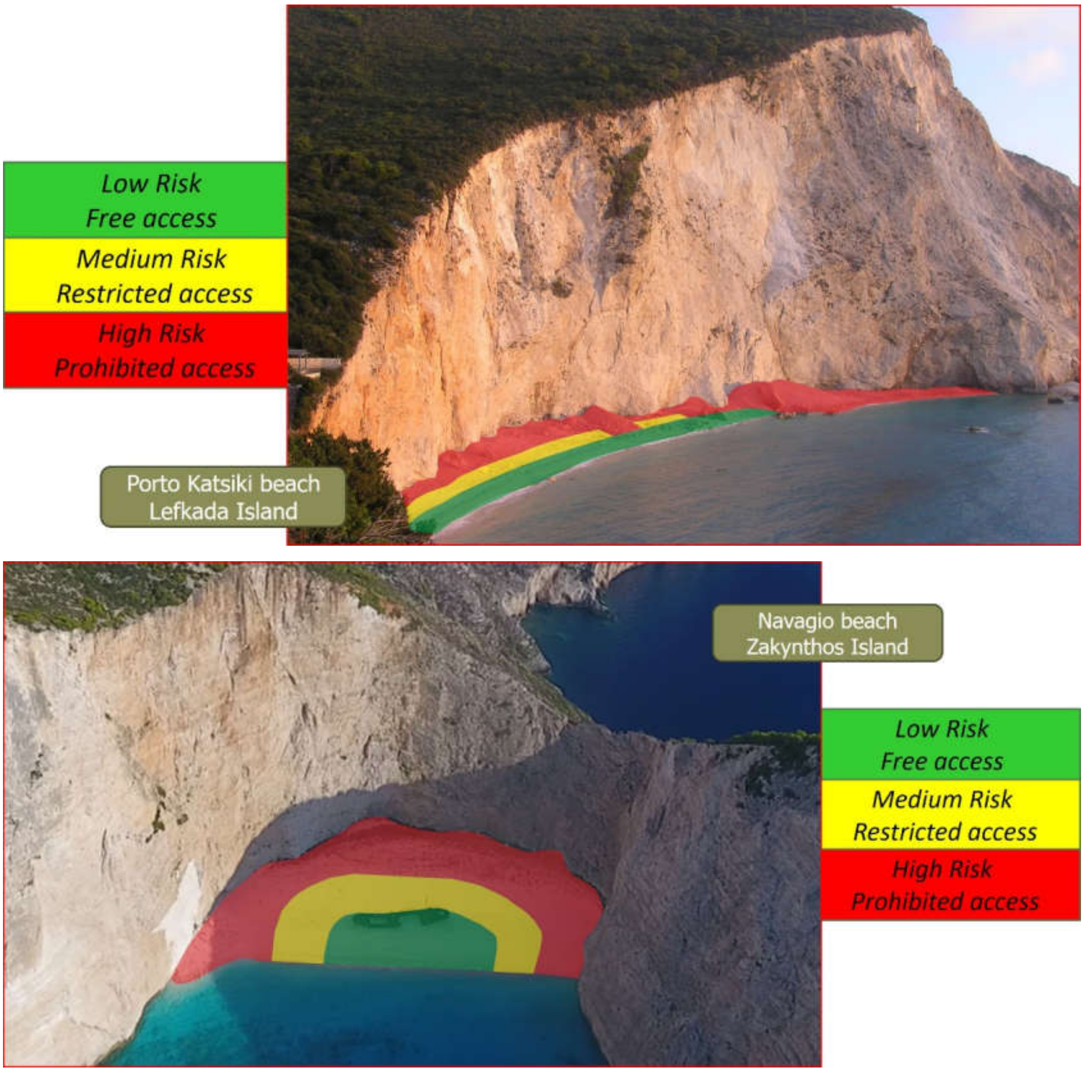

Figure 4: Application of the beach zonation for mitigation of landslide risk and responsible tourism development in Porto Katsiki (up) and Navagio (down) beaches in the western part of Lefkada and Zakynthos respectively.

5. Conclusions

This study aims to the proposal and the application of a methodology comprising beach zonation for mitigation of landslide risk and responsible tourism development. This methodology comprises the classification of the beach into three zones with different access based on the landslide risk: (a) the high risk, prohibited access zone, (b) the medium risk, restricted access zone and (c) the low risk, free access zone. Based on the Porto Katsiki and Navagio examples, it is concluded that the proposed beach zonation could be implemented in short term without high cost and with positive results instead of medium- and long-term approaches requiring no beach access until completion of protection measures with adverse effects in the economic activity of the affected areas. Moreover, it could be applied not only in the Ionian Islands but also in other coastal areas with similar geological, geomorphological and socioeconomic characteristics.

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SUSTAINABLE FOREST BIOMASS EXTRACTION AS A TOOL FOR FOREST FIRE RISK REDUCTION AND CLEAN ENERGY PRODUCTION.

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Abstract

The importance that each nation and its authorities give to the primary stage of designing and preventing natural disasters is a qualitative indicator of its organization. The citizens' protection is ensured through the principles of the rule of law. However, the climate change seems to reinforce the problem of natural disasters like forest fires in Greece. Forest fires are one of the most common natural disasters in the Mediterranean zone with direct consequences for the society, the environment and the economy. Forest fires cause also subsequent natural disasters such as severe floods. The Principles of Prevention and Precaution are central to the General Principles of Environmental Protection. Sustainable management and the multifunctional role of forests contribute to Sustainable Development. In this context, the purpose of the present study is to highlight the idea of sustainable forest biomass extraction, which can effectively reduce forest fire risk by reducing fuel source. Through research experience and literature review, the key issues of the ecological constraints on forest biomass extraction for the ecosystems' sustainability and the spatial constraints for the system's sustainability are presented. Possibilities for the utilization of forest biomass parts for clean energy production in a decentralized scale, with adding economic value for local production are also explored.

Keywords: Forest biomass, Forest fires, Bioenergy, Sustainability, Ecology, Wildland-Urban Interface areas

Introduction

Forests produce a significant amount of accessible and renewable fuel source. Nevertheless, their exploitation should be sustainable in an ecological, social and economic framework in order these sources to be preserved for the future generations too (Röser et al., 2008). The sustainable forest biomass harvesting and utilization for energy purposes could work also as a tool in order the forest fire risk to be reduced. Particularly, in Mediterranean countries, where natural disasters such as the forest fires are a common occurrence.

The sustainable forest biomass extraction process is affected by many factors such as the environmental criteria, the terrain characteristics, the protection status and the heterogeneity of the landscape. These can be applied with the aid of the appropriate research and scientific tools which contribute to the rational bioenergy framework (Manolis et al., 2018). As the conversion of the biomass through a variety of processes can produce gas, solid and liquid products, the bioenergy production from biomass is increasing worldwide. Thus, the quantification and the qualification of the forest biomass play a pivotal role for its rational exploitation (Manolis et al., 2016).

There is a chain which consists of three factors during the forest fires. These factors are the burning forest fuel, the oxygen and the temperature over the flash point. Thus, there is an effort during the forest fires, in order to put them out, this chain to be broken by the use of various means (Kailidis, 1981). The appropriate and sustainable management of forest biomass could reduce the forest fire risk and prevent such natural disasters. That is important for the Wildland-Urban Interface areas which face an increased forest fire risk, having also settlements without multiple planning process.

The purpose of the current study is through a holistic approach and the scientific literature review to highlight the concept of the sustainable forest biomass extraction, which can reduce the fuel source and accordingly the forest fire risk. Extensive scientific research is a prerequisite in order a sustainable framework to be shaped for the viable harvesting of the forest biomass for energy purposes. Thus, several restrictions and capabilities are discussed, investigating the golden mean.

Materials and Methods

Through an interdisciplinary approach and according to the literature review but also from research experience the current study aims to emerge the idea of sustainable forest biomass extraction. This study focus on Mediterranean forest ecosystems and aims to give ecological solutions not only for preventing natural disasters such as forest fires, but also for producing at the same time renewable green energy. Investigating the golden section, several restrictions and capabilities are discussed. This study is also supported by an extensive photographic archive.

Results and Discussion

By harvesting in a rational way the accumulated and unexploited forest biomass, which consists the fire's fuel, it is also reduced one of the three necessary factors (Fig.1) that cause the forest fires' outbreak.

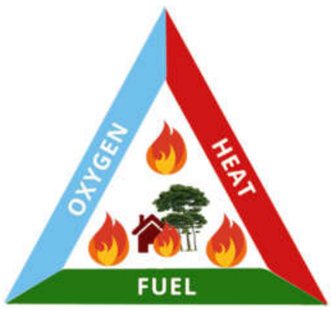

Fig. 1. The Fire Triangle. The forest fires are results of combustion. A chemical reaction which combines three factors. The Oxygen, the Heat and the Fuel. The sustainable Forest Biomass extraction for energy utilization would reduce the forest fire risk by reducing the fuel source in a viable and ecological way.

Thus the risk of several Natural Disasters like forest fires and floods, which are following soon after, is reduced. Also, it fragments the fuel's coherence and continuity and that reduces further the fire's spread. In addition, when this sustainable extracted forest biomass is converted, through thermochemical conversion (Fig.2), into green energy products then several other Natural Disasters caused also by the climate change are preventing.

Fig. 2. The PP20 Power Pallet (© ALL Power Labs, Berkeley, California). A compact and portable biomass power generation solution that converts Forest Biomass (Softwood and Hardwood chips) into electricity, heat and also biochar, which could be reused as a soil amendment. Such small-scale decentralized carbon-negative energy technologies could supply clean energy, through the local forest biomass gasification, to the local communities in mountainous forest areas, the rural regions and the settlements in Wildland-Urban Interface areas by producing socio-economic and ecological impacts and reducing the unemployment rates and the forest fire risk. In addition, there are incentives for the local authorities via the "Energy Communities" (Greek Law No. 4513/2018) to take further advantage of the local biomass sources for bioenergy purposes.

However, in order the forest biomass to be maintained as a really Renewable Energy Source, several ecological and other restrictions must be implemented into the forest biomass supply chain and extraction process. Shaping a sustainable framework involves extensive scientific research and approaches. One step is in the field the carefully destructive sampling for research purposes of representative trees from well distributed forest plots. After detailed laboratory analysis, the average biomass content (g dry mass) of each compartment (stem, branches, foliage) per tree is estimated. During this quantifying process is also important to estimate separately some primary residues (Fig.3).

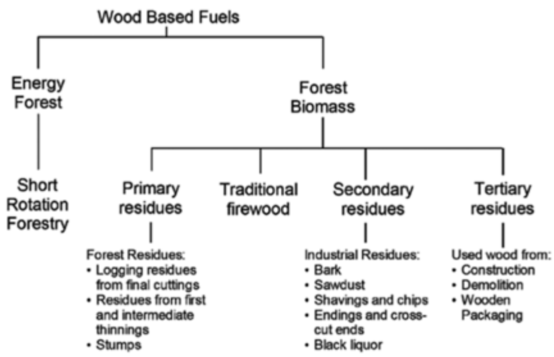

Fig. 3. Wood based fuels - classification (Röser et al., 2008).

One such example is the tree's unmerchantable top compartment, which is non-tradable as it has lower standards and is left unexploited in forest stand after the commercial logging procedure. Also, after statistical analysis the correlation between the independent variables of trees' physiology (e.g. the tree's Diameter at Breast Height) and the the trees' dependent variables (e.g. the tree's total Above-Ground Biomass), leads to accurate forest biomass prediction equations for broader, fast and simple application (Manolis et al., 2016). Such research processes leads in quantification of the possibilities and the forest biomass potential, before several restrictions to be implied. Through plant tissues analysis it emerges also the content's distribution of the macronutrients and the micronutrients among the different trees' parts. This knowledge of nutrients' mean content differentiation and allocation in the aboveground biomass emerges a distinct significance of each tree part for the ecosystem's sustainability (Manolis, 2015). For example, according to Dafis (1986) in the foliage biomass is located the largest nutrients' amount and thus it is ecologically important to remain in the ecosystem, since further the litterfall is crucial for the nutrient supply and circulation. Biomass's moisture content is also a key issue for its chemical conversion to energy and affects also transport costs and storage issues. Laboratory analysis results indicate that moisture content among the tree parts is differentiated (Manolis et al., 2016). Spatial limitations in forest biomass harvesting are also vital for the system's sustainability. The detection of accessible slopes (0-35%), the exclusion of the protected areas (e.g. the ecological network Natura 2000), the landscape's connection and diversity preservation and also the spatial distribution of the forest biomass potential are crucial spatial criteria for the sustainability and are explored by the Geographic Information System and the Remote Sensing (Manolis et al., 2018).

Conclusions

Such integrated and sustainable frameworks could act as prevention tools for upcoming Natural Disasters, especially in Wildland-Urban Interface areas (Fig. 4,5,6) where the forest fire risk can cause fast unforeseen consequences with devastating results.

Fig. 4. The wider region of Sounion in Attica, Greece, in the 1980s. The unregulated residential sprawl within forest areas will create very complicated situations in the future. Settlements without environmental and urban planning management, with high forest fire risk. One such case was the settlement of Mati in Attica, Greece, where the lethal forest wildfires caused devastating impacts on July, 2018.
(Photo archive: Hellenic Agricultural Organization 'Demeter', Institute of Mediterranean Forest Ecosystems, Athens, Greece).

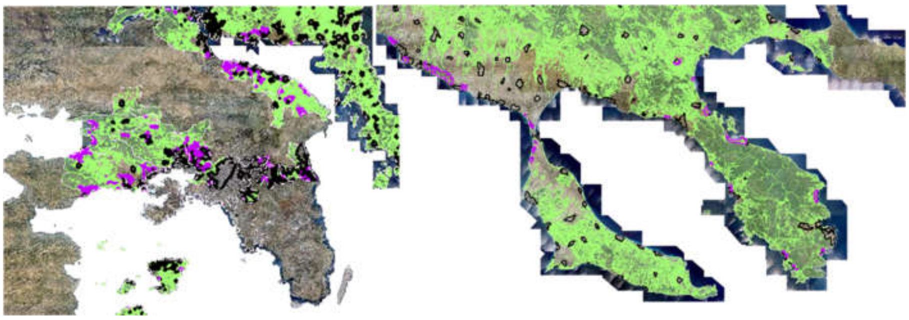

Fig. 5,6. The areas within purple color are the «residential densities» (Common Ministerial Decision No. 34844/2016) in Attika (left) and Chalkidiki (right), Greece. Briefly, «residential densities» are concentrations of buildings, which are not located neither in approved street plans or legally existing settlements, nor in areas under planning approval or under settlements' demarcation…Further, the «residential densities» are gatherings of buildings presumed as illegal (Decision No. 1942/2017, Hellenic Council of State). There is an ongoing effort for further clarification and management of the "residential densities". Within the «residential densities» there are areas with forest character. Thus, these areas are facing an increased forest fire risk as they are Wildland-Urban Interface areas with settlements that are lacking of a multiple planning process. (Orthophotos source: National Cadastre and Mapping Agency S.A.).

Appropriate forest biomass, which is useless and accumulated (Fig.7), after Natural Disasters, could also be converted in bioenergy.

Fig. 7. Huge amounts of forest biomass have been gathered in piles after the lethal forest fires in the settlement of Mati in Attica, Greece. The local Authorities are searching an effective way in using them. Utilizing and converting them into electricity would be also one green solution. (Photo archive: Hellenic Agricultural Organization 'Demeter', Institute of Mediterranean Forest Ecosystems, Athens, Greece).

Finally, in Mediterranean region of primeval forests, agroforestry landscapes and climate change issues, combining in a viable way investments in Renewable Energy Sources and environmental protection is crucial for the Sustainable Development.

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RENEWABLE ENERGY GENERATED BY THE IMPACTS OF NATURAL AND ACCIDENTAL WATER-BASED DISASTERS

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Abstract

In 2018, Hurricane Florence in the Southeast US Coast and Typhoon Mangkhut (known as Typhoon Ompong in the Philippines) in South China Sea caused 53 and 134 fatalities respectively. Such events highlight that the magnitude of extreme water-based disasters (WDs) cannot always be accurately predicted at a local level, largely due to their scale and unpredictable nature.

Most current weather forecasting models present generalized or large-scale solutions based on limited and/or inaccurate input data. As a result, incorrect or missed alarms frequently lead to property losses and human casualties, especially in remote and low income areas. Rural communities in riparian and deltaic areas are often affected, as they are unable to manage WDs effectively. Furthermore, insufficient and unstable power resources in these regions also undermine disaster response capabilities, along with wider socio-economic growth.

Hydropower could provide solutions, as it offers the potential of energy production autonomy to such communities. However, can hydropower systems also provide warnings and “smart” evacuation routes during the WDs? This research introduces a pioneering plan for the use of potentially lost energy during the WDs to directly support emergency response. It investigates the conceptual model of a mini (or smaller-scale) hydropower generator that includes early-warning alarm systems appropriately designed to operate at the local level. In practice, this study focuses on units that support power needs to end-users under both normal and extreme conditions. Positive outcomes could lead to the direct integration of sustainable economic development and disaster preparedness within these communities.

Keywords: hydropower, early warning system, disaster resilience, local community, rural development

1. **Introduction**

With the levels of climate change showing increasing effects worldwide, the frequency and magnitude of extreme weather events have reached concerning levels. Water-based disasters (WDs), such as torrential floods and heavy rainstorms may occur suddenly and significantly impact numbers of people, especially vulnerable rural populations residing in riparian and deltaic (RaD) areas (Few, 2003). The region of Asia and the Pacific (APAC), in which over 5,000 natural hazards (43 percent of the global total) have occurred since 1970, is the most vulnerable territory on Earth. In numbers, catastrophic weather phenomena affected more than 6 billion people, caused at least 2 million fatalities and cost US$ 1.15 trillion in damages (Kim et al., 2015). The most recent disaster is the Typhoon Mangkhut (known as Typhoon Ompong in the Philippines) that resulted in 134 fatalities, several injuries and over 2.5 billion US$ in damages (Typhoon Mangkhut, 2018).

Other reports based on the Intergovernmental Panel on Climate Change, show that Africa has been substantially affected by climate change as well, having the second highest natural hazard occurrence rate since the early 1970s. Floods and other water-based hazards have caused more than 20,000 deaths and affected almost 40 million people in just a few decades (Parry, 2007; Davidson et al., 2007). One notable example is the excessive rainfall of 2000 in Mozambique that lasted 5 weeks and caused approximately 900 deaths, thousands casualties and homeless, as well as damages in local ecosystems, infrastructures and the economy (Christie and Hanlon, 2001). Europe and the Americas should also be mentioned since the impacts of climate change are disastrous in their territories as well. In 2003, Europe and North America faced floods and storms that caused 15 deaths and almost US$ 3 billion in damages (Kim et al., 2015); similarly, the torrential floods in Costa Rica, Nicaragua, Guatemala and Greece in 2017 and the Hurricane Florence in the Southeast US Coast in 2018 resulted in dozens of fatalities and countless property losses.

One of the major causes of these disasters is the alteration of forested and RaD environments and their water flow frequencies due to human activity. Many of these regions have been inhabited hundreds or even thousands of years ago because of the multiple benefits they offer, including the clean water, food, sheltering and energy. Consequently, they have experienced intensive and continuous land use or other human disturbances (Corbacho, Sánchez, and Costillo, 2003). Another cause is the excessive use and dependence on fossil fuels. The overuse of natural resources is a major contributing factor to the increasing impacts of WBs (Rogelj et al., 2016). Lastly, the design and use of weather forecasting and early-warning systems (EWS) is another critical issue. Many WDs occur at the local level and can often develop rapidly. However, most applied EWS do not focus on the specific atmospheric and hydrogeomorphological (AHG) characteristics of local areas, mainly due to the high cost of such coverage.

Floods related to overflow of water in predominantly dry regions is a common phenomenon in drainage basins. In torrent basins, the developing floods increase in magnitude, speed and intensity of flood waters. It only requires few minutes from the early stages of the heavy precipitation to reach the flood event's climax; therefore, the response time is often extremely limited. The elderly or people with kinetic problems within the disaster area do not have time to prepare as there is no warning of the upcoming disaster. Furthermore, sudden shocks and panic can undermine the evacuation procedure, especially if the affected individuals have not received any relevant training. Remote communities frequently have limited knowledge in disaster education, poor disaster resilience mechanisms and unsustainable energy sources. Their pace of socio-economic development may not align with populations in cities or central region and, as a result, they may have to be more self-reliant in order to effectively manage such hazards and grow their communities.

Renewable energy, such as hydropower could provide solutions for these communities under both normal and extreme conditions. While hydropower applications and their potential in WDs have not yet been fully exploited, mainly due to the disproportionate cost-to-benefit relationship, recent international policies and frameworks including the United Nations 2030 Agenda for Sustainable Development ('Transforming our world: the 2030 Agenda for Sustainable Development', 2015), support combined strategies that can bring results to multiple issues, including socio-economic development, disaster resilience and renewable energy. This awareness shows that there is potential to prevent and minimize the impacts of natural hazards by securing continuous environmental sustainability and socio-economic resilience.

To further support this awareness, this study examines the community establishment of a renewable energy source and the utilization of potentially lost energy during WDs to directly support emergency response. It investigates the conceptual model of a mini (or smaller-scale) hydropower generator that includes EWS appropriately designed to operate at the local level. In practice, this study focuses on the establishment and use of multi-functional hydro-generating units placed in appropriate locations selected according to hierarchical flood risk estimates at the local level (Emmanouloudis, Myronidis, and Ioannou, 2007) in order to to bring integrated solutions to the end-users under both normal and extreme conditions.

2. General Understanding of Hydropower Generation

The current energy production and usage of most countries dealing with extreme hazards, is highly dependent on fossil fuels; an energy source that increases the risk probability of large catastrophes, since the fossil fuel industry plays a significant role in the occurrence of extreme weather events, alterations in temperatures, sea level rises, etc. (Bauer et al., 2016). The great majority of scientists have warned humanity that global average temperature rises will result in an increase and intensification of climate-related disaster events. According to the Paris Agreement within the United Nations Framework Convention on Climate Change, the most realistic method of avoiding this outcome is to restructure energy usage by reducing the fossil fuel needs and maximizing the potential of renewable energy (Rogelj et al., 2016).

As the world's largest renewable energy source, hydropower could be a critical factor in achieving a successful transition from fossil fuels. It is based on the natural water cycle and it is currently the most reliable, cost-effective and mature renewable power generation available. It produces over 15% of the global electricity and over four-fifths of renewable electricity worldwide. Additionally, it can behave as a power source for large, centralized, small and isolated grids, while it can be combined with water supply services, such as flood control and irrigation systems and provide multiple social and economic benefits (Gielen, 2012). It is generally environmental-friendly since it is carbon dioxide free; however, it may produce greenhouse gas emissions and have other environmental impacts, depending on the size schemes and their processes (e.g. construction of large hydropower schemes). Other challenges that could turn into serious threats are the possible changes in river flows and the impacts on the local biodiversity and population. Concerning changes usually occur with the establishment of large hydropower generators in RaD ecosystems (Hermoso, 2017). Importantly, small, localised hydropower generators do not affect the environment to such degree and they are a more cost-competitive option for electrification in rural communities. They can be also considered a reliable option, especially for the remote populations in low income areas or during extremes (Gielen, 2012).

There are several parameters that need to be considered in order to evaluate the feasibility and cost-to-benefit advantages of a hydropower application. The most critical parameters are the following ('Hydropower', 2015):

- **Good head**: this is one of the most important parameters for the efficiency of hydropower stations. The power, as well as the energy of a hydro site corresponds to the head that is the difference in height from one point to another. Low head usually leads to large water volume (low levels of pressure and velocity), and therefore the investment cost is increased. On the other hand, an increased head results in lower cost and an increased power and energy production. This, however, does not always apply to every hydropower application; low or no head sites can be equally productive, depending on the needs of the site and the available head.
- **Good flow**: This is another important factor for a productive hydropower generator. Usually, low head means high flow rates. For instance, low-head areas have less tributaries; therefore, increased flow rates. The flow rate is required for investigating how much energy can be generated in a site and consequently it can determine if a project is viable or not, especially due to the cost.
- **Site layout and position of the main parts**: simple (natural) sites are always preferred; however, this is not always realistic. System parts should be close to each other in order to reduce the cost and any environmental impact (i.e. small scale hydropower generators are installed at low-head sites, reducing the cost).
- **Grid Connection**: A good grid connection that can "take" all the generated energy is the optimal scenario. Grid maintenance and upgrade is important in order to obtain the maximal benefits from the hydropower station.
- **Site accessibility**: This parameter is essential for the construction, maintenance and upgrade of the station, when necessary. Usually this phase is investigated after the completion of the hydro feasibility study in order to minimize the cost.

- **Ownership**: Commercial agreements, percentage sharing and ownership must be thoroughly investigated before the installation of any hydropower station.
- **Environmental Impacts**: The environmental analysis is a major factor for the biodiversity and the sustainability of the local ecosystems. Therefore, all the processes should be designed with respect to the environment.

After investigating the aforementioned parameters, the size of the hydropower station must be determined at a specific site. Usually the size is categorized as pico, micro, mini, small, medium, and large (scale: small to large). In absolute terminologies and numbers, the size is neither accurate nor worldwide agreed (i.e. a small scale can power hundreds of residencies or other facilities). However, it helps deciding the type construction based on the total amount of the receivers and their needs. Table 1 presents the most accepted categories and number of residences based on average electrical needs (12 kWh/day) in the UK (‘Hydropower’, 2015).

Table 1. Categories of Hydropower and Number of “average” Residencies in UK

Hydro-Generator	Power Range	Residences
Pico	<5kW	Up to 5
Micro	5kW-100kW	Up to 100
Mini	100kW-1MW	Up to 1,000
Small	1MW-10MW	Up to 10,000
Medium	10MW-100MW	Up to 100,000
Large	>100MW	More than 100,000

3. Why current Disaster Early Warning Systems fail?

In order to detect extreme weather events in time, systems related to weather/flood forecasting and early-warning are established worldwide not only for the safety of the public but also for an efficient disaster risk reduction. They mainly refer to the identification events that can be detected prior to the causative phase and the damage they may produce. According to the United Nations International Strategy for Disaster Reduction, the term “early-warning” is briefly defined as “a comprehensive mechanism for natural and manmade disaster prediction, forecasting and monitoring that allows all types of stakeholders, from individuals to governments, to respond in advance and to reduce possible impacts of hazardous events” (‘Early Warning System’, 2017). It is usually cost-effective, especially if applied in regions with frequent hazards (i.e. APAC). Thus, the early forecasting of severe storms and floods is critical for the protection of lives and properties, as well as the preparedness of emergency response units.

Such systems are usually enhanced with the latest technological and scientific achievements, use numerical weather predictions (NWP) as basic input data, and are designed in such a way so to cover national or regional territories. These features allow them to “early-detect” extreme weather events and in many cases, the sufficient lead-time is usually enough for emergency response, including the search and rescue. Another key advantage of these systems is that the NWP can increase or even modify the forecast horizon, based on the input data, leading to trusted weather predictions. Overall, the data obtained from the EWS may determine to what degree a disaster may trigger larger catastrophes, including human and material losses.

Despite the many advantages they offer in large areas, at the local level a lot more needs to be accomplished before forecasting can reach its maximum potential. Short-lived heavy rainstorms may often trigger concerning flash floods and debris flows at small areas. While these events develop at space and time scales, the current conventional rainfall, streamflow and sediment discharge observation systems seem unable to monitor them accurately. This is because the AHG and environmental factors on the relative processes are poorly investigated, leading to a plethora of uncertainties in warning and alerting management that unavoidably influence the effectiveness of the EWS. In general, the most common approaches for the early indication of rainfalls and flash floods require the comparison of the latest precipitation observations and weather forecasts in order to pre-define reference warning thresholds. However, as the forecast uncertainties for the operational efficiency of EWS are high, the challenges of detecting local severe precipitation below the resolution of most available NWP models are numerous (Alfieri et al., 2012). Currently, the technologies of remote sensing (including the use of UAV) and NWP are emphasized so to improve the accuracy of flood forecasting at the local level (Borga et al., 2014).

Another disadvantage of the current EWS is that they cannot be fully embodied in national and local decision-making policies, owning to multiple factors, such as impassive public awareness and support, as well as the limitations in direct benefits to the end-users. Hurricane Katrina that struck the US Gulf Coast in 2005 is an example of such weaknesses. The meteorological warnings were accurate and released many hours in advance. However, the response of both the officials and public was rather inadequate. The officials were not able to persuade the public regarding their immediate evacuation. For its part, the public were not in position to conceive the size of the threat since they were not familiar with EWS data and its translations to risk messaging. Furthermore, they did not want to leave their properties unprotected fearing looting incidents in particular. Approximately 1,800 people died and the economic losses were over $US 80 billion. What is more, the disaster risk governance was ineffective as there was no sufficient prediction for the meta-problems of the disaster. Many survivors were left without basic living supplies such as food, water and energy for several days, until the response units rescued them (Borger, and Campbell, 2005).

This tragic event shows that even though the theoretical predictions, the information received by forecasting systems and the counseling of professionals are highly essential, the currently established mechanisms and their operators do not always correspond to real life conditions, particularly public involvement and "ownership" of risk messaging. The main purpose of EWS is to protect the public; thus, it is equally essential to early-detect and contribute in the limitation of the challenges that may appear after the occurrence of a disaster. For that reason, people-centered strategies in EWS are of high significance, since every phase of disaster management must be formulated by prioritizing services for affected populations and actively involving communities in these decisions and decision making (Schismenos, 2017). The success of WDs forecasting and EWS is a nexus of complex procedures that includes not only their design and implementation, but also their management, adaptation and promotion at every level.

4. Hydropower Generation during Water-based Disasters

Most hydropower generators are established in locations in which they offer maximum energy production under normal conditions (Almeida, et al., 2011). As previously stated, the mini hydropower generators have several benefits such as their small size, cost-effectiveness, low environmental impact, grid independence, sufficiency in covering the electrical needs of small communities, etc. In basins where flood phenomena are usual, they could be placed in locations that can provide energy both under normal and extreme conditions. Thus, the classification of local areas should be based on their hydropower efficiency and AHG flood risk probability. By doing so, the generators continue to operate even after the occurrence of an extreme event, depending on their durability, design and proper establishment.

This research will be based on the available data and products relevant to the research. Furthermore, it will involve the installation of a mini (or smaller-scale) hydropower generator for the completion of the project. The energy generator will be linked with EWS (graduating lights and alarms) for WDs detection and "smart" evacuation routes (egress lighting). Subject to location, an articulated system can support pumped hydro to provide increased, dispatchable (on demand) power, support uses within cropping/agriculture, and even direct mitigation of WDs through water displacement as part water management planning. Such actions can increase the efficiency of disaster response implementation at the local level. This conceptual idea is based on technological capabilities that currently exist but have not been used in a combined way, especially in the disaster response at the local level.

A study by the University of Strathclyde (UK) and University of Kathmandu (NEPAL) proves that the produced power of the hydropower generator they tested is sufficient for the needs of remote communities (Sah et al., 2014). Other studies (Table 1) show that small scale hydropower generators are capable of providing power autonomy to small communities (a residence in the UK requires more energy compared to a residence in a developing area – Africa, Latin America). According to our hypothesis, the energy produced by a standard hydropower generator is not only sufficient to power EWS, but also nearby shelters or safe zones. The produced energy could also be available for the first responders and humanitarian aid workers. Under normal conditions, the energy is enough to support small agricultural and ecotourism activities, and other community needs with such “daily use” supporting familiarization, ownership and adaptation to WD preparedness.

5. Limitations

In theory, generating hydropower from WDs is a promising initiative. Systems that already generate power from water could be placed in the paths of flash floods, typhoons and heavy storms and provide a free and unlimited energy source. However, how productive can these systems be in practice? First of all, generators that capture energy under normal conditions should differ in design and durability from those for extreme conditions. This increases the cost, especially if the generators need to be replaced after each disaster. Another major concern is the frequency of the natural hazards. Although natural disasters have increased over the last decades, they do not occur that often; therefore, maintaining their utilization and ongoing readiness over long periods is critical and requires evaluation. Lastly, natural hazards release large amounts of energy but as they occur only for a short time it is impossible to consume or store all that energy at once. The cost to benefit analysis, impacts and contribution to the environment and psychosocial alternations of their end-users should be thoroughly investigated.

6. Conclusions

This study aims to prove whether hydropower generators designed for local-level applications and disaster response can accurately detect phases of WDs, warn both the authorities and nearby communities prior to flood inundation and increase the effectiveness of disaster response. This can be achieved by generating the minimum energy required for activating of warning systems (lights, sirens) and evacuation routes (lights) during the early stages of WDs. Positive findings can contribute to EWS programs that can save lives during WDs, especially among vulnerable groups such as the elderly and those with mobility issues which affect timely evacuation. It could also prevent conflict and maintain human dignity in post-disaster phases. To our knowledge, this approach is pioneering in the field. Importantly, this unit will support power needs to end-users in pre-, peri- and post-disaster contexts – supporting its direct integration with sustainable economic development. While this work is currently in its preliminary stage, it will be improved and provide its findings in future reports.

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CHARACTERISTIC OF DISASTER SITUATIONS.

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Abstract

A disaster is a serious disruption, occurring over a relatively short time, of the functioning of a community or a society involving widespread human, material, economic or environmental loss and impacts, which exceeds the ability of the affected community or society to cope using its own resources.

In contemporary academia, disasters are seen as the consequence of inappropriately managed risk. These risks are the product of a combination of both hazards and vulnerability. Hazards that strike in areas with low vulnerability will never become disasters, as in the case of uninhabited regions.

1. Introduction

Disasters can take many different forms, and the duration can range from an hourly disruption to days or weeks of ongoing destruction. Below is a list of the various types of disasters – both natural and man-made or technological in nature – that can impact a community

Natural Types of Disasters

• Agricultural diseases & pests • Damaging Winds • Drought and water shortage • Earthquakes • Emergency diseases (pandemic influenza) • Extreme heat • Floods and flash floods Hail	• Hurricanes and tropical storms • Landslides & debris flow • Thunderstorms and lighting • Tornadoes • Tsunamis • Wildfire • Winter and ice storms Sinkholes

Hurricanes and tropical storms are among the most powerful natural disasters because of their size and destructive potential. Tornadoes are relatively brief but violent, potentially causing winds in excess of 200 mph. Both earthquakes and tornadoes strike suddenly without warning.

Flooding is the most common of natural hazards, and requires an understanding of the natural systems of our environment, including floodplains and the frequency of flooding events. Wildfires are more prevalent in the event of a drought. Disasters impacting food supply can be extremely costly; American officials say that a food contamination scare similar to the one that hit the Belgian poultry industry in the 1990's could jeopardize U.S. agricultural exports in excess of $140 billion.

2.Definitions

Business Definition for: Disaster Management "…the actions taken by an organization in response to unexpected events that are adversely affecting people or resources and threatening the continued operation of the organization." Disaster management includes: - the development of disaster recovery plans,(for minimizing the risk of disasters and for handling them when they do occur,) and the implementation of such plans. Disaster management usually refers to the management of natural catastrophes such as fire, flooding, or earthquakes. Related techniques include crisis management, contingency management, and risk management.

Disaster/emergency management is the discipline of dealing with and avoiding risks. It involves preparing for a disaster before it happens, disaster response (e.g. emergency evacuation, quarantine, mass decontamination, etc.), as well as supporting, and rebuilding society after natural or human-made disasters have occurred. 2 In general, any Emergency management is the continuous process by which all individuals, groups, and communities manage hazards in an effort to avoid or ameliorate the impact of disasters resulting from the hazards.

Actions taken depend in part on perceptions of risk of those exposed. Effective emergency management relies on thorough integration of emergency plans at all levels of government and non-government involvement. Activities at each level (individual, group, community) affect the other levels. It is common to place the responsibility for governmental emergency management with the institutions for civil defense or within the conventional structure of the emergency services. In the private sector, emergency management is sometimes referred to as business continuity planning. Other terms used for disaster management include: -Emergency Management which has replaced Civil defense, can be seen as a more general intent to protect the civilian population in times of peace as well as in times of war. -Civil Protection is widely used within the European Union and refers to governmentapproved systems and resources whose task is to protect the civilian population, primarily in the event of natural and human-made disasters. -Crisis Management is the term widely used in EU countries and it emphasizes the political and security dimension rather than measures to satisfy the immediate needs of the civilian population. -Disaster risk reduction An academic trend is towards using the term is growing, particularly for emergency management in a development management context. This focuses on the mitigation and preparedness aspects of the emergency cycle .

3. Phases and professional activities

The nature of emergency management is highly dependent on economic and social conditions local to the emergency, or disaster. Experts have long noted that the cycle of emergency management must include long-term work on infrastructure, public awareness, and even human justice issues. This is particularly important in developing nations. The process of disaster management involves four phases: mitigation, preparedness, response, and recovery.

4. Mitigation

Current research defines the concept of mitigation as central to the success of disaster management. In the mid-1990s many of the United States' top hazards experts met and collaborated on the *Reassessment of Natural Hazards in the United States,* which was completed in 1998 (Mileti 1999). Based on its findings, Mileti concluded that a shift in the field of disaster management must take place so that it would be possible to focus on "sustainable hazard mitigation" (2). Mileti argues that there are six objectives that must simultaneously be reached.

In order to mitigate hazards in a sustainable way: (1) maintaining and enhancing environmental quality (i.e., human activities should not reduce the carrying capacity of the ecosystem), (2) maintaining and enhancing people's quality of life, (3) fostering local resiliency and responsibility, (4) recognizing that vibrant local economies are essential, (5) ensuring inter- and intra-generational equity (i.e., not precluding a future generation's opportunity for satisfying lives by exhausting resources in the present generation), and (6) adopting local consensus building.

The importance of mitigation is recognized in FEMA' s major initiative, "Project Impact" (FEMA 2000), which was developed as a partnership between communities, government, and businesses in order to build disaster-resistant communities. Sustainable hazard mitigation warrants an inter-disciplinary approach that encompasses environmental, social, and economic considerations as well as technical analysis in order to determine hazards, risks, and vulnerabilities. This being the case, it is clear that an adequate HRV analysis is critical to the success of sustainable hazard mitigation.

This concept of mitigation parallels the conclusions of MacCrimmon and Wehrung (1986, 10) concerning risk: “There are three components of risk—the magnitude of loss, the chance of loss, and the exposure of loss. To reduce riskiness, it is necessary to reduce at least one of these components.” Taking into account Mileti’s conclusions regarding mitigation, one could reword MacCrimmon and Wehrung to state that the components of mitigation strategies are to eliminate or reduce (1) the consequences of loss, (2) the probability of loss, and (3) the sharing of loss. In most cases it will be impossible to eliminate the probability of loss (i.e., the probability of a natural hazardous event taking place), but it may be possible to do so in the case of person-induced hazards (e.g., hazardous waste in-situ spills).

In keeping with Mileti’s conclusions, any definition of disaster management must be able to incorporate the concept of mitigation. As will be seen, mitigation is also central to the definitions of “hazard,” “risk,” “vulnerability,” and “risk management.”

5. Disaster Characteristics

As we’ve seen, the variety of disasters is vast and it would not be feasible to have a specific response plan for each particular type of event. Instead, emergency responders generally take an “all hazards” approach based on a general plan that can then be tailored to the specific type and timing of an actual event. We’ll take a similar approach on the mental health side: Rather

than teaching you how to help the survivor of, say, a hurricane versus a terrorist attack, we’ll focus on certain key characteristics that research has identified as tending to influence survivors’ psychological reactions to their experiences. As we’ll see, what matters is less the specific type of disaster than factors such as event size, cause, and timing. Those patterns provide an important basis for understanding how a specific event is likely to affect people, but it’s essential to keep in mind that survivors are individuals first. Specifically, each person you’ll encounter had different pre-disaster strengths and challenges; each person had a different private experience of the event; and each person will have access to different resources to assist in their recovery. That may seem obvious, but it’s easy to lose sight of when you’re dealing with large groups of survivors after a major disaster. It can be tempting to adopt a one-size-fits-all approach to interventions, but that’s likely to misallocate limited mental health resources by directing unneeded attention to some people who already have sufficient personal resilience or access to support, while depriving others of the full level of assistance they could benefit from. It’s essential to bear in mind that any one survivor’s reaction will be an interaction between the characteristics of the disaster, the individual, and the response.

5.1 Intensity

Refers to level of damage in terms of injuries and deaths—the event’s human cost. Of course, any serious injury or loss of life will feel tragic for those directly affected, but disasters that cause multiple losses can compound distress for everyone involved, including professional responders who may suffer secondary trauma from exposure to many injured people or dead bodies. The effect of losing multiple loved ones goes beyond pure addition: Someone whose child and spouse were both killed in a disaster is not only grieving two deaths at once, but he or she may have lost what would have been the main source of comfort in grappling with the death of a child, as well as a chief reason to keep on going in coming to terms with the sudden loss of a partner. As a result, people who experienced multiple losses are at the highest risk of a difficult bereavement process and readjustment and should be a focus of early mental health attention. Scope and intensity are often linked, but not always. An event may be large in both, or large in one measure and small in the other. For example, a hurricane or ice storm may cause extensive property damage, but if warnings were provided and complied with, the human cost may be minimal. In contrast, an event like a fire in a nightclub can cause extensive casualties but affect only one building, leaving the rest of the community’s physical infrastructure intact as it copes with the human loss.

5.2 Duration

May be thought of in multiple ways. First, it can refer to the length of the disaster itself, which could range from seconds for an earthquake or explosion, to hours or days for a hurricane or blizzard, and even to weeks for a slowly advancing and receding flood. Or we can think of duration as the length of time people are affected by a disaster, including the recovery period as physical damage is repaired and losses are adjusted to emotionally. In the case of very large scope events that could take years, or could never be fully completed. From the mental health perspective, the most useful way to think about duration falls somewhere between those two measures: It's the length of time until survivors begin to feel safe again. Real recovery can only begin when survivors believe that the imminent danger has passed, but sometimes that point is not clear. In addition to the threat of additional physical harm, ongoing uncertainty about whether an event is truly over can greatly compound distress, since survivors never know when they can let their guard down. Survivors of earthquakes often sleep outside for fear of aftershocks. Terrorist attacks are often organized simultaneously or in sequence, leaving survivors wary of repeat attacks. Exposure to biohazards may cause great anxiety about long-term health effects. In any event without a clear end point, survivors may remain in a state of heightened vigilance that interferes with their ability to recover emotionally from the initial experience. Scope, intensity, and duration tend to be correlated with the degree of impact on professional and community response systems: Are there enough emergency responders to contain damage and rescue survivors? Can area hospitals handle the number of injured people? Can schools and workplaces reopen quickly? Are people displaced for extended periods of time? While the resulting logistical difficulties are obvious, there's also a clear mental health connection: All three measures tend to predict survivors' reactions in what is referred to as a "dose-response relationship," meaning the bigger the dose of disaster a person experiences, the worse his or her psychological reaction tends to be. Therefore, in assessing mental health needs post-disaster, survivors whose disaster experience was particularly intense or long lasting are likely to require more support than those who received a smaller dose of trauma.

5.3 Disaster Cause

While the relationship between dose and response is fairly clear-cut (more = worse), the impact of a disaster's cause is more nuanced—as is the division between causal categories. The most basic way of classifying disasters is as natural or human-caused. However, this is a more complex divide than might be evident, since natural events can trigger secondary technical disasters (referred to as na-tech events), and human-created conditions can limit or increase damage resulting from natural events. For example, in Hurricane Katrina the storm was obviously natural, but the flooding of New Orleans was caused by the failure of levees due to human error and neglect. In Japan in 2011, a natural earthquake and tsunami led to the meltdown of a nuclear power plant that displaced hundreds of thousands of residents. We noted earlier the impacts of climate change and population growth. A large wildfire in an unpopulated region might have little human impact; only after people decide to build in these areas does the potential for property damage and injury or death exist. Should that be considered natural or human-caused? Should increased flooding caused by higher sea levels as the atmosphere warms and polar ice melts be considered natural or human-caused? Another factor that blurs the line between causes is differences in building practices. The massive devastation and death toll of over 230,000 caused by the magnitude 7.0 Haitian earthquake in early 2010 was largely due to the use of unstable building materials and designs, resulting in the collapse of countless structures. In contrast, the 8.8 magnitude Chilean earthquake six weeks later was 500 times more powerful, yet the death toll was below 1,000 since strict building codes kept most buildings standing long enough for people to escape. Therefore, the built environment can affect the intensity of damage caused by a naturally occurring event. We should also note that there has not been a death due to fire in an American public school in over 40 years. This is because fire departments and the general public have demanded and achieved rigorously enforced fire codes in US schools. This is a triumph that could serve as a model for other efforts at prevention. Another type of disaster, public health emergencies, can be either naturally occurring such as pandemic flu, or intentionally caused, as in a bioterrorism attack. Even when they are natural in origin their psychological impact is closer to human-caused events. As these examples illustrate, there's not always a clear divide between causes. However, for those events that can be classified as natural or human-caused, research has identified certain typical emotional reactions. In particular, differences in anger and blaming are often seen.

5.4 Public Health Emergencies

Whether they're caused by a naturally developing disease like influenza, an accidental release of radiation or other toxins, or an intentionally introduced act of bioterrorism, public health emergencies create some specific stressors for responders and for those who have been exposed—or merely fear they might have been. Above all, the uncertainty around this type of threat is extremely upsetting. In most disasters, whether natural or human-caused, we know immediately if we've been physically harmed. That's not generally the case with diseases that may have an incubation period of several days from exposure to the development of symptoms, and it's certainly not the case where exposure to a toxin may result in cancer, lung problems, or other health issues only years later. For some people the thought that they may have been exposed to something harmful, but don't know for certain, can be terrifying, so public health emergencies often produce large numbers of "MUPS," or people with Medically Unexplained Physical Symptoms (formerly referred to as the "worried well"). These people may interpret the physiological expressions of their stress reactions (such as a pounding heart or shortness of breath) as symptoms of the disease they fear they're developing, and they may flood emergency departments or healthcare clinics that already have their hands full dealing with those who are actually suffering from the condition in question, as well as with their ordinary flow of patients. Mental health professionals may need to help respond to MUPS to prevent them from unnecessarily consuming medical resources, as well as to assist with managing crowd emotions and behaviors at settings like Points of Dispensing (PODs) for large-scale distribution of vaccinations or medications, or at decontamination sites. These experiences are unfamiliar to most people and may create concerns about additional exposure in addition to worries about side effects of the treatment. For example, during the 2009 emergence of the H1N1 influenza pandemic, many people resisted getting vaccinated because of media-fueled rumors that the vaccine was unsafe—even though it used the exact same technology as seasonal flu vaccine development and production. This kind of fear is an emotional reaction, but it can lead to very real health consequences if it causes people to avoid necessary prophylaxis or treatment. Above all, remember that most people have limited understanding of disease processes or treatments. For example, many are uncertain about the difference between vaccines and antiviral medicines. They also don't understand the difference between isolation that separates sick people with a contagious disease from people who are not sick and quarantine that separates and restricts the movement of people who were exposed to a contagious disease to see if they become sick (Centers for Disease Control and Prevention, 2015). Therefore, public health emergencies tend to create both personal worry about becoming sick and a susceptibility to rumors or misinformation that will be compounded if accurate information is not provided in a timely, credible, and comprehensible manner. Mental health professionals may be limited in our ability to respond to the actual health threat but we can contribute by obtaining and disseminating accurate information, and by preparing for and intervening in the cognitive and emotional distress public health emergencies cause.

5.5 Timing

A final characteristic to consider is the timing of the disaster, which can influence its severity, the speed and success of the emergency response, and the distress it produces. Time of day obviously determines whether it's light or dark during the event and the immediate response and recovery efforts. Especially if electrical power is lost, darkness can increase the risk of injuries and complicate rescue activities. It can also cause disorientation and increase fear and anxiety as people try to help each other or wait forassistance. On the positive side, families are more likely to be together at night, whereas during weekdays they're typically apart, with parents at work and children at school. Being separated during a disaster causes tremendous anxiety and often results in parents rushing to locate children, potentially clogging roads needed by emergency responders and creating traffic flow problems at schools. Time and day may impact other logistical factors, which in turn affect the dose of trauma survivors may receive. Does rush hour traffic slow the ability of survivors to escape a disaster site or of emergency responders to reach it? Are hospitals fully staffed or at nighttime personnel levels? In areas with volunteer fire departments and ambulance corps, are responders available to report to a firehouse or disaster scene quickly? Are children in transit on school buses and even more difficult for anxious parents to find? Does a shift change mean twice as many factory workers are present during an industrial explosion? These timing questions can influence the ability of responders to help out effectively, as well as the emotional impact of experience. Of course season is directly connected with certain kinds of disasters (hurricanes, blizzards), but season and climate can also impact conditions in the recovery period, particularly sheltering needs. For example, when a major earthquake struck in the mountains of northern Pakistan in October 2005, the combination of high elevation and approaching winter meant that providing warm temporary housing was essential to survival. In contrast, Haiti's tropical climate meant that emergency sheltering after the 2010 earthquake did not need to provide heat—however, the approach of the rainy season three months after the disaster meant that tents and tarpaulins did not provide adequate protection for homeless survivors for long. Weather can have other effects as well, positive or negative. The brutal heat following Hurricane Katrina certainly increased the suffering of those who were displaced or awaiting rescue and increased the number of casualties. In contrast, when US Airways Flight 1549 landed in the Hudson River, the clear skies and daylight facilitated the rescue of the passengers, which might have been far less successful at night or during a winter storm. Is this a mental health issue? The principles of Psychological First Aid clearly tell us that people’s physical needs must be attended to before they can benefit from mental health interventions. If people are extremely hot or cold, feel physically unsafe, or lack adequate shelter, food, and clothing, they’ll be unable to focus on anything beyond these immediate needs. Therefore, addressing the effects of these logistical conditions must be considered a first step in mitigating psychological reactions to trauma

Conclusion

Disasters have substantial social and psychological impacts, which reflect not only the impact characteristics (e.g., magnitude and severity), but the pre-existing social and economic vulnerabilities, which intensify the loss and disruption. Effective disaster management, therefore, needs to ensure that the diverse interests and priorities of communal life are integrated into planning and response, especially those of vulnerable persons and groups. At the same time, it is important to take into consideration the psychological effects of disasters, particularly in relation to response mechanisms and processes. The level of psychological distress generated by a disaster may be either diminished or intensified by planning and management decisions, which in turn can enhance or impede recovery and reconstruction. providing psychosocial relief has been well exemplified. There is a need in the Indian scenario to have community mental health teams trained for such events.

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MASS MEDIA MODELS AND THEORIES OF CRISIS MANAGEMENT

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Abstract

In the management of the crisis, there are some roles and responsibilities, as well as organizational requirements related to the process of a company. The reaction to catastrophic seizures involves action and specific reception crisis assessment, adequate crisis preparation, ensuring a rapid and adequate response to the crisis, keeping clear lines of reference and communication if crisis and agreement between the rules for eliminating the crisis occurs. The techniques that could be used to manage the crisis relate to a variety of steps, namely understanding the fact that the crisis in the company influences, understanding prevention, alleviating and overcoming various types of the crisis. The aim of the research is to help all those who are interested in developing the necessary skills to be able to deal effectively with critical situations. Our research has the sole purpose of optimizing existing logical practices and tactics to address and respond. As a method, design-based research and approach to living labs are adopted. It builds on the existing knowledge of the International Telecommunications Union and the European Broadcasting Union. In conclusion, experience with both natural and man-made disasters highlights the simple truth that communications are useful only to the extent that they are accessible and usable by people in communities at risk. During disaster events, many vulnerable communities are often cut off from national response systems due to lack of appropriate communications that should have been in place before a disaster occurs.

1. Introduction

In the management of the crisis, there are some roles and responsibilities, as well as organizational requirements related to the process of a company. The reaction to catastrophic seizures involves action and specific reception crisis assessment, adequate crisis preparation, ensuring a rapid and adequate response to the crisis, keeping clear lines of reference and communication if crisis and agreement between the rules for eliminating the crisis occurs.

The techniques that could be used to manage the crisis relate to a variety of steps, namely understanding the fact that the crisis in the company influences, understanding prevention, alleviating and overcoming various types of the crisis.

Crisis Management generally addresses the following:

- implementation of methods to be used to respond to the reality of the crisis
- Establish crisis-related measures and scenarios to trigger the necessary crisis-response mechanisms
- Communicate during the response phase of the emergency management scenarios.

The methods used to manage the crisis include the implementation of a crisis management plan. The British standard BS11200: 2014 enables the terminology and contexts of the crisis to be understood. This model includes exposure to risks and events that may pose a threat of crisis. It is therefore an international standard.

Crisis management is referred to as incident management, although the word management of the crisis is supported as a more accurate terminology. A basic mindset in a crisis involves the ability of the individual to think of the worst case scenario as to the consequences of the crisis, while at the same time a basic mentality is also the option of finding solutions to the crisis.

The trial and error are acceptable tactics, since the implementation of a first strategy is not effective in dealing with the crisis. So, it is right to maintain a list of emergency plans so that everyone gets vigilant. It is important to prepare individuals and organizations for a rapid crisis response plan, where analysis and practice are required

Both the sentiment and the reputation of those affected by the crisis are negatively affected. Organization and communication are key elements for quick response to crisis situations and are a major challenge for any business / organization / public or private affected by the crisis. Open and consistent communication can ensure a successful communication process of catastrophic crises.

Emergency is about the promptness of the response to crisis assistance and in the long-term recovery and crisis recovery phases. It is, therefore, wrong to claim that crisis management is not about risk management, as disasters could not be mitigated at that time.

2. Models and theories of crisis management

2.1 The Crisis Management Strategy

The Crisis Management Strategy is a key corporate development strategy. It was designed to prevent the crisis and enable each individual and organization to control the evolution of the crisis. It therefore concerns a complex management strategy. Therefore, keeping an eye on the internal and external environment, choosing and implementing an appropriate crisis prevention strategy and through proper management, it is possible to show the future. Thus, the situation is monitored on the basis of this continuous monitoring of the internal and external environment, by choosing effectively and applying the Crisis Response Strategy.

2.2 The Crisis Management Model,

For the implementation of this model, it is necessary to understand how a crisis is addressed. It is the arc of the crisis where crises are avoided, tempered and recovered. The three key phases of crisis management, therefore, are as follows:

- The imminent problem or danger signs are diagnosed
- Select the appropriate recovery strategy
- The process of changing and monitoring the crisis.

2.3 Crisis Management Planning

There is no possibility that a business or organization might be expected to disrupt the business or organization, especially when the crisis event is widespread. A public scrutiny can have negative economic, political, legal and governmental consequences. Thus, crisis management is planned to provide the best response to a crisis situation.

2.4 Contingency planning

Preparing contingency plans is a key plan to manage the crisis. This is the first step in order to ensure the proper preparation of an organization, individual or business for the crisis. Those who undertake to manage the crisis should prepare a crisis plan by developing a simulated scenario for its use as a method of exercise.

Through this plan, it is defined who will be able to talk about the crisis, such as a representative. Ideally, the spokesman is willing to be on hand at any time. It can also work with SMEs, which would be the best option in the event of a crisis, ensuring that all questions are answered in a timely manner and giventhe appropriate information on the conditions of the crisis, which was to be resolved.

With the cessation of the crisis, they are the most critical hours, so prompt response and response are needed in a quick and effective way. The spokesperson must provide accurate and clear information about the event. When incorrect or manipulated information is provided, the situation may be reversed or even worse.

The emergency plan is what will provide information and will properly guide those responsible to take appropriate measures and decisions in order to reduce the effects of the crisis decision in the short and long term

2.5 Planning to continue work

The crisis pushes the disruption of the organization, the enterprise and people in general. The plan to continue the work can limit this disorder caused by the crisis. First of all, it is important to identify critical functions and processes to maintain the functioning of the organization where the crisis occurs. This should be done during the initial crisis management phase and is part of the impact analysis of businesses or the organization affected by the crisis.

Each critical operation or process corresponds to a separate contingency plan, so that if the operation or the process is interrupted by many, then the affected organization or enterprise is more resilient and restrict the possibility of invoking another. The testing of these emergency plans are resumed by similar actions in a simulation, enabling those who have been involved to become more aware of the possibility of the crisis. Thus, when there is a real crisis, the member's of the management team will be mobilized quickly and efficiently.

When planning scenarios, the necessary attention should be given. Simulations may not be inventive and lose the value of training. However, this point can be improved by using external exercise designers who are not an integral part of the organizational culture but can be tested for the response they will have to organizations or businesses that are in crisis to make a crisis of confidence in them who manage vital systems.

As the simulation exercise is applied, the process of control is followed in a detailed and systematic way in every crisis simulation. In this way, a link is created and lessons learned from the reality of simulated representation and reality.

Finally, there should be a periodic review of the process of planning the continuation of the organization or business that it is experiencing in order to identify the number of changes, as it may be judged that it may be necessary to cancel the current project.

3. The theory of structural-functional systems theory

In order for an organization or business to properly manage a crisis, information should be provided to the organization or business when it is hit by the crisis. In the Theory of Structural Operational Systems, information networks and complex organizational communication are faced with this fact. This theory, therefore, defines the flow of information.

3.1 Diffusion of innovation theory (Diffusion of innovation theory)

For the exchange of information, the method of diffusing innovation theory can be used as a means of managing the crisis. This method was developed by Rogers. According to his theory, he describes how to spread and communicate innovation through the use of specific channels in a period of time. Innovation spreads when a person communicates a new idea through others. The process of communication is as follows:

- Innovation communication
- Communication through a person or unit who knows or has experience with the use of innovation
- communication through a person or unit who is not aware of innovation
- via a communication channel linking the two units.

The communication channel is the basic tool for transmitting messages from one person to another.

3.2 The role of apology in crisis management

It is believed that the apology allows an organization to have any legal consequences. Compensation or sympathy is considered to be the least expensive strategy, but it is considered as effective as "apology", as it creates perceptions about the organization that assumes responsibility for the crisis it has caused, as these strategies focus on the needs of the victims of the crisis. Compensation, on the other hand, gives the possibility to compensate for the pain experienced during the crisis.

4. The theory of crisis leadership

According to James, there are five leadership capabilities that contribute to facilitating the organizational structure during the crisis or after the crisis. These skills are as follows:

- Creating an environment of trust
- changing the attitude of the organization, which is responsible for provoking the crisis
- learning to change through the experience of the crisis and its consequences

The issue of crisis leadership has been explored, suggesting that leadership action in crisis shows the organization's ability to act. As the organization is tested through the crisis, it can show how well the organization's goals are being served and how long the structure of the leadership of the institution has in the crisis. It is important to develop effective human resources to build organizational capabilities through the administration of the executive crisis.

5. Disparate theories of human capital

Through the discrimination treaty, the organizational crisis stems. The economic theories of the human brain and social capital are the basis on which James's theories about unequal human capital and social status are based. Based on his theory, therefore, minority workers have limited organizational benefits compared to individuals who have access to executive management. On the basis of studies, race is a predictive factor of opportunity for promotion or lack. Consequently.

Discrimination can lead to adverse reactions of those who are interested in the event, damage the reputation of the business or organization and be a significant threat to their survival

6. Conclusions

In conclusion, experience with both natural and man-made disasters highlights the simple truth that communications are useful only to the extent that they are accessible and usable by people in communities at risk. During disaster events, many vulnerable communities are often cut off from national response systems due to lack of appropriate communications that should have been in place before a disaster occurs.

We have to remember that the effectiveness is partly reflective of preparedness. In this respect, training plays a critical role, no matter how sophisticated or robust the system. An effective notification system requires continuous public education and awareness of the purpose and capabilities of the system. Whatever existing communication methods are chosen for disaster management, all groups that are part of the disaster cycles should be involved in the planning, implementation and operation of their systems.

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EXPLORING OMEGA VERTICAL VELOCITY PATTERNS DURING JULY 23 2018 WILD FIRES IN ATTICA, GREECE

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Abstract

The Omega Vertical Velocity (VV) is an atmospheric parameter useful for exploring extreme atmospheric phenomena. The study of this parameter can help us to understand phenomena related to mesoscale meteorological patterns. In this short note, we explore the vertical and horizontal spatial distribution of this atmospheric parameter during July 23, 2018 wildfires in Attica – Greece. For this purpose we extract model results of the vertical velocity from NCEP/NCAR NOAA reanalysis database and ECMWF database. Furthermore we compare the values of Omega vertical velocity to the climatological ones over the Greater Athens Area, using the 1981 – 2010 ECMWF reanalysis data climatology. The results indicate the occurrence of unusual down to surface values of Omega vertical velocity for this time of year (constant values of VV are occurred during warm season of the year and elevated values during cold season of the year). This behavior of vertical velocity may was an additional factor contributed to the rapid expansion and spread of the devastating wild fires.

Keywords: Omega Vertical Velocity (VV), Attica wild fires

1. Introduction

Omega Vertical Velocity (VV) is used to represent the rate of change of pressure in a parcel over time, dp/dt. When pressure is used as the vertical coordinate dp/dt is analogous to the horizontal velocities, u=dx/dt and v=dy/dt. Thus dp/dt=ω is in the nature of a velocity. Under hydrostatic balance it is proportional to the vertical wind velocity. Omega is the vertical velocity in pressure coordinates (so positive omega is negative ω). Omega has units of pressure per time [Pa/s].

Although vertical wind speeds are much smaller than horizontal, they can reach high significant values, influencing decisively the weather phenomena (Holton 1992; WMO 1992; Hoskins et al, 1985; Akritidis et al. 2010; Mavrakis et al. 2010; Batakis et al. 2017).

In this short note, we explore the vertical and horizontal spatial distribution of this atmospheric parameter during July 23, 2018 wildfires in Attica – Greece. For this purpose, we extract model results of the vertical velocity from NCEP/NCAR NOAA reanalysis database, and ECMWF database. Furthermore, we compare the values of Omega vertical velocity to the climatological ones over the Greater Athens Area, using the 1981 – 2010 ECMWF reanalysis data climatology.

2. Data used

For this purpose, we extract model results of the vertical velocity from NCEP/NCAR NOAA reanalysis database. Furthermore, we compare the values of Omega vertical velocity to the climatological ones over the Greater Athens Area, using the 1981 – 2010 ECMWF reanalysis data climatology (Vlamaki, 2017).

3. Results

A series of wildfires in Greece, during the 2018 European heat wave, began in the coastal areas of Attica (namely Kineta and Mati) in July 2018. As of 12 September 2018, 99 people were confirmed dead. On 23 July 2018 at 13:00 Eastern European Time, a wildfire started west of Athens near Kineta. A few hours later, a second wildfire started burning at the north of Athens near Penteli.

Due to very strong wind gusts in the area both wildfires spread quickly which were up to 124 km/h (or 77 mph or 12 Beaufort). The fire in Kineta burned houses in the area, while the fire in Penteli headed east towards the beach, where it started burning parts of Neos Voutzas, Mati and Kokkino Limanaki just north of the town of Rafina and as far as its northern fringes. The flames were so intense that they trapped and burned people inside their houses, cars, or a few metres away from the seashore. Thousands of vehicles and houses were destroyed before the fire was brought under control hours later. An entire summer camp composed of 620 children was evacuated in an overnight operation. The fire was the deadliest wildfire event to have occurred in Greece, after deadly fires in Ilia Prefecture during 2007 heat wave events.

Model results from Earth System Research Laboratory (Fig 1) shows down to surface very high values of Omega vertical velocity. Those unusual values for this time of year are shown also to anomaly charts from the same provider. Additionally the vertical cross section of Omega vertical velocity according to 6-Hourly NCEP/NCAR Reanalysis Data Composites, Right figures and according to ERA – Interim Reanalysis Data Composites seems to have a strong down to surface movement, especially at 12utc. Also wind direction vertical chart support this finding (Fig 3b). Horizontal wind direction (Fig 3a) was from west – northwest direction, something which also very rare for July month in the area. In Attica area winds during summer months usually blow from north directions (etesians) and in general the climate has as a main characteristic the long and hot dry summer.

Also Climatology of July 23 and Anomaly of July 23, 2018 at 850 hPa, averaged during the period 1981-2010 (Fig 4) has shown the same results.

At Fig 5, if we compare the values of Omega vertical velocity at 1000 hPa and 850 hPa for July 23, 2018 with Intra-annual variation of Omega vertical velocity for 3 isobaric levels (300, 500 and 850 hPa) and iso-PV level of 2 PVU averaged during the period 1981-2010, we can characterized them as extremes.

From meteorological point of view, possible this was one more factor which contributes to the rapid spread of this devastating fire.

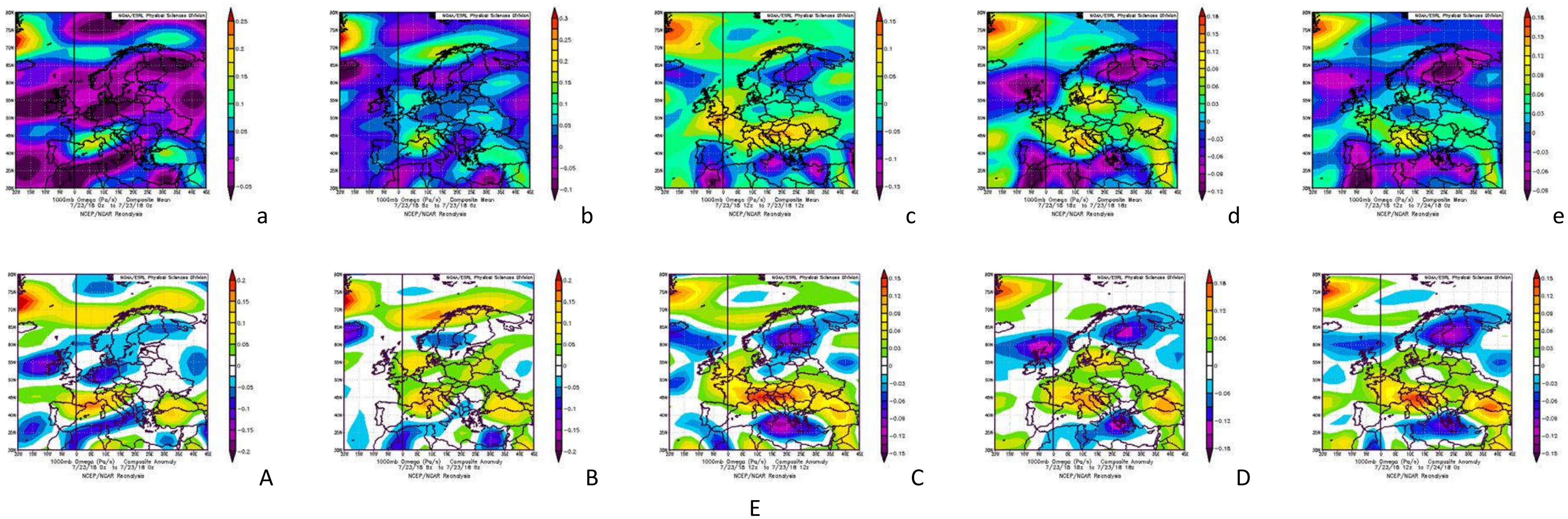


Fig. 1. Omega vertical velocity (Mean) 6-Hourly NCEP/NCAR Reanalysis Data Composites for July 23, 2018 to July 24, 2018 (a – 00utc, b – 06utc, c – 12utc, d – 18utc, e – 00utc) and Omega vertical velocity (Anomaly) 6-Hourly NCEP/NCAR Reanalysis Data Composites (A – 00utc, B – 06utc, C – 12utc, D – 18utc, E – 00utc). Figures generated from https://www.esrl.noaa.gov/psd/data/composites/hour/

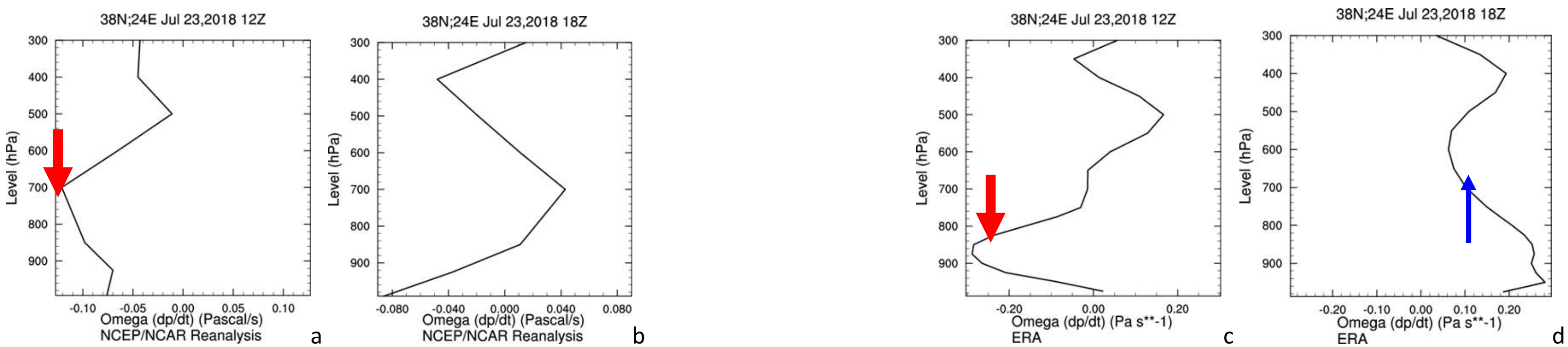
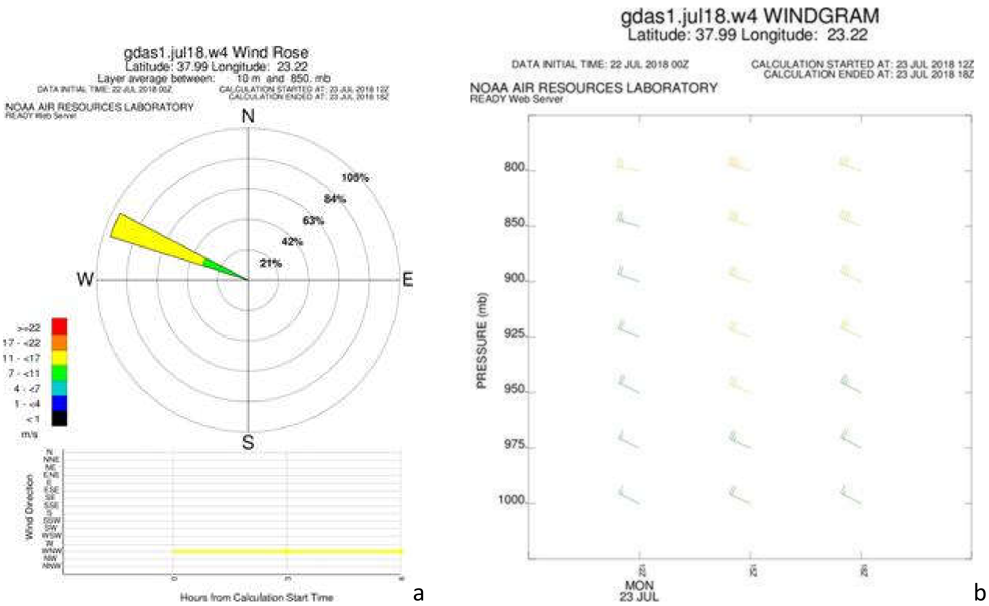
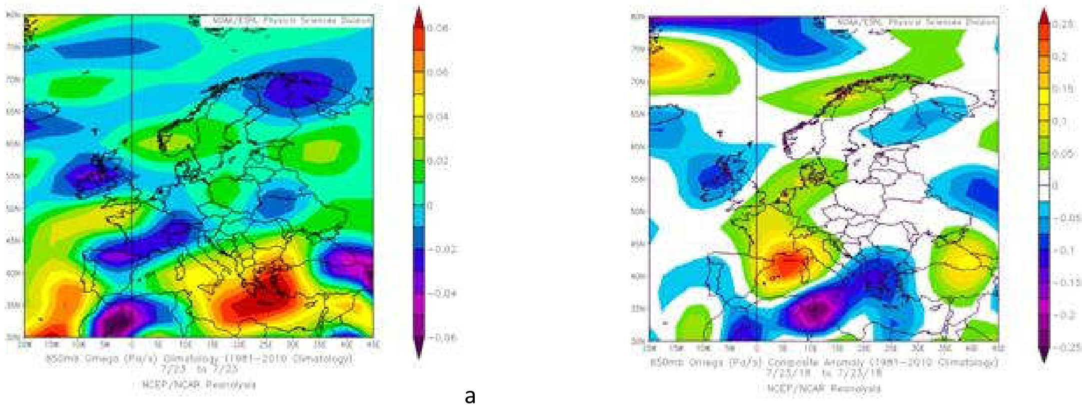


Fig. 2. Vertical cross section of Omega vertical velocity: Left figures (a, b) according to 6-Hourly NCEP/NCAR Reanalysis Data Composites, Right figures (c, d) according to ERA – Interim Reanalysis Data Composites. Figures generated from https://www.esrl.noaa.gov/psd/data/composites/hour/



a b

Fig. 3. Wind Direction: Horizontal (Left figure) and Vertical cross section (Right figure). Figures generated from https://www.esrl.noaa.gov/psd/data/composites/hour/



a

b

Fig. 4. July 23 Climatology (left) and 7/23/2018 Anomaly (right) at 850 hPa, averaged during the period 1981-2010. Figures generated from Earth System Research Laboratory (ESRL) – Physical Sciences Division (PSD) website

4. Conclusions

In this short note, we explore the meteorological parameter of Omega vertical velocity during July 23, 2018 deadly wildfires in Attica – Greece.

The model results indicate the occurrence of unusual down to surface high values of Omega vertical velocity for this time of year, strong wind speeds at 12 Bf and unusual west – northwest wind directions.

This behavior of vertical velocity may was an additional factor contributed to the rapid expansion and spread of the deadly and devastating wild fires.

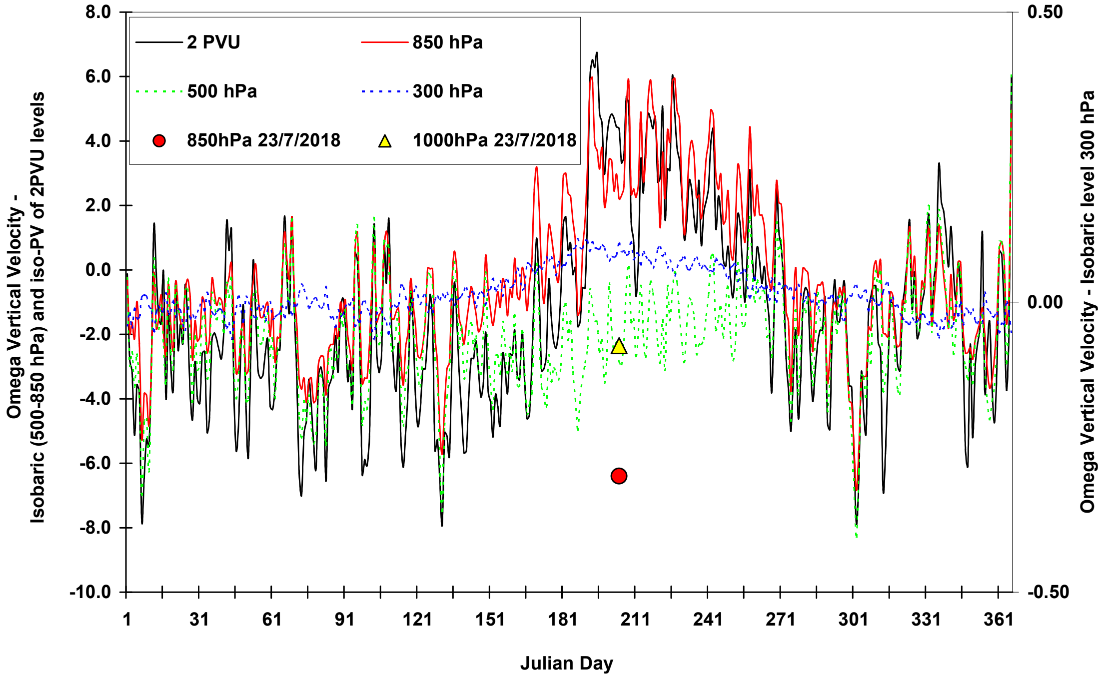


Fig. 5. Intra-annual variation of Omega vertical velocity for 3 isobaric levels (300, 500 and 850 hPa) and iso-PV level of 2 PVU averaged during the period 1981-2010 and values at 1000 hPa and 850 hPa for July 23, 2018. Values can be characterized as extremes.

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THE COMMUNICATION BETWEEN THE MEDIA AND THE MANAGERS OF THE CRITICAL SITUATION / EVENT"

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Abstract

Research points that can improve the relationship between SMEs and crisis managers, which are listed below:

•Control accessibility of SMEs to the critical situation.

•The interview of each person is oriented towards the media. Interviewers should refer to the key points of an issue. This is feasible by repeating the question in a different way.

•The answers of the interviewers are comprehensive, so in case of editing, not to alter the content of the interview.

•Regarding the body language and the emotional intelligence of the interviewees, they appear to be honest and honest when referring to really actual events rather than fantastic.

As a method, design-based research and approach to living labs are adopted.Television, radio and the press, as well as the internet, are the mainstream media through which information is made available to the public about crises. The central idea of these instruments is the absolute freedom of the press, with reasonable constraints imposed by the media during the crises, of course. In particular, these restrictions are set by the National Council for Radio and Television. The key role of SMEs in crises is the collection and distribution of information at a rapid pace and with precision. People must rely on the media to reveal the mistakes and injustices of those who exercise power. During a crisis, it is important for the media to be free and free from checks of unjustified acts of those exercising political authority. Otherwise, politicians would be unchecked. Every democratic state can not afford not to give the proper value and to recognize the media. However, SMEs are required to be efficient and functionally operational, based on the democracy of society.

1. Introduction

There are some points that can improve the relationship between SMEs and crisis managers, which are listed below:

- Control accessibility of SMEs to the critical situation. Therefore, there should be ways of reducing the arbitrary invasion of SMEs in critical situations. However, when the area is expanded, then there is the possibility of control, when those responsible for the accessibility of SMEs are identified. Another solution is to protect the crisis managers and victims from the attention of the media, to protect their privacy and to preserve their emotions and reasoning. Alternatively, control freedoms can also make limited accessibility to a certain number of SME representatives possible. The representatives of SMEs undertake to collect the visual and audio material and to distribute it to each member of the media. The effectiveness of SME management, therefore, is achieved through the finding by SME managers of suitable individuals as victims or as managers of the crisis, to be interviewed by the media[1].

- The interview of each person is oriented towards the media. Interviewers should refer to the key points of an issue. This is feasible by repeating the question in a different way.

[1]Ch. Deriziotis, Harokopos I., Skyftos K.: Business Communication. From theory to practice, Sofia edition, Thessaloniki 2006.

- The answers of the interviewers are comprehensive, so in case of editing, not to alter the content of the interview.
- Regarding the body language and the emotional intelligence of the interviewees, they appear to be honest and honest when referring to really actual events rather than fantastic. This is feasible with their emotional abilities and their attempts to answer every question. Crisis managers, when conducting an interview, should not behave competing or ambiguous. Still, their body should be normal, with moderate gestures, visual contact, normal breathing, and a steady tone of voice to convince the audience watching their interview. Finally, they should be sensitized and influenced by the fact they describe. In this way, the public may not accept journalists who are unfriendly to the crisis managers who seem honest and honest.
- Show the human profile. Those who promote a story should show a willingness to contribute with their efforts to an unpleasant event. They should not blame or collide with journalists, they should not express the "comment", as this statement reveals the mood that they want to conceal some truth.
- You should avoid speculation. Any answer can be the start of problems. When managers are called upon to speculate about alternative scenarios, they should be negative in speculation statements, as they will give a negative impression to the audience watching them.
- Avoid giving any responsibility, as this will show that there is no unity when trying to cope with the crisis, when there are conflicts or when litigation is taking place.
- Avoid conflicts with SMEs. In particular, those who come in contact with media representatives should be aware that members of the media exercise significant control over the information and the way they present them to the general public.

2. The meeting between SME staff and crisis managers during the crisis

2.1 Unprepared interviews

Journalists are immediately responding to the news that a critical event is happening somewhere and are very quick and timely at this point. Consequently, the crisis staff quickly comes into contact with journalists as soon as the critical event occurs. Journalists are also those who are looking for unprepared interviews, as they draw on information material that is untreated, real and immediate. They can also secure a statement that is exclusive, perhaps in contrast to the other SME representatives and their colleagues.

Through unprepared interviews given in a critical situation, careless answers are provided by the staff of the organization, which is specially trained and must be in order to deal with press inquiries. The lack of appropriate training can be seen by refusing to speak or by finding alternative ways to escape the interview process and the questions of journalists.

But when it is impossible to escape from them, then it should make an auxiliary statement. On the other hand, in cases where crisis managers are approaching and not prepared, the following three-stage process follows:

Stage 1: consists of a statement demonstrating the availability and willingness of the manager to give answers and his inability as he did not process the facts

Stage 2: includes recurring questions about people who have been threatened or affected by the crisis. Indeed, priority and interest is given here to these people who have been hit by the crisis and how they will be given the appropriate support and assistance.

Stage 3: managers are searched for ways to exclude the journalist, and then follows the statement here usually that the critical event requires extraordinary attention and management approach.

The co-operation between these two sides, then, may be manifest by shifting the question to another time and place. In general, the effectiveness of the three steps of the answers is given and does not exist in the "no comment" response cases. Indeed, misinterpretation of the embarrassment and silence of interviewees as guilt, remorse and non-interest can be made.

2.2 Prepared interviews

In cases where interviews are given on issues with current issues, interviews and content are already well prepared beforehand. Journalists take care to get exclusive interviews or even spontaneous interviews. Interviewees receive appropriate information prior to the start of the interview for their questions, so they have all the time to prepare the answers they will give. In this way, a good message is transmitted to the general public watching their interview. Of course, interviewees should have gathered some of the strengths of the information they will give, have sufficient and correct knowledge about them and thus to orientate the interview where they want.

2.3 Press Releases

Not so interesting are press releases for journalists. However, they are considered to be of great interest to the organization's stakeholders and stakeholders. The value of press releases is therefore being denied by journalists, as information is provided, which is standardized and limited.

The main reason for this attitude of journalists towards press releases is because effective press releases provide the following:

- A clear and comprehensive wording of the speech for which the press release and its contents are made
- Accepts the subject in a way that shows interest in the consequences a human life event may have
- Describes in a brief and clear manner the facts and the way a situation has been addressed
- Informs the public about the way and means, in detail, of the stakeholders.

The validity of press releases is sparked by the fact that details of the organization's history, which has been involved in a critical situation, are provided. Thus, the structure, functional features, object, etc. of this organization can be represented. In fact, this information can be accompanied by photographs and diagrams. The material is collected, processed and presented before the crisis even occurs as long as the body is functioning normally and physiologically. This is the key crisis management plan and is part of the organization's recovery after the end and end of the crisis.

2.4 Press conferences

Through press conferences, the public can be informed in a meaningful way. However, the main concern of the media is to live the critical situation live, ie to derive live statements from the region where the crisis unfolds, even if there is no official body in the region. Thus, each organization should properly prepare its staff for any kind of interview. An effective and correct press conference is the instrument from which important information can be obtained, which will be in progress. In fact, it is the media organizations that make selection and processing of interview material with the additions of experts, witnesses, victims and spectators.

According to the organizations, the press conference enables those responsible for their defense. In particular, managers have the lead, through press conferences:

- Describe in a brief way the time of the critical situation they have experienced
- Provide a detailed description of the methodology used when the crisis was under management
- Provide their own interpretation of the impact of the critical situation and the impact it will have in the future
- To show people with a rich emotional world and sensitivities, which have been adversely affected by the crisis.

It is not possible to control unofficial information from the managers of critical events from former employees, viewers and victims etc. Therefore, press conferences should provide a wide range of varied information on critical events to prevent or cover informal information that may come from any source.

3. The role of SMEs in critical situations

The role of SMEs is critical and very important in the emergence of the critical situation. Significance and reason is for the objectivity of informing the public about the critical event. Media is the backbone of democracy, but it is not always applied, as mentioned in the first sub-section of this chapter.

The judgments generally concern unpredictable events about sustainability, reliability and reputation. Recently more than crisis issues seem to be of interest to the general public. Political crises are an inherent issue of the times in each country. How media coverage of political crisis issues converts the reputation of the country and has serious implications for organizational efficiency and the perception of this natio. An example is the indignant movements, with a central slogan of Spain, "Do not wake up the Greeks.

In countries where there is no press freedom, the role of the press in the crisis is not worth mentioning. This is not true due to the irresponsibility of the press or the media, because they are unaware or ignorant. On the contrary, it is because of the strong restrictions imposed by the government. The restriction of SMEs concerns their supportiveness to the government and their contribution to control and deception during the crisis. These regimes discourage the possibility that the people who ruled can accuse them of accountability for the current crisis.

On the other hand, in a democratic state with the existing freedom in both the press and the media, other functions apply to the media during a crisis. Thus, in these cases, the media submit full news and reports that can lead to the fall of corrupt governments and make the media as an effective and reliable ally of the public. Also, in such cases, when a news story, the crisis report, is scrutinized and honestly considered a fact of the crisis, then the message and the impression that the elected governments are responsible and democratic.

Of course, the concern lies in the fact that SMEs do not operate in the above-mentioned democratic way. Therefore, they do not work properly. So, when they show political news, they focus more on personalities, disagreements and not on their views and ideologies. The news, in this way, becomes entertainment and not informative. Although there is a high level of public interest in the crises, more focus on media is given to the individual's privacy rather than to celebrity action. This makes people cynical for politicians. During the crisis, informing the media is therefore causing panic to the public that the people exercising power are influential in their lives

4. Results

During a crisis, it is important for the media to be free and free from checks of unjustified acts of those exercising political authority. Otherwise, politicians would be unchecked. Every democratic state can not afford not to give the proper value and to recognize the media. However, SMEs are required to be efficient and functionally operational, based on the democracy of society

Television, radio and the press, as well as the internet, are the mainstream media through which information is made available to the public about crises. The central idea of these instruments is the absolute freedom of the press, with reasonable constraints imposed by the media during the crises, of course. In particular, these restrictions are set by the National Council for Radio and Television. The key role of SMEs in crises is the collection and distribution of information at a rapid pace and with precision. People must rely on the media to reveal the mistakes and injustices of those who exercise power.

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METEOROLOGICAL CONDITIONS AND THE EVOLUTION OF WEST NILE FEVER IN WEST ATTICA, GREECE

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Abstract

Summer and early autumn months are namely as a transmission season for West Nile virus. In this short note, we explore the possible link between precipitation patterns of summer 2018 in West Attica – Greece and the numeric evolution of confirmed cases of West Nile fever. Precipitation during summer months of 2018 was extremely high reaching 500% above climatological ones in some cases, as is the West Attica area in Greece. Those conditions were favorable for mosquitoes. At the same time an outburst of West Nile fever cases was reported compared to previous years in the area. Summer 2018 cases were elevated in comparison with previous year statistics states European Centre for Disease Prevention and Control (ECDC) risk assessment, which provide all available data each week. Precipitation and meteorological data of Elefsis station which belong to Hellenic National Meteorological Service network stations were adopted from the relevant database. The results indicate that the occurrence of unusual high values of precipitation for this time of year, may have contributed (throw a lag process) to the rapid expansion and spread of the West Nile fever in West Attica causing a lot of confirmed cases and fatalities.

Keywords: West Nile Fever (vitus), West Attica, weather conditions

1. Introduction

West Nile Fever is an infectious disease caused by West Nile fever virus. It occurs most commonly in the Middle East but may now be found worldwide, including North America. Although it is generally a mild disease (approximately 8 out of 10 infected persons have mild or no symptoms), it may cause encephalitis (brain inflammation), especially among the elderly.

After a 2-year hiatus, West Nile virus has re-emerged in Greece, spreading to new territories, according to researchers from the University of Athens Medical School (Mavrouli et al., 2015; Mavrouli et al., 2017). Since the country's first documented outbreak in 2010, West Nile virus (WNV) cases were identified in several regions, mostly in municipalities of southern and northern Attica. WNV transmission persisted in Greece until 2014. However, no new cases were reported in 2015 or 2016. Despite the absence of infections in people, serological testing revealed that the virus was still circulating in birds (Mavrouli et al., 2015; Mavrouli et al., 2017). The decline in human infections may have been the result of mosquito management strategies and other preventive measures that were implemented to reduce exposure. Additionally, the development of immune response against WNV may have reduced human cases by depleting the susceptible human population (Mavrouli et al., 2015; Mavrouli et al., 2017). It is also possible that WNV caused infections that were asymptomatic, as occurs in approximately 80% of cases, or that remained undetected, including neuroinvasive cases. Of course, climatic conditions cannot be excluded since virus replication rate within mosquitoes, as well as vector competence and population dynamic, are mainly weather dependent. Forty-five cases of West Nile virus infection were reported in Greece between July and September 2017. Most were found in areas with no documented history of transmission. After 2 years with no new WNV infections, the Hellenic CDC was notified of 45 laboratory-confirmed cases between July and September 2017, according to the researchers. More than half (57.8%) of these patients were diagnosed with West Nile neuroinvasive disease. The remaining cases were characterized as West Nile fever. Five deaths occurred among adults aged older than 70 years with underlying conditions. All new infections originated from southern Greece, the researchers reported. Forty cases were detected in previously unaffected regions, including Argolis (n = 37) and Corinth prefecture (n = 3). Another case was identified in Crete, while the remaining four occurred in the previously affected prefectures of northwestern Peloponnese (Achaia and Ilia). According to Mavrouli et al., 2017 (2017), the re-emergence of WNV and its expansion into new areas suggest that Greece’s ecological and climatic conditions are suitable for WNV circulation. Therefore, he said, future transmission may occur. The risk of WNV transmission is complex and multifactorial; it concerns the virus, the vectors, the animal reservoirs, the environmental conditions and human behavior (Mavrouli et al., 2015; Mavrouli et al., 2017).

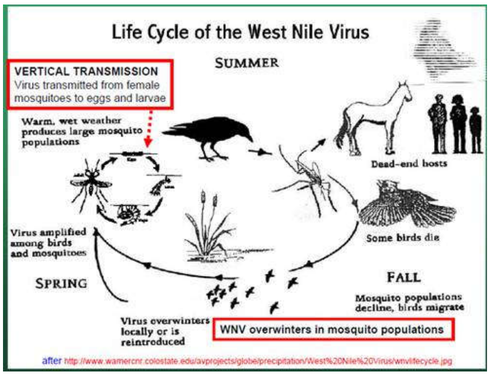


Fig 1. Mosquito life cycle and West Nile Virus transmission cycle diagram after Schwarzbach (2006)

Preventing or reducing WNV transmission depends on successfully controlling the vector’s abundance or interruption of human-vector contact. Also, targeted WNV surveillance within mosquito populations may contribute to the well-timed detection of the virus prior to its emergence in equine species or human populations (Mavrouli et al., 2015; Mavrouli et al., 2017).

West Nile Fever has been spreading widely in recent years, while it has been established in Greece following an increase in mosquito populations migrating from Africa. Even though it is called West Nile, as its symptoms were fist categorised and isolated in Uganda, the virus reportedly afflicts people and livestock in Europe, Asia, Africa, and North America. Last year (2017), only 10 municipalities reported cases of the virus which has infected at least 77 people from May 31 until August 20, claiming five lives in Attiki alone. The virus has also infected people in Viotia, Halkidiki, Thessaloniki, Evia, Imathia, Pella, Corinth, Kilkis and Rethymno, Hellenic Center for Disease Control & Prevention (KEELPNO) refers via press released.

In this short note, we explore the possible link between precipitation patterns of summer 2018 in West Attica – Greece and the numeric evolution of confirmed cases of West Nile fever.

2. Data

Summer 2018 confirmed cases data were adopted from Greece’s Center for Disease Prevention and Control (KEELPNO) press released and European Centre for Disease Prevention and Control (ECDC) risk assessment, which provide all available data each week. Precipitation and meteorological data were adopted from the relevant database of National Observatory of Athens (NOA) weather stations network. Two stations were used: Elefsis (http://penteli.meteo.gr/stations/elefsina/) and Aspropyrgos (http://penteli.meteo.gr/stations/aspropirgos/). Also climatological data and products for Europe were adopted from Copernicus Climate Data Center and European Drought Observatory.

3. Results

Summer and early autumn months are namely as a transmission season for West Nile virus. On those months precipitation during 2018 was extremely high reaching 500% (Fig 2a) above climatological ones in some cases, as is the West Attica area in Greece. Those enormous precipitation values have contributed to an enormous increase of Soil Moisture Anomaly (Fig 3 – above figures) and Vegetation Productivity Anomaly (Fig 3 – below figures) for June – July – August and September 2018 (from left to right), in a well known semi-arid area (Mavrakis et al., 2015), which climate characteristics are long and hot dry summers.

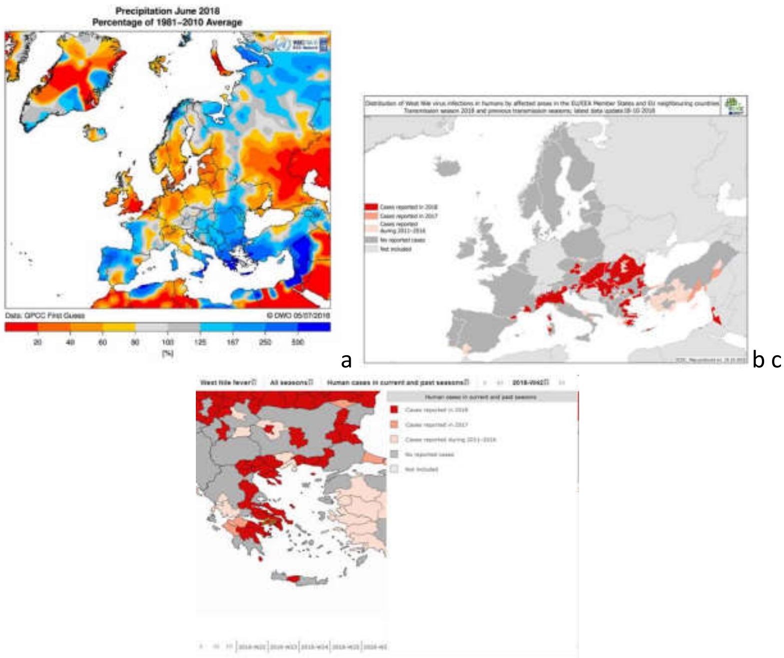
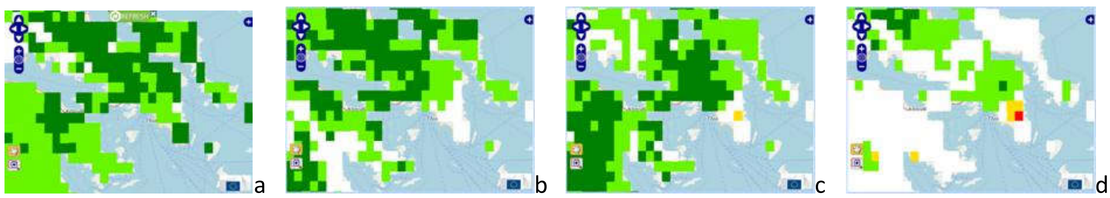


Fig. 2. a) June 2018, Precipitation Anomaly for Europe, Mediterranean and North Africa. https://www.ecokontor.com/2018/07/4681/. b) – c) West Nile Fever: confirmed affected areas in Europe and Greece. European database (https://ecdc.europa.eu/en/west-nile-fever/surveillance-and-disease-data/disease-data-ecdc).



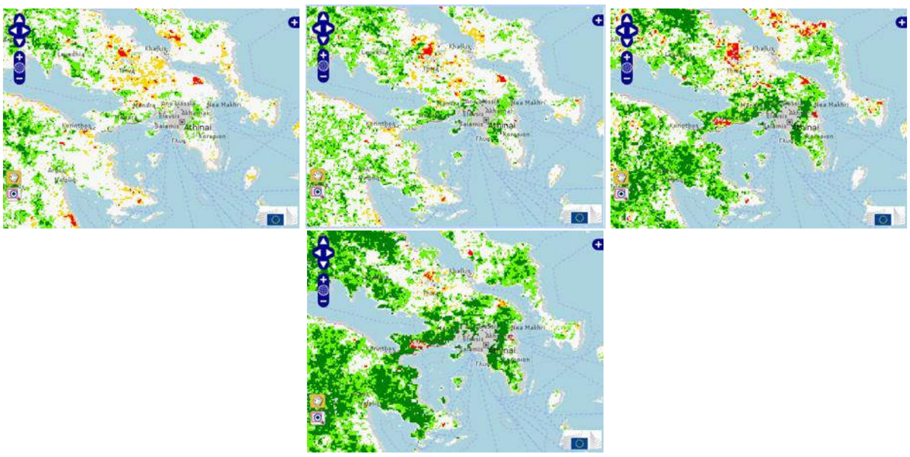
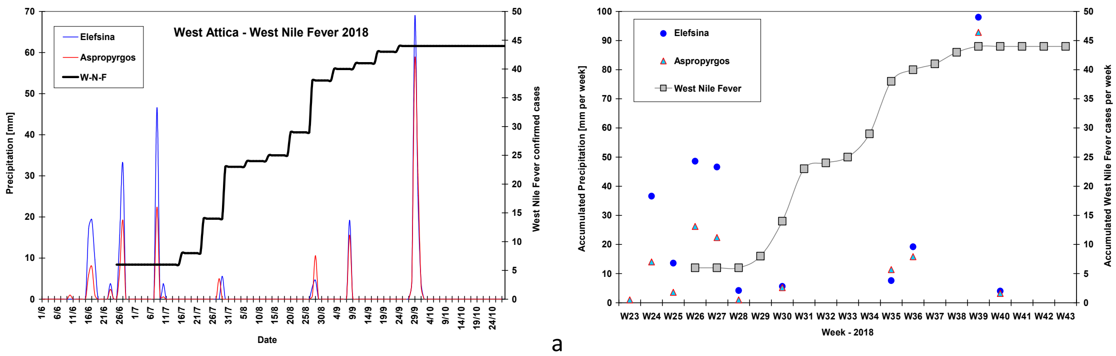


Fig. 3. Soil Moisture Anomaly (above figures) and Vegetation Productivity Anomaly (below figures) for June (a) – July (b) – August (c) and September (d) (from left to right). Figures generated via European Drought Observatory, http://edo.jrc.ec.europa.eu/edov2/php/index.php?id=1141



a b

Fig. 4. a) Daily Precipitation values and West Nile Fever confirmed cases for West Attica – Greece per week (W23 – W43 or June 1st to October 26th 2018). b) Weekly accumulated Precipitation values and number of confirmed cases

Those weather conditions were favorable for increasing mosquito's population. Insects have the ability to replicate rapidly when the conditions favor it, and then make raids by transferring infectious diseases by affecting the population on a large scale. Such raids usually cause large losses to the economies of the provincial societies of developing countries, and in poorer countries can cause plague.

At the same time an outburst of West Nile fever cases was reported compared to no confirmed cases during previous years in the area. Summer 2018 cases were elevated in comparison with previous year statistics states European Centre for Disease Prevention and Control (ECDC) risk assessment, which provide all available data each week.

Κρούσματα λοίμωξης από τον ιό του ΔΝ	Έτος							
	2010	2011	2012	2013	2014	2015	2016	2017
Με προσβολή του ΚΝΣ*	197	75	109	51	14	0	0	28
Χωρίς προσβολή του ΚΝΣ	65	25	52	35	1	0	0	20
Θάνατοι κρουσμάτων	35	9	18	11	6	0	0	5
Σύνολο κρουσμάτων	**262**	**100**	**161**	**86**	**15**	**0**	**0**	**48**

Fig. 5. West Nile Fever confirmed cases for Greece, as reported by Hellenic Center for Disease Control & Prevention – KEELPNO – http://www.keelpno.gr/el-gr). The region of West Attica was not included during previous years.

4. Conclusions

In this short note, we explore the possible link between precipitation patterns of summer 2018 in West Attica – Greece and the numeric evolution of confirmed cases of West Nile fever.

The results indicate that the occurrence of unusual high values of precipitation for this time of year, may have contributed (via a lag process) to the rapid expansion and spread of the West Nile fever in West Attica causing a lot of confirmed cases and fatalities.

West Nile virus show a positive signal to climate changes in Europe, affect the spread of diseases transmitted by transmitters (usually insects). Outdoors high temperatures in the spring, prolonged rains at the beginning of summer and the heat waves that followed, formed ideal conditions not only to create new outbreaks of mosquito proliferation but also to multiply the virus itself in the mosquitoes. Obviously climate change makes environment friendlier to mosquitoes. The spread of the West Nile virus is indeed a very serious public health problem. But in fact it is a symptom of an infinitely more severe disease, that of the planet, because of increase of temperature.

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DEFINITION,CRITERIA AND CLASSIFICATION

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Abstract

Developing countries suffer the greatest costs when a disaster hits – more than 95 percent of all deaths caused by hazards occur in developing countries, and losses due to natural hazards are 20 times greater (as a percentage of GDP) in developing countries than in industrialized countries.

'Disaster is a crisis situation that far exceeds the capabilities'. -Quarentely, 1985.

1. Introduction

Man-Made and Technological Types of Disasters

• Hazardous materials • Power service disruption & blackout • Nuclear power plant and nuclear blast Radiological emergencies	• Chemical threat and biological weapons • Cyber attacks • Explosion Civil unrest

Disasters also can be caused by humans. Hazardous materials emergencies include chemical spills and groundwater contamination. Workplace fires are more common and can cause significant property damage and loss of life. Communities are also vulnerable to threats posed by extremist groups who use violence against both people and property.

High-risk targets include military and civilian government facilities, international airports, large cities and high-profile landmarks. Cyber-terrorism involves attacks against computers and networks done to intimidate or coerce a government or its people for political or social objectives.

2. Disaster Management Cycle- General

Disaster management cycle includes the following stages/ phases

a) Disaster phase – The phase during which the event of the disaster takes place. This phase is characterized by profound damage to the human society. This damage / loss may be that of human life, loss of property, loss of environment, loss of health or anything else. In this phase, the population is taken by profound shock. 1 Not generally considered as phase, but the incident that promotes the actual 4 phases 3

b) Response phase – This is the period that immediately follows the occurrence of the disaster. In a way, all individuals respond to the disaster, but in their own ways

c) Recovery phase – When the immediate needs of the population are met, when all medical help has arrived and people have settled from the hustle – bustle of the event, they begin to enter the next phase, the recovery phase which is the most significant, in terms of long term outcome. It is during this time that the victims actually realize the impact of disaster. It is now that they perceive the meaning of the loss that they have suffered.

d) Risk reduction phase – During this phase, the population has returned to predisaster standards of living. But, they recognize the need for certain measures which may be needed to reduce the extent or impact of damage during the next similar disaster. For example, after an earthquake which caused a lot of damages to improperly built houses, the population begins to rebuild stronger houses and buildings that give away less easily to earthquakes. Or, in the case of tsunami, to avoid housings very close to the shore and the development of a 'green belt'- a thick stretch of trees adjacent to the coast line in order to reduce the impact of the tsunami waves on the land. This process of making the impact less severe is called Mitigation.

e) Preparedness phase – This phase involves the development of awareness among the population on the general aspects of disaster and on how to behave in the face of a future disaster. This includes education on warning signs of disasters, methods of safe and successful evacuation and first aid measures. It is worth to note that the time period for each phase may depend on the type and severity of the disaster.

3. Predictors of survivor reactions:Variables to consider

3.1 Disaster characteristics**:**

• Was it human-caused or natural, or a combination?

• Was there a warning period?

• Was there a clear endpoint to the disaster, or uncertainty about it recurring or about its long-term health effects?

• How widely was the community infrastructure damaged (scope)?

3.2 Individual characteristics

• If there was a warning period, did the individual take protective action?

• How directly was the individual impacted? (i.e., injury, loss of home, death of loved one)

• Did the individual have pre-existing strengths or vulnerabilities that might impact response?

• Does the individual have an intact support network to draw on?

• Did the individual have previous disaster experience?

3.3 Response characteristics

• Did the community have pre-existing resources to aid recovery?

• How were survivors treated immediately after the disaster?

• How were survivors treated in the longer-term recovery stages?

With that said, there are some evidence-based correlations between those disaster characteristics and typical emotional reactions. Let's now examine the characteristics that tend to influence survivors' mental health. Specifically, relevant characteristics include categorizing disasters by size, by cause, and by whether they were expected or not. Additionally, the timing of the event can influence both its logistical and emotional impact. Disaster Size Scope, intensity, and duration all measure different aspects of the size of an event. In essence, they describe how big, bad, and long the disaster was. Note that there are no standard definitions for these characteristics (for example, there's no official number of fatalities that qualifies an event as low versus high intensity), and that the notion of available resources relative to demands certainly will influence the response. Scope can be thought of as a measure of the breadth of damage caused by a disaster. It describes how extensively the larger community is impacted, including the rescue and support infrastructure, which in turn predicts how much help is available and how quickly recovery can proceed. In an event with a large scope, survivors may be unable to turn to their normal support systems of friends, family, and neighbors as they would after a smaller scale traumatic event, since those people may be dealing with their own recovery needs. Very large scope events, like Hurricanes Katrina and Sandy, or the 2010 earthquakes in Haiti and Chile, may leave survivors without a place to shop, work, go to school, or pray. Many may be forced to relocate in order to find housing, work, and schools, which adds the emotional stress of resettling and losing one's community on top of the direct disaster losses.

4 .Expected or Unexpected

A third major factor associated with typical psychological reactions is whether a disaster was expected or unexpected. This factor primarily means whether the disaster allowed for a specific warning that it was approaching, but to some degree expectedness applies to simple recognition that a type of event is even possible. Expected Events Expectedness is partially correlated with causality. Many natural disasters offer a warning period, but some, like earthquakes, do not. For those events that do allow warnings, the length of the warning periods varies widely, and as a result so does the type of protective action possible. Major storms can be predicted with reasonable accuracy days in advance, allowing for evacuation and the advance opening of emergency shelters, while tornado warnings might allow a few minutes' notice to seek safety. This is a mental health issue because survivors generally demonstrate less intense emotional reactions to expected disasters. Of course, in part this is because warnings provide an opportunity to evacuate, seek shelter, or take other protective action and avoid or minimize the dose of trauma received. Apart from that obvious practical protection, receiving a warning also allows for some psychological adjustment to the idea that a threat is approaching, rather than blindsiding people. However, warnings are not without a downside. Essentially, receiving a warning places the recipient in an unpleasant decision-making situation: Will they comply with it or not? Choosing to comply means first acknowledging that a potential threat to life and property is approaching, which is not something most of us readily embrace. If we do accept the threat as legitimate, most recommended protective actions are onerous in terms of time, money, effort, and distress. As a result, the typical tendency after receiving a warning is to deny that one is at risk and to disregard it, or to wait to collect more information—sometimes until it's too late to take the most effective action. If people receive a warning and they fail to take action, they're likely to experience guilt and shame later from the recognition that they could have avoided some losses, which of course is devastating if those losses include the deaths or serious injuries of loved ones. Survivors may then have to cope with self-blame, as well as blame by others who question why they didn't heed the warning. These can be powerful emotions that complicate recovery, as survivors must learn to accept that part of their losses were due to their own decisions. However, vowing not to repeat that mistake and to follow subsequent warnings can provide them with some perception of control over the future. It's also possible that survivors might take reasonable steps in reaction to a warning, only to discover that they were insufficient. For example, before evacuating in response to a flood warning, residents might place valuables in high locations within their homes. If the floodwaters rise higher than expected and the items are destroyed, survivors might still engage in self-blame that is unreasonable—they did take precautions they believed would be appropriate—but nonetheless distressing. Residents in disaster-prone areas like flood plains may also engage in self-blame because they know they made a choice to live in harm's way. In the case study described at the beginning of the reading we saw that after a false alarm concerning the approaching wildfire, survivors were less likely to take precautions when there was a subsequent warning. We could reassure them that their actions were typical and understandable. False alarms often create an impression that warnings are exaggerated which leads to less compliance to subsequent alerts. Hopefully this would mitigate their self-blame.

5. Unexpected Events

Most human-caused and technological disasters do not have specific warning periods— if they did, the events could potentially be averted, or at least people in the area could be protected from harm. However, there may be recognition that an event is at least possible, which can allow for some logistical and psychological preparation. For example, those living near levees and dams probably have some idea that breaches are possible; those working in buildings that would be high-value terrorist targets may be aware of that vulnerability. That theoretical awareness can help people function more productively during a disaster than they might in response to a completely unforeseen event, but obviously it offers less protection than an actual warning period does. Since people who experience unexpected disasters have no chance to prepare physically or psychologically, they're more likely to be overwhelmed during and after the event. They also may feel helpless or vulnerable to a recurrence: If a traumatic event occurred once with no warning and with nothing they could do to prevent it, that can happen again and there is no way to protect oneself or one's family in the future. There should be less guilt in this group since there was no warning to respond to and so no need to blame oneself for failing to act. However, people often feel or express guilt over things they could not realistically have foreseen or controlled, such as "I should have seen it coming," "we never should have bought that house," "I shouldn't have let him get on that flight," and so on. Even if these thoughts are implausible, they still cause very real pain to survivors, so mental health interventions might include gently correcting these distorted cognitions.

6. Conclusion

The development of mental health care faces special challenges in developing countries. There is a need for mental health professionals to shift from a clinical to a public health focus; the development of training materials, case records, information systems, and the availability of adequate numbers of mental health professionals to implement the plan. There is a need for training all those involved in disaster relief work. The importance of trained Community Level Workers (CLWs) to implement an organized effort aimed at providing psychosocial relief has been well exemplified. There is a need in the Indian scenario to have community mental health teams trained for such events.

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