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Multi-hazard Risk Approach and Inclusive Community Engagement in Disaster Risk Management: Experiences & Lessons learned by a recent Wildfire Event in the Greek Island of Rhodes amidst COVID-19 pandemic crisis

S. Karma, S. Georgiou, I. Boukis, I. Argyris, E. Pelli, M. Statheropoulos

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Preface

The extreme weather events that have been recorded the recent years at international level are mostly correlated with the so called “climate crisis” that we currently experience. As a result, prolonged droughts, intense heat waves, destructive wildfires, exceptional rainfall and flash-floods are observed on a global basis.

Especially for the wildfires, due to the fact that an increased number of population has moved to urban and suburban areas in the “Wildland Urban Interface” (WUI), it seems that wildfires at those areas may result in major impacts in terms of human and property losses. In such cases, all the population, especially vulnerable groups like people with disabilities, older people, or children, are considered more susceptible because most of the times they don’t know how to keep themselves safe, therefore it is more likely to be injured or killed. In the above context, empowerment of communities towards undertaking active roles in emergency preparedness and response with inclusive criteria may be a key element for building disaster resilience for all.

Nowadays, the COVID-19 pandemic crisis has intensified the challenges and difficulties for effective disaster risk management. It appears that complex emergencies will be the case for the future and therefore a multi-hazard risk approach might be necessary for copying with the relevant impacts. In that perspective, this work strives to provide with the experiences and lessons learned by a recent complex emergency, namely the management of a wildfire amidst COVID-19 pandemic crisis. In this context, a data file of the wildfire event has been prepared.

Summary

The volume entitled *"Multi-hazard Risk Approach and Inclusive Community Engagement in Disaster Risk Management: Experiences & Lessons learned by a recent Wildfire Event in the Greek Island of Rhodes amidst COVID-19 pandemic crisis"* aims to highlight emerging issues in the field of disaster risk management, such as the need for multi-hazard risk assessment in case of viral pandemics. Under this perspective, a strong emphasis is given on the importance of the community engagement for building disaster resilience with inclusive criteria.

"Chapter 1: Introduction", provides with general information on the current situation in terms of climate crisis driven disasters that have been recently recorded on a global basis, and of the emerge of viral pandemics like the COVID-19. In that prospect, the challenges and limitations in the case of an evacuation are mentioned.

"Chapter 2: Multi-Hazard Risk Approach: Wildfire Smoke and COVID-19 health impacts" introduces the "multi-hazard risk" approach with the prospect of focusing on co-existing multiple hazards, such as wildfires during viral pandemics. In that context, an overview of the health impacts due to wildfire smoke exposure is provided, focusing on the case of COVID-19 pandemic for assessing the total impact.

In *"Chapter 3: Strengthening Disaster Resilience of Communities with Inclusive Criteria"* the term "Community Engagement" is analyzed and explained; interconnection with vulnerability reduction and strengthening of disaster resilience is given. In these terms, key steps towards enhancing community engagement are provided, focusing on preparedness and response upon "Wildfires and Wildfire Smoke impacts" specifically for the populations situated in the "Wildland Urban Interface" (WUI). In that context, indicative tools and practices worldwide are presented under the schema of "Get prepared", "Get

informed" and "Get involved" that a community should follow for reducing the wildfire and wildfire smoke risks, taking also into account a pandemic situation. Emphasis is also given to the inclusive approach that needs to be considered.

In *"Chapter 4: Case study: Wildfire at the Greek island of Rhodes during the Summer of 2021 and Evacuation of the "Valley of Butterflies"* the Case Study of a wildfire event that occurred in the Rhodes Island, Greece during the summer of 2021 amidst COVID-19 pandemic is presented. Due to this wildfire the "Valley of Butterflies" had to be evacuated for precautionary reasons. The "Valley" is known worldwide as a shelter of unique butterflies' species especially during summer, hosting every year a huge number of visitors and tourists. The data file of this wildfire event has been prepared, including geographical, vegetation – land use and meteorological data, as well as the resources used for suppressing the fire. Data files can generally be used for developing guidelines, as well as for improving tactics and enhancing strategies.

Finally, *"Chapter 5: Lessons learned"* strives to summarize what has been argued in the previous Chapters, concerning the multi-hazard risk approach and the role of community engagement as substantial elements of effective emergency management. As a reference, the experiences obtained during the recent wildfire event amidst pandemic crisis is used; namely, the evacuation of the "Valley of Butterflies" in the Rhodes Island on the 1st of August 2021.

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Glossary of terms

In the following glossary, a number of key terms are provided according to the United Nations Office for Disaster Risk Reduction (https://www.undrr.org/terminology)

Capacity:

The combination of all the strengths, attributes and resources available within an organization, community or society to manage and reduce disaster risks and strengthen resilience.

Annotation: Capacity may include infrastructure, institutions, human knowledge and skills, and collective attributes such as social relationships, leadership and management.

Climate crisis:

Climate crisis is a term describing global warming and climate change, and their consequences.

Coping capacity:

Is the ability of people, organizations and systems, using available skills and resources, to manage adverse conditions, risk or disasters. The capacity to cope requires continuing awareness, resources and good management, both in normal times as well as during disasters or adverse conditions. Coping capacities contribute to the reduction of disaster risks.

Disaster:

A serious disruption of the functioning of a community or a society at any scale due to hazardous events interacting with conditions of exposure, vulnerability and capacity, leading to one or more of the following: human, material, economic and environmental losses and impacts.

Annotations: The effect of the disaster can be immediate and have a local impact, but is often widespread and may last for a long period of time. The effect may test or exceed the capacity of a community or society to cope using its own resources, and therefore may require assistance from external sources, which could include neighbouring jurisdictions, or those at the national or international levels.

Disaster impact:

Is the total effect, including negative effects (e.g., economic losses) and positive effects (e.g., economic gains), of a hazardous event or a disaster. The term includes economic, human and environmental impacts, and may include death, injuries, disease and other negative effects on human physical, mental and social well-being.

Disaster risk management:

The application of disaster risk reduction policies and strategies to prevent new disaster risk, reduce existing disaster risk and manage residual risk, contributing to the strengthening of resilience and reduction of disaster losses.

Early Warning System:

An integrated system of hazard monitoring, forecasting and prediction, disaster risk assessment, communication and preparedness activities systems and processes that enables individuals, communities, governments, businesses and others to take timely action to reduce disaster risks in advance of hazardous events.

Annotations: Effective “end-to-end” and “people-centred” early warning systems may include four interrelated key elements: (1) disaster risk knowledge based on the systematic collection of data and disaster risk assessments; (2) detection, monitoring, analysis and forecasting of the hazards and possible consequences; (3) dissemination and communication, by an official source, of authoritative, timely, accurate and actionable warnings and associated information on likelihood and impact; and (4) preparedness at all levels to respond to the

warnings received. These four interrelated components need to be coordinated within and across sectors and multiple levels for the system to work effectively and to include a feedback mechanism for continuous improvement. Failure in one component or a lack of coordination across them could lead to the failure of the whole system.

Emergency:

Is sometimes used interchangeably with the term disaster, as, for example, in the context of biological and technological hazards or health emergencies, which, however, can also relate to hazardous events that do not result in the serious disruption of the functioning of a community or society.

Evacuation:

Moving people and assets temporarily to safer places before, during or after the occurrence of a hazardous event in order to protect them.

Annotation: Evacuation plans refer to the arrangements established in advance to enable the moving of people and assets temporarily to safer places before, during or after the occurrence of a hazardous event. Evacuation plans may include plans for return of evacuees and options to shelter in place.

Hazard:

A process, phenomenon or human activity that may cause loss of life, injury or other health impacts, property damage, social and economic disruption or environmental degradation.

Annotations: Hazards may be natural, anthropogenic or socionatural in origin. **Natural hazards** are predominantly associated with natural processes and phenomena. **Anthropogenic hazards**, or human-induced hazards, are induced entirely or predominantly by human activities and choices. This term does not include the occurrence or risk of armed conflicts and other situations of social instability or tension which are subject to international humanitarian law and national legislation. Several hazards are **socionatural**, in that they are

associated with a combination of natural and anthropogenic factors, including environmental degradation and climate change.

Hazards may be single, sequential or combined in their origin and effects. Each hazard is characterized by its location, intensity or magnitude, frequency and probability. Biological hazards are also defined by their infectiousness or toxicity, or other characteristics of the pathogen such as dose-response, incubation period, case fatality rate and estimation of the pathogen for transmission.

Multi-hazard:

Means (1) the selection of multiple major hazards that the country faces, and (2) the specific contexts where hazardous events may occur simultaneously, cascadingly or cumulatively over time, and taking into account the potential interrelated effects.

Hazards include (as mentioned in the Sendai Framework for Disaster Risk Reduction 2015-2030, and listed in alphabetical order) biological, environmental, geological, hydrometeorological and technological processes and phenomena.

Multi-hazard early warning systems:

Address several hazards and/or impacts of similar or different type in contexts where hazardous events may occur alone, simultaneously, cascadingly or cumulatively over time, and taking into account the potential interrelated effects.

A multi-hazard early warning system with the ability to warn of one or more hazards increases the efficiency and consistency of warnings through coordinated and compatible mechanisms and capacities, involving multiple disciplines for updated and accurate hazards identification and monitoring for multiple hazards.

Resilience: The ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions through risk management.

Vulnerability:

The conditions determined by physical, social, economic and environmental factors or processes which increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards.

Annotation: For positive factors which increase the ability of people to cope with hazards, see also the definitions of “Capacity” and “Coping capacity”

1. Introduction

Extreme weather events that have been recorded the recent years at European and International level, like prolonged droughts, heat waves in terms of increasing trends in frequency, duration and cumulative heat, as well as intensive rainfalls and flooding have been correlated with global warming and climate change, the so called “climate crisis” . According to the IPCC, for 1.5°C of global warming, there will be increasing heat waves, longer warm seasons and shorter cold seasons [1].

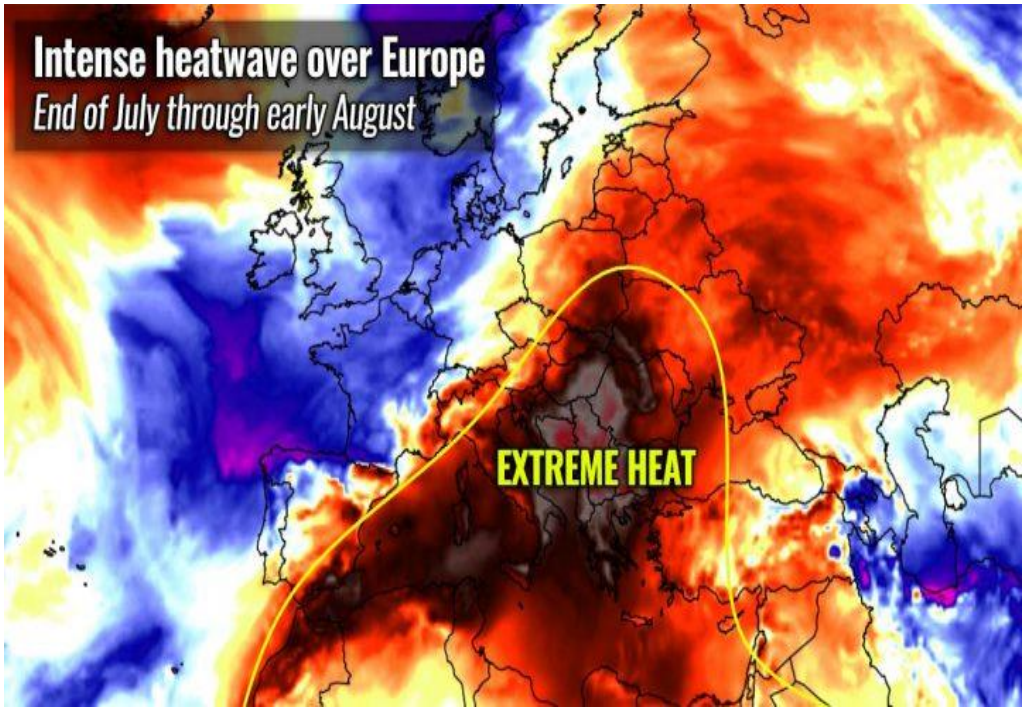

Figure 1. Intensive heat wave over Europe recorded in summer 2021 [2]

According to Figure 1, the final days of July and early August of 2021 were some of the most intense in terms of heat recorded during this summer in Europe. Temperatures reached the 40 °C or 45 °C. This phenomenon has significantly increased the wildfire threat across the Mediterranean region and the Balkan peninsula [2]. Figure 2, indicates the Fire Danger Forecast provided by the European Forest Fire Information System (EFFIS) on the 31st of July 2021,

showing “very extreme” (purple shading) around the Mediterranean for the 7th of August [3].

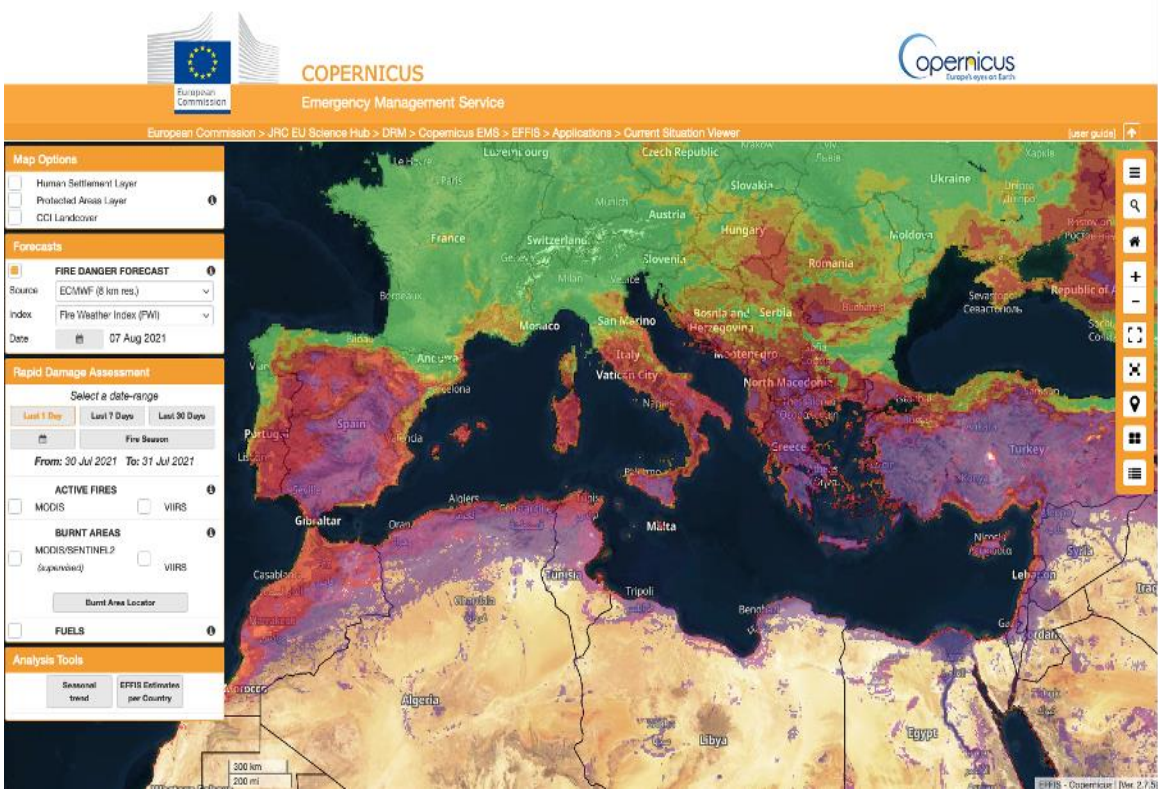

Figure 2. Fire Danger Forecast on 31 July 2021, showing “very extreme” (purple shading) around the Mediterranean for the 7th of August (EFFIS) [3]

The combination of dryer winters and hotter summers formulate the perfect substrate for large-scale wildfires causing the respective impacts in terms of great quantities of smoke produced. Figure 3, shows the smoke dispersion occurred in August 2021 due to the wildfires in Siberia; the smoke reached the North Pole for the first time in recorded history (NASA’s , MODIS satellite, 6 of August 2021) [4, 5].

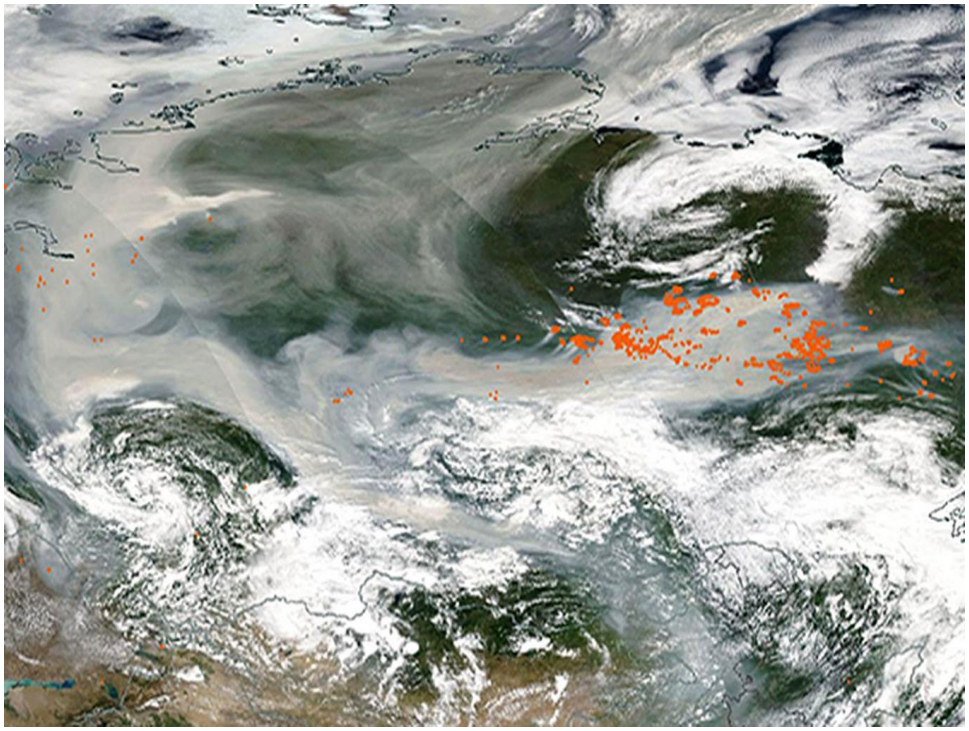

Figure 3. Smoke from wildfires in Siberia reached the North Pole for the first time in recorded history (NASA, MODIS) [5]

Apart from the existing natural and technological hazards, humanity has recently faced another hazard, this of Covid-19 pandemic that caused one of the greatest sanitary crisis of all years. The Covid-19 dispersion created “a new normal” for the human kind, in terms of health and safety protocols application in their every-day life. Additionally, the social and economic impact was globally extraordinary [6-8].

It is a real challenge if a need of emergency evacuation exists amidst a pandemic situation like the one caused by the COVID-19. It is quite complicated and difficult to evacuate significant number of people and guide them to safe shelters when very strict hygiene protocols are needed for all the evacuees.

According to the above, paving the path towards reinforcing the coping capacity of communities upon emerging hazards and risks under a “multi-hazard risk” concept, seems a great challenge currently and for the coming years.

2. Multi-Hazard Risk Approach: Wildfire Smoke and COVID-19 health impacts

Chapter 2 of this document introduces the “multi-hazard risk” approach with the prospect of focusing on coexisting multiple hazards, such as wildfires during viral pandemics. In that context, an overview of the health impacts due to wildfire smoke exposure is provided, focusing on the case of COVID-19 pandemic for assessing the total impact.

2.1 The Multi-Hazard Risk Approach

In contrary to single hazard events, the assessment of multiple hazards and their interconnections is a real challenge in terms of hazards and vulnerability assessment of the exposed populations. Exposure to multi-hazards may result to an additive or a synergistic result of the effects, multiplying the overall level of the risk.

Some authors differentiate between “multi-hazard risk” and “multi-risk”. Based on a literature recording [9], a multi-hazard risk is defined as “a risk evaluation that considers the impact of multiple hazards”, and multi-risk as “related to the assessment of multiple risks”, e.g. economic, environmental, social, etc. Based on other references [10, 11] the term multi-risk can be used to define an approach that determines the whole risk from various hazards, measuring any possible hazards and vulnerability interactions resulting to a multi-hazard and multi-vulnerability approach.

According to literature, the conception of multi-vulnerability refers to “the ensemble of interconnected and dynamic vulnerabilities among different exposed elements” [11]. Under this perspective and for effective disaster risk reduction, the mitigation measures should also be adjusted to confront multi-hazards. As a conclusion, multi-hazard risk assessment is necessary to be incorporated to the risk reduction strategies in planning development at different levels [12].

One example of a multi-hazard risk is the case of health effects that can be caused to the relevant receptors due to their exposure to wildfire smoke, assessed together with the health implications that can be caused due to COVID-19 virus. The next paragraphs will give an insight to this concept.

2.2 Wildland fires and smoke health impacts: General Overview

Recently, there has been a significant movement of population to urban and suburban areas that has resulted to an increase of building houses inside or nearby urban forest areas, the so called “Wildland Urban Interface” (WUI). This fact has increased the risk of forest fires and hence, the severity of the respective effects in terms of human and property losses, as well as the exposure to hazardous smoke components. Wildfire smoke is a complex chemical mixture of various components that are considered hazardous; particles (fine and ultrafine), gaseous pollutants, like carbon monoxide, carbon dioxide, or ammonia, dioxins, as well as other highly toxic compounds that can be generated when forest fires expand [13-16].

The huge quantities of smoke particles produced in combination with the extreme thermal radiation emitted, usually causes suffocation and death of the people that are directly exposed [17]. It should be mentioned that the smoke impacts can be a serious problem not only for the fire affected area but for all the regions that are situated in the pathway of the generated smoke plume, depending on the meteorological conditions, such as the wind direction and velocity (see Figure 3). For example, fine particles, such as $PM_{2,5}$, PM_1 and ultrafine particles ($PM_{0,1}$) can be transferred far away from the fire source, affecting areas in long distances (transboundary effects) [18].

Based on epidemiological studies, fine and ultrafine particles are known to have adverse health effects, especially for the vulnerable groups of population, such as the elderly, pregnant women, children, people with disabilities, or hidden disabilities, like asthma and cardiopulmonary diseases [19-22]. The degree of

human exposure to a fire smoke event is based on the frequency, duration and the routes of exposure (inhalation, skin absorption, ocular absorption, ingestion) to the possible contaminants. Acute exposure is usually less than 24-h, short-term exposure lasts usually one week, sub-chronic lasts about the 10% of someone's life, whereas chronic exposure consist a significant time duration, over 10% of human life [19-22].

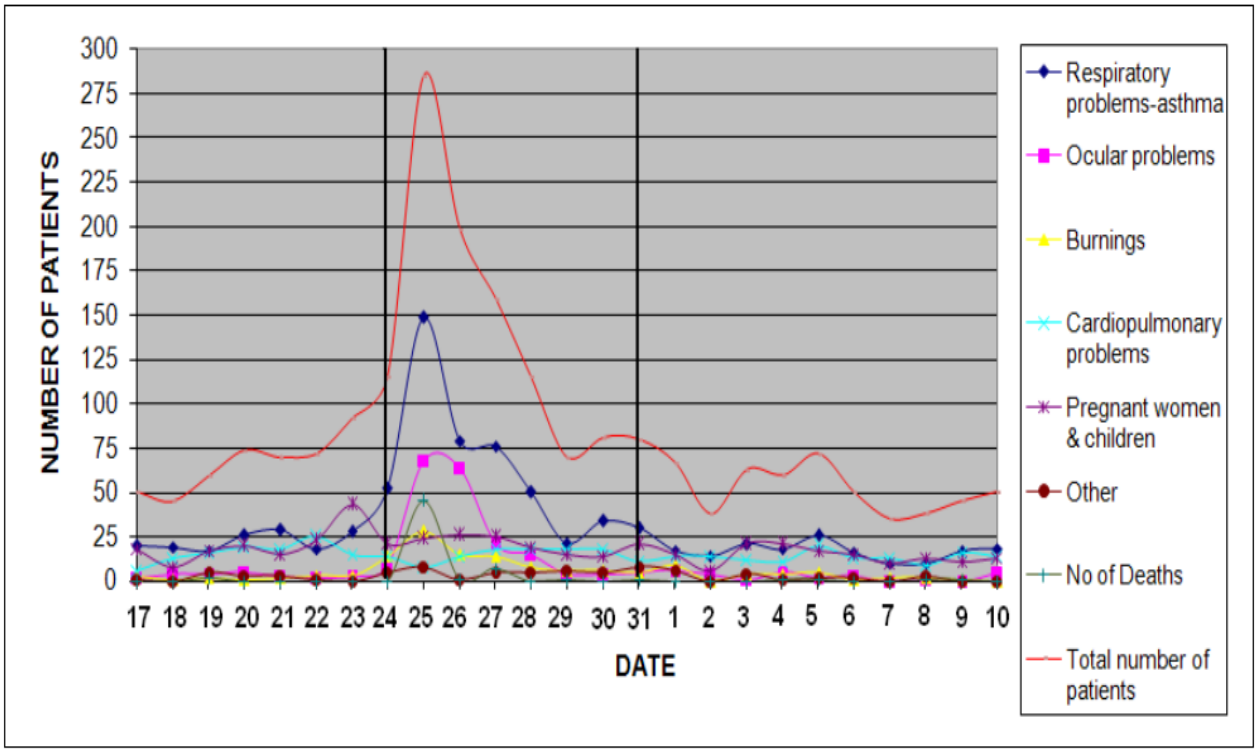

Figure 4. Profile of the number of admissions and number of deaths according to 19 medical centers and hospitals of Peloponnese in between the 17th of August to the 10th of September 2007 [23]

In a previous work implemented by the European center for Forest Fires [23], a data file of a fire event in Peloponnese, Greece that took place on the 23th and 24th of August 2007 was prepared, where the health impacts of population due to the smoke exposure in terms of admissions to hospitals were recorded. The profile of the number of admissions to hospitals and medical centers of Peloponnese per category of symptoms (respiratory problems, asthma, ocular problems, burnings, cardiopulmonary problems, pregnant women, children) and

deaths, emphasizing on the period 24-31 of August 2007, are indicated (Figure 4).

Geographical, vegetation, meteorological data, as well as data on health, environmental and infrastructure impacts, together with the resources and means used for suppressing the fire have been proposed to be included in these types of data files.

A data-driven approach in preparing these files is the one that could provide the decision makers, the operational people and all the involved parties with valuable information from past events for better risk assessment and more efficient disaster risk management in the future, under a multi hazard concept.

In the present work, a number of data regarding the wildfire event that took place in the Greek Island of Rhodes amidst COVID-19 pandemic crisis in summer 2021 has been gathered and will be presented in Chapter 4 of this document.

2.3 Wildfire smoke and COVID-19 health impacts

An emerging and at the same time challenging issue is how to use the multi-hazard risk and multi-vulnerability approach for making the overall health risk assessment when exposed to wildfire smoke particles amidst viral pandemics.

According to literature, researchers have found that fine particulate pollution has been associated with increased risk of COVID-19 cases and death [24]. Based on the same study which was conducted at the Harvard T.H. Chan School of Public Health, it was found that a quite impressive number of COVID-19 cases and deaths in California, Oregon, and Washington recorded between March and December 2020, could be attributed to the increases of fine particles air pollution, such as PM2.5, from wildfire smoke. This study provided with evidence that climate crisis, which escalates the frequency and intensity of wildfires, together with the pandemic can be really a disastrous combination.

As already noted in paragraph 2.2 of this work, large-scale wildfires produce huge quantities of smoke that entails high levels of fine particulate matter, which have been associated with adverse health effects like asthma, chronic obstructive pulmonary diseases (COPD), and other respiratory diseases [25]. This fact could increase the vulnerability of the exposed people in case they are also infected by SARS-CoV-2 virus, intensifying the severity of the overall health impacts. The above argument is also in line with another study concerning the toxic effects of wildfire smoke due to the wildfires at Southeast Asia in 2020 and their association with COVID-19 casualties [26].

It appears that wildfire smoke and COVID-19 health impacts is an issue that will be in the center of research focus the coming years under a multi-hazard risk perspective. The challenge is how to shield communities upon such emerging multiple risks, striving to strengthen disaster resilience.

3. Strengthening Disaster Resilience of Communities with inclusive criteria

In Chapter 3 of this document, the term “Community Engagement” is analyzed and explained; interconnection with vulnerability reduction and strengthening of disaster resilience is given. In this framework, key steps towards enhancing community engagement are provided, focusing on preparedness and response upon “Wildfires and Wildfire Smoke” impacts, especially for the populations situated in the “Wildland Urban Interface” (WUI). In that context, indicative tools and practices worldwide are presented under the schema of “Get prepared”, “Get informed” and “Get involved” that a community should follow for reducing the wildfire and wildfire smoke risks, taking also into account a pandemic situation. Emphasis is also given to the inclusive approach that needs to be considered.

3.1 Community Engagement for Disaster Resilience

Due to many factors that may cause an increase in the vulnerability of societies, under a “multi-hazard” and “multi-vulnerability” concept as presented in Chapter 3, it appears that a shift towards local capacity building is vital to confront the emerging multiple hazards and risks around the world. A complex science-policy interface is needed to achieve this goal [27].

In the above concept and focusing on the “Priority 1: Understanding disaster risk”, as well as, “Priority 4: Enhancing disaster preparedness” of the Sendai Framework for Disaster Risk Reduction 2015-2030 [28], actual involvement of citizens in the disaster risk management cycle seems more urgent than ever. Moreover, adaptation measures to emerging risks, like the climate deregulation, as well as current or future pandemics, are substantial for enhancing the coping capacity of communities and for making them more resilient to different types of disasters.

It should be emphasized that disaster resilience cannot be developed for, or on behalf of, communities. On the contrary, it relies on the sharing of information, understanding, decision-making, responsibility and resourcing within and between communities and involved parties [29]. Sharing knowledge and expertise on best practices and lessons learned may facilitate effective disaster risk management. For example, “weADAPT” is a collaborative platform on climate change adaptation issues, allowing practitioners, researchers and policy-makers to access credible, high-quality information and exchange experience and know-how [30].

In general, community engagement is defined as “the process of communities and the respective stakeholders working together in order to build resilience through collaborative action, shared capacity building and development of strong relationships” [29]. Aligned with the inclusive perception, community engagement through flexible and inclusive approaches, as well as by considering the diverse needs of the local community members, could strengthen disaster resilience of community as a whole.

In the following, as an example key steps towards enhancing community engagement are presented according to the Australian Institute for Disaster Resilience, based on a recent report [29]:

1. “Place the community at the centre.
2. Understand the environmental, political, or historical context that surrounds any hazard, emergency event or disaster.
3. Recognize complexity and dynamic nature of hazards, disaster risk and emergency events.
4. Work in partnership between the community and all the involved parties.
5. Communicate respectfully and inclusively considering any strengths, weaknesses, needs, diversities.
6. Recognize and build capability to reduce disaster risk and increase resilience”.

A number of key performance indicators will be needed for monitoring the status and progress of the above process, as presented in the specific report [29].

In the following paragraph, community engagement aspects focusing on disaster preparedness and response upon wildfires and wildfire smoke impacts will be presented.

3.2 Community Engagement in the "Wildland Urban Interface" (WUI) for coping with Wildfires and Wildfire Smoke Impacts

Under the multi-hazard concept and the complex emergencies that evolve, paving the path towards community based and community led risk management could reinforce the adaptation and the coping capacity of the exposed populations worldwide.

Focusing on the WUI areas and for coping with the wildfires and the resulted wildfire smoke impacts, the Forest Service U.S. Department of Agriculture (USDA), the Nevada Division of Forestry, the US Department of the Interior Bureau of Land Management and the University of Nevada have sponsored a website entitled ***"Living with Fire"***, directed to the public for enhancing their preparedness and response towards wildfires [31].

According to this website there is a number of steps in order the citizens who are living in the WUI area to be proactive and shield themselves upon certain hazards, like wildfires and the smoke produced: (a) get prepared, (b) get informed, (c) get involved [31].

Following the above proposed structure, a number of actions will be presented in this work, based on international experiences and available relevant material.

✓ *Step 1. Get prepared: Planning and Preparing*

Dwellers in the WUI areas should learn how to live more safely with the threat of a wildfire.

Indicative steps of *"Planning and Preparing"* are summarized as follows [31]:

- Make my house fire safe.
- Understand and Assess the Wildfire Risk.
- Align with the Community fire protection plan.
- Prepare my Evacuation Plan.

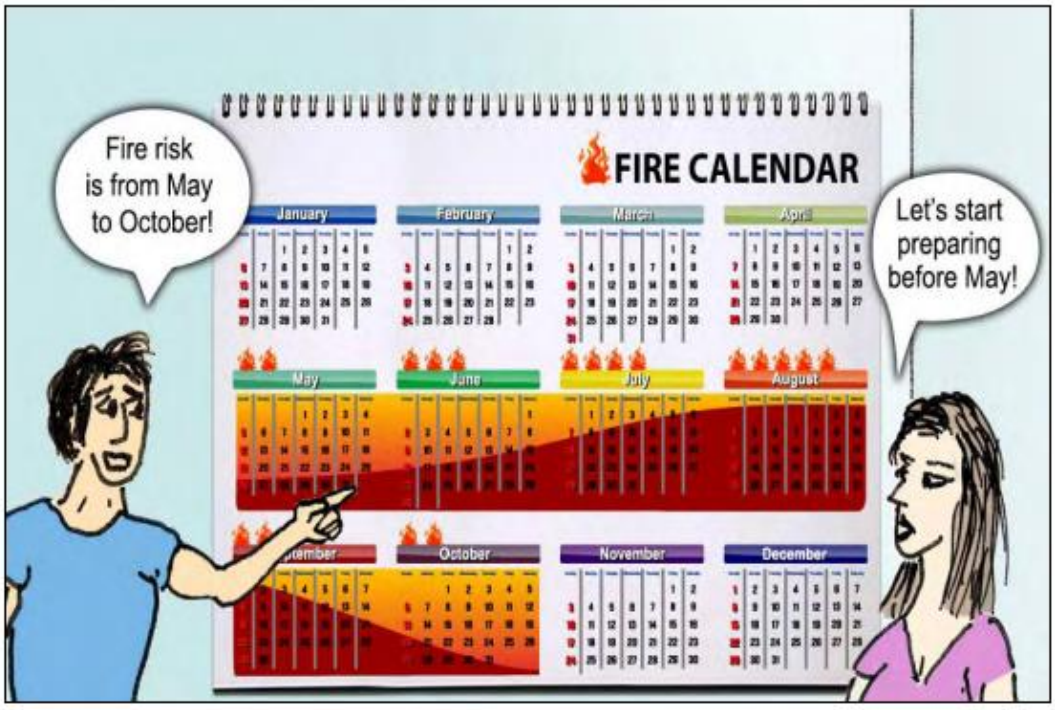

Figure 5. Your family should plan the preparation of the season of high wildfire risk [32]

Based on a recent work prepared by the European and Mediterranean Major Hazards Agreement (EUR-OPA), entitled "Defence of Villages, Farms and Other Rural Assets against Wildfires, Guidelines for Rural Populations, Local Communities and Municipality", the preparation of properties against wildfires seems vital. Based on the same work, it is important to be prepared especially during the fire season (Figure 5), because the conditions are more favorable for a

fire to be ignited; the vegetation is dried due to hot and dry conditions, hence the forest surroundings become fire prone [32].

Figure 6. Removing the living and dead vegetation and firewood storage nearby houses and outbuildings is needed to make them safer upon wildfires [32]

Community fire protection plan is really important, hence understanding and assessing the wildfire risk may result to better preventive measures for the whole community. Hence, for making a house safer upon wildfire hazard it is crucial to remove the living and dead vegetation and firewood storage nearby houses and outbuildings (Figure 6) [32].

During a wildfire, the combustible exterior building components such as roof coverings, siding, and decks can ignite, leading to severe damage or to total loss of the building. Hence, using noncombustible or fire-resistant materials should be considered; Figure 7 shows the components of the building envelope [33].

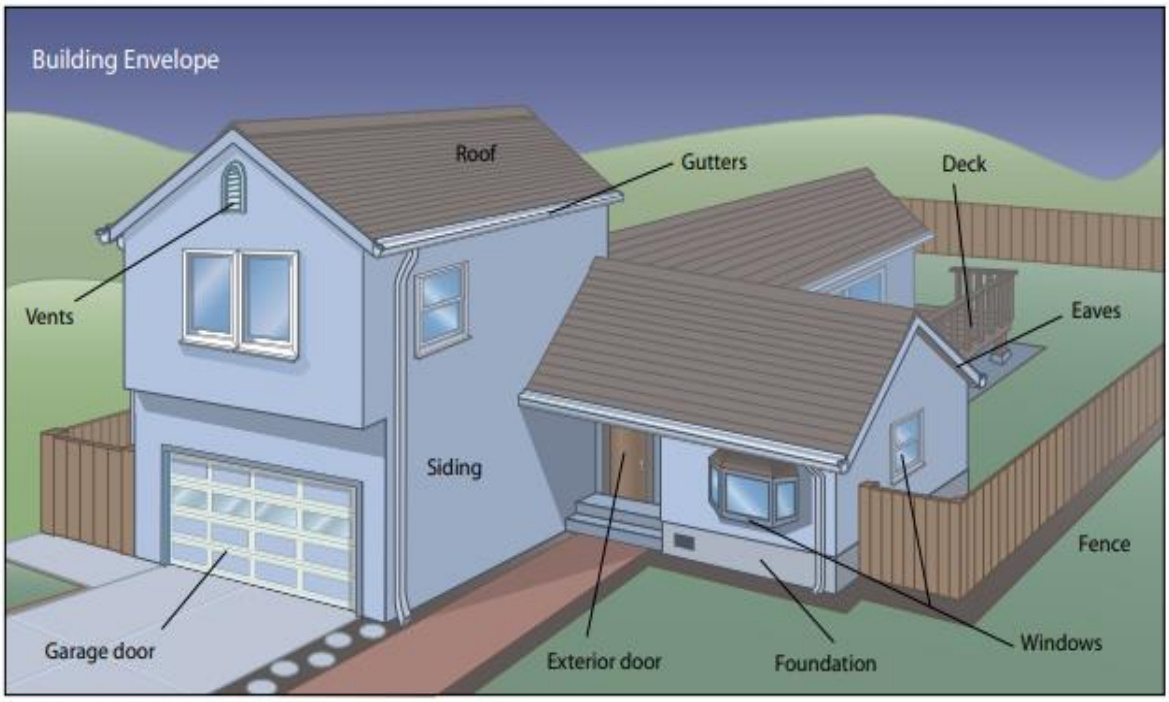

Figure 7. Building envelope: Noncombustible or fire-resistant materials should be considered for exterior components of buildings in WUI areas [33]

Since wildfire risk assessment is very important in raising awareness, understanding that factors such as (a) topography and weather (b) the existence or not of wildfire protective zones (c) the type of the building envelope, can significantly affect the wildfire behavior, could help in making fire-protection wise decisions in terms of buildings' construction in the WUI areas [33].

Community Risk Assessment and Community Risk Reduction Plan Development have been recently centered into focus by the National Fire Protection Agency (NFPA), by releasing a new standard in the year 2020, the NFPA 1300. In practice, NFPA 1300 provides guidance on conducting a Community Risk Assessment (CRA), creating and implementing a community risk reduction (CRR) plan, and establishing ongoing evaluation of that plan [34].

Aligned with NFPA 1300 and towards enhancing community risk assessment tools, a friendly to the user platform in the format of a web-game has been developed, named CRAIG 1300™ [35].

Figure 8. CRAIG 1300™ is a web game-platform aligned with NFPA 1300 standard that can be utilized for preparing community risk assessment plans [35]

With CRAIG 1300™ one can easily visualize and assess the risks, hazards, and capacities in a community for a more effective data-informed risk reduction plan, together with the competent stakeholders (Figure 8) [35].

Figure 9. Prepare your own emergency evacuation plan
(Source: General Secretariat for Civil Protection, Greece) [36]

In the above context and in order to confront emergency situations, the preparation of a personal emergency evacuation plan seems crucial. In Figure 9, an indicative example of how to prepare one's emergency evacuation plan is

provided in native language, based on the guidelines given by the General Secretariat for Civil Protection, Greece [36].

Preparation of one's evacuation plan appears even more essential for the groups of population that are considered vulnerable, especially under the concept of multi-hazards and complex emergencies that have been previously addressed in Chapter 2; more details on the Personal Emergency Evacuation Plan (PEEP) focusing on people with disabilities will be given in paragraph 3.3.4 of this document.

✓ *Step 2. Get informed: Raising self-awareness*

Indicative steps of *"Raising self-awareness"* are summarized as follows [31]:

- Be aware of the Fire Weather Index to prevent wildfires.
- Be informed on what to do in case of a wildfire emergency.
- Get to know how to be protected against wildfire smoke exposure.
- Be informed on how to be protected on current pandemics.

The European Forest Fire Information System (EFFIS) has adopted the Canadian Forest Fire Weather Index System (FWI) in 2007, as the method to assess the fire danger level in a harmonized way throughout Europe; proper adjustments have been made based on the different climatic conditions in Europe, providing with the "Fire Danger Forecast" [3]. According to the same source, a *"Very Extreme"* Fire Danger Class was introduced in June 2021 to provide discrimination regarding the level of fire danger in extensive areas that were initially classified at "Extreme" Fire Danger in the Mediterranean region, during the summer period. The "Very Extreme" class includes areas with FWI values over 70. Figure 2, shows the Fire Danger Forecast on 31 July 2021, showing "very extreme" (purple shading) around the Mediterranean for the 7th of August.

Moreover, fire danger smart displays are often available in different countries for raising public awareness, as shown in Figure 10; National Fire Danger Rating System by the Forest Service U.S. Department of Agriculture (USDA) [37].

Figure 10. Fire danger warning smart display for raising public awareness [37]

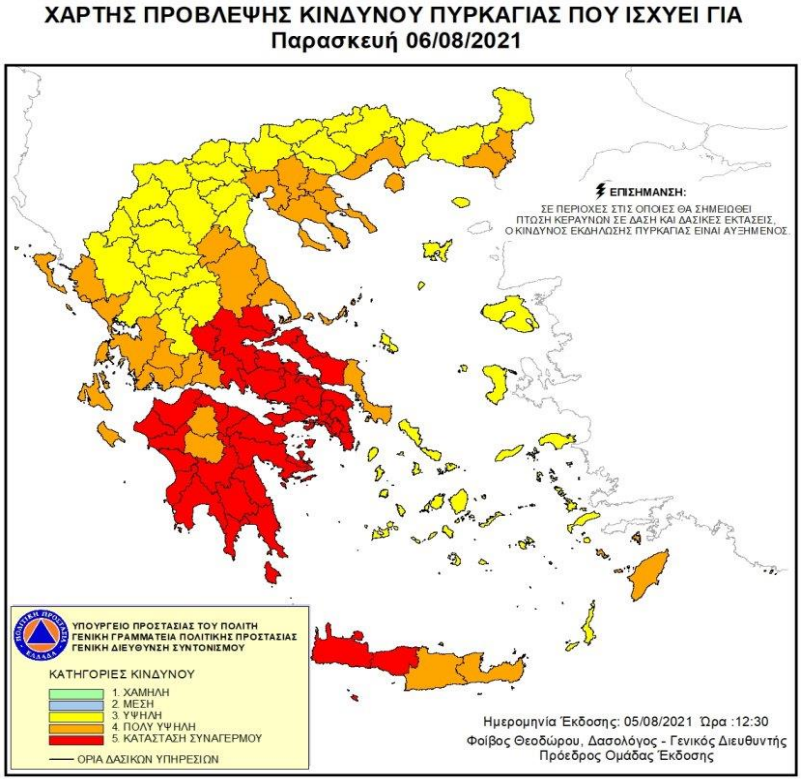

Figure 11. The Fire Risk Map of Greece for the 6th of August 2021 (Source: General Secretariat for Civil Protection, Greece) [38]

A daily Fire Risk Map is prepared by the General Secretariat for Civil Protection, Greece and is available to the public during the whole fire-season in order to be informed for possible high wildfire risk conditions and severity of the situation. Figure 11, presents the Fire Risk Map of Greece for the 6th of August 2021; the red color represents very high wildfire risk, categorized as 5, in a scale from 1 to 5 [38].

With the aforementioned early warning tools people and especially the residents of the WUI areas can be aware of avoiding any actions that may lead to a fire ignition by negligence, or they can be alerted for direct actions in case a wildfire occurs nearby their houses, following the respective national protection guidelines; an example of such guidelines is given in Figure 12.

Figure 12. Guidelines of protection for the public against various hazards (Source: General Secretariat for Civil Protection, Greece) [36]

In regard to the smoke produced in wildfires it seems that the best way for someone to be protected against the possible harmful effects of wildfire smoke is to do whatever is feasible in order to reduce exposure. In paragraphs 2.2 and 2.3

of this document the possible health impacts due to wildfire smoke exposure have been addressed, focusing also in the case of co-existence with dangerous viruses like SARS-CoV-2.

According to the guidelines entitled “Wildfire Smoke and COVID-19” that have been recently released by the Centers for Disease Control and Prevention [39], the best practice in reducing someone’s smoke exposure amidst COVID-19 pandemic, is for example, by looking for cleaner air shelters and/or air spaces. Moreover, limiting outdoor exercise when it is smoky or choosing lower-intensity activities to limit the smoke exposure is also a way of protection. It should be mentioned that due to the physical distancing guidelines that came into force during the pandemic, finding cleaner air might be more difficult if public facilities, e.g. libraries, shopping centers or malls are closed or have restricted capacity [39]. These guidelines should be seen combined with the ones that are also available by the Environmental Protection Agency (EPA, U.S.) for reducing airborne transmission of COVID-19 [40] and under the framework of what the World Health Organization suggests for COVID-19 protection [8].

Based on the work entitled “Defence of Villages, Farms and Other Rural Assets against Wildfires, Guidelines for Rural Populations, Local Communities and Municipality”, prepared by EUR-OPA, a number of tips are proposed for reducing indoor exposure to wildfire smoke (Figure 13), in case evacuation is not yet judged necessary by the stakeholders and someone is waiting for the official instructions, e.g. via the emergency messages sent by the European Emergency Number 112.

These tips are summarized as follows [32]:

- *“If you do not have a smoke mask, breath through a handkerchief to help filter smoke.*
- *Stay inside with windows and doors shut and use wet towels to prevent smoke insertion from outside through the openings.*
- *Use the recycle or recirculation mode on the air conditioner in your home or car, so that no smoke can enter from outside.*

- *Avoid cooking and vacuuming. They can increase pollutants indoors.*
- *People with health problems should be especially careful, avoid intense physical activity and should use handkerchiefs for breathing all the time.*
- *Consult your doctor if you have chest pain, chest tightness, shortness of breath, or severe fatigue. This is important for people with chronic lung or heart disease and for people who have been previously diagnosed with such diseases.*
- *Keep airways moist by drinking lots of water. Breathe through a warm, wet washcloth to help relieve dryness."*

Figure 13. Reducing indoor exposure to wildfire smoke: Keep the windows and doors closed and prepare breathing protection [32]

It should be highlighted though that cloth masks used to slow the spread of COVID-19 cannot protect someone from wildfire smoke [39]. This is because they cannot filter the fine, $PM_{2,5}$, PM_1 and ultrafine particles ($PM_{0,1}$) that are considered the more hazardous ones, as thoroughly described in paragraph 2.2. However, N95 and KN95 respirators can provide protection from wildfire smoke and from getting and spreading COVID-19 [39].

✓ *Step 3. Get involved: Taking actions*

The development of effective Disaster Risk Reduction (DRR) strategies is certainly an issue of concern and responsibility of the relevant authorities. However, the grade of success in DRR plans is directly correlated with the interaction of the stakeholders with the community itself, meaning that citizens may also need to get involved and take actions. Here are some indicative steps towards this direction:

- Citizens' active role in risk reduction campaigns/exercises without exclusions.
- Involvement especially of young people in DRR.
- Volunteerism and participation in Forums.
- Reaching the outcomes relevant EU-projects' outcomes.

A disaster risk management policy, including measures for reducing the risk and for mitigating the emergencies may strengthen the local capacity. Organization of relevant informative campaigns and exercises, especially for the people who live in the WUI areas may reinforce community resilience. Under the perspective of "Living no-one behind", this type of initiatives should be aligned with inclusive criteria; this issue will be argued in paragraph 3.3.

In the above context, focusing on the young people can potentially increase the coping capacity of a community. Investment in building fire safety culture of young people now, may lead to adults ready to response upon emerging risks in the future. Hence, raising awareness and training of students of elementary or secondary schools, as well as of young people, towards involvement in DRR actions may strengthen community resilience.

A characteristic example of young's people involvement in "Understanding Disaster Risk" is the European and Mediterranean Major Hazards Agreement (EUR-OPA) Olympiad, organized in the context of the BeSafeNet project (Figure

14); Secondary schools from the member states of EUR-OPA take part annually in a competition on “Better knowledge against disasters” and the three winners get a prize. This competition offers the students a chance to consolidate their knowledge on natural and technological hazards that they could face inside or outside of school. The aim is also to promote among young people adequate behavior in risk situations in order to reduce the potential disaster impacts [41].

Figure 14. The European and Mediterranean Major Hazards Agreement (EUR-OPA) Olympiad, is organized annually in the context of the BeSafeNet project, with the participation of Secondary schools from the member states [41]

Volunteerism and participation to “active citizens” forums” is also a way of community engagement towards local capacity building and disaster risk reduction. In the following, there is an indicative list of European Projects that their outcomes could be useful for the interested parties:

- ***CUIDAR***: Cultures of Disaster Resilience Among Children and Young People [42].
- ***I-REACT***, Improving Resilience to Emergencies through Advanced Cyber Technologies [43].

- ***RESISTANT***, Training and Knowledge Sharing Platform for First Responders and Educational Tools for students' and citizens' awareness and preparedness against Natural and Manmade Disasters and Risks [44].
- ***beAWARE***, Enhancing decision support and management services in extreme weather climate events [45].

3.3 Reducing Vulnerability through Inclusive Community Engagement

Vulnerability of individuals, communities and the environment is a critical parameter as regards to the exposure to disaster risks that generally reduces resilience; though, such risks do not have the same impact for anyone.

Considering the previous paragraph, it appears that the challenge for an inclusive community engagement in order to increase resilience is how to smoothly integrate different groups of population, including the more vulnerable ones, in the DRR policies in order to reduce the respective impacts.

3.3.1 Vulnerability of populations

The term vulnerability, according to the UNDRR, is directly correlated with the coping capacity of people, organizations, or systems, meaning the ability of using available skills and resources, to manage adverse conditions, risk or disasters (see the glossary of terms).

A number of vulnerability indicators have been recorded in literature in order to take them into consideration during the risk assessment procedure for people with vulnerabilities, or people who may become vulnerable, under the framework of an effective local response [46]. Based on the findings of the same work, the proximity of population to an event, i.e. the lack of warning or of understanding to an event, are considered crucial factors of vulnerability.

The World Health Organization (WHO) defines that vulnerable groups include children, pregnant women, the elderly, malnourished, and people who are ill or immunocompromised [47], whereas the Council of Europe, considers as vulnerable groups the people with disabilities, the migrants, the asylum seekers, the refugees and children, who are considered particularly susceptible upon disasters [48]. In the following paragraph, the interest will be focused on the people with disabilities.

3.3.2 People with Disabilities in Disasters

People with disabilities are at significant risk in case of a disaster, since they often lack access to inclusive disaster risk reduction information or guidelines. As a result, a significant number of casualties has been recorded in a global basis, e.g. according to a study, between 1970 and 2010, 1.7 million deaths were reported in the region of Asia Pacific [49].

Based on a survey conducted by the United Nations, over 5.500 people with disabilities have been questioned from 126 different countries and it came out that the 71% had no personal preparedness plan for disasters; 31% referred that had someone to help them evacuate, while the 13% answered that they never had anybody to help them [50].

Taking into consideration the multi-hazard concept it seems vital to include people with disabilities in the disaster management cycle in order to confront multidisciplinary problems, like the COVID-19 pandemic. It is important to mention that disabilities can be found in various types, such as mobility and visibility impairment, speech or hearing impairment, cognitive impairment, as well as the so called “invisible disabilities” or hidden disabilities, like asthma, diabetes allergies, or other diseases [51].

Focusing on the current pandemic, the Council of Europe, released in 2021 a working document entitled “Disabled persons in viral pandemics: the example of Covid-19” [52]. According to this work, engaging persons with disability and their

representatives into planning the pandemic response is vital; as in any other disaster, people with disabilities should not be considered as a “category”, but should be treated as individuals with specific needs, based on the type of impairment.

3.3.3 Early Warnings and Accessible Broadcasting

Early warning systems can be proved substantial for hazards monitoring, forecasting and prediction, enabling individuals, communities, governments and the relevant parties to take timely action for reducing disaster risks in advance of hazardous events, according to the UNDRR (see the glossary of terms).

However, the key of early warning for effective emergency management is the communication of information to the different receptors. In that framework, access to information, in terms of inclusive information broadcasting is a fundamental right of all the people and should be part of disaster risk management policies.

According to the National Fire Protection Agency, USA (NFPA), in case of an emergency situation where the evacuation of a building is necessary, there are some vital questions that have to be easily answered by all residents, including people with disabilities [53]:

- “*Is there an emergency?*
- *What is the emergency?*
- *How to respond to the emergency?*
- *Where is the way out?*
- *How can I move to a safe place? Alone, or assisted?”*

Hence, the communication modalities that the emergency messages are provided should be seen under an inclusive risk communication framework.

Early Warning Systems that are "people-centered" can empower individuals and communities, including also people with disabilities to act in sufficient time and in an appropriate way so that to reduce the possibility of personal injury, loss of life or property damage, e.g. the Community Early Warning Systems (CEWS) that are developed in the local communities and are managed by them [12].

3.3.4 Building an inclusive fire safety culture: Personal Emergency Evacuation Plan (PEEP)

Considering the above paragraphs it appears that targeted response plans for people with disabilities is crucial for strengthening their coping capacity. It should be mentioned that such plans need to be adjusted to the specific needs of each individual, per category of impairment.

Guidelines on how to prepare a *Personal Emergency Evacuation Plan (PEEP)* for people with disabilities has been proposed by the National Fire Protection Agency (NFPA). This PEEP for disabled people is considered quite new relevant to the ones that also exist in UK, or Australia [51, 53].

As presented in a recent EUR-OPA work, entitled “Evacuation planning of Critical Infrastructures in case of an Earthquake or a Fire for people with disabilities”, a PEEP can generally be used as a tool for fire emergency preparedness and response of a disabled person (Figure 15); though its effectiveness needs contribution and training of both, people with disabilities and the personnel involved in the evacuation exercise [51]. Participation of people with disabilities in emergency exercises, if allowed by their physical condition and well - being, is suggested especially for those living in the WUI areas.

Figure 15. A Personal Emergency Evacuation Plan (PEEP) is necessary for anyone who needs assistance when leaving the building in an emergency [54]

Moreover, people with disabilities, older persons and their families need to prepare a Personal Disaster Preparation Kit (Figure 16), so that they limit their dependence on others in case of an emergency.

Figure 16. Personal Survival Kit [49]

According to the Guidelines on Inclusive Disaster Risk Reduction prepared by The Global Alliance on Accessible Technologies and Environments (GAATES) in collaboration with the Asia Pacific Broadcasting Union and the Asia Disaster Preparedness Centre, the personal survival kit should include [49]:

- "*A communication plan: a mobile phone, a flag or personal alarm or sign to alert people that help is needed.*

- *A list of emergency contacts of family and friends who will check on them and will provide assistance if necessary.*
- *Medical supplies and a supply of personal medications.*
- *Water, matches, a battery-powered flashlight and dried food supplies.*
- *Blankets and extra clothing.*
- *Tools and extra mobility devices, personal items such as hearing aid batteries."*

Figure 17. Guidelines for Preparing the emergency kit and safety network of vulnerable groups like people with disabilities
(Source: General Secretariat for Civil Protection, Greece) [36]

An indicative example of guidelines for preparing the emergency kit and safety network especially for vulnerable groups, like people with disabilities, is also presented in Figure 17 [36].

4. Case study: Wildfire at the Greek island of Rhodes during the Summer of 2021 and Evacuation of the “Valley of Butterflies”

Chapter 4 of this work presents the Case Study of a wildfire event that occurred in the Rhodes Island, Greece during the summer of 2021 amidst COVID-19 pandemic crisis. Due to this wildfire the “Valley of Butterflies” had to be evacuated for precautionary reasons. The “Valley” is known worldwide as a shelter for unique butterflies’ species especially during summer, hosting every year a huge number of visitors and tourists. The data file of this wildfire event has been prepared, including geographical, vegetation – land use and meteorological data, as well as the resources used for suppressing the fire.

4.1 “The Valley of Butterflies” in the Rhodes Island

On the western side of the island of Rhodes is situated the “Valley of the Butterflies”, also known as “Butterflies Valley” (Petaloudes in Greek). Every year, especially during summer, it attracts a huge number of visitors and tourists (Figure 18).

Figure 18. The “Valley of Butterflies” in the Island of Rhodes, Greece [55]

Figure 19. Unique butterflies' species can be found in the "Butterflies Valley" of the Rhodes Island in Greece [55]

During August, swarms of butterflies move to the "Butterflies Valley" to find a less hot place in order to reproduce (Figure 19).

4.2 Wildfire Event in the Rhodes Island on the 1st of August 2021: Data file

In this paragraph, different type of data relevant to the wildfire event that took place in the Rhodes Island on the 1st of August 2021, threatening the "Valley of Butterflies", are provided. In a previous work implemented by the European Center for Forest Fires [23], a similar data file of a fire event in Peloponnese, Greece which took place on the 23th and 24th of August 2007, was prepared. Both data files might be used for developing guidelines, as well as for improving tactics and enhancing strategies.

4.2.1 Geographical Data

The island of Rhodes is 79.7 km (49.5 mi) long and 38 km (24 mi) wide, with a total area of approximately 1,400 square km and a coastline of approximately 220 km. The geographical coordinates given by the World Geodetic System are, Latitude: 36°26′26″ N, Longitude: 28°13′21″ E, Elevation above sea level: 29 m. Figure 20, shows Rhodes Island topographic map.

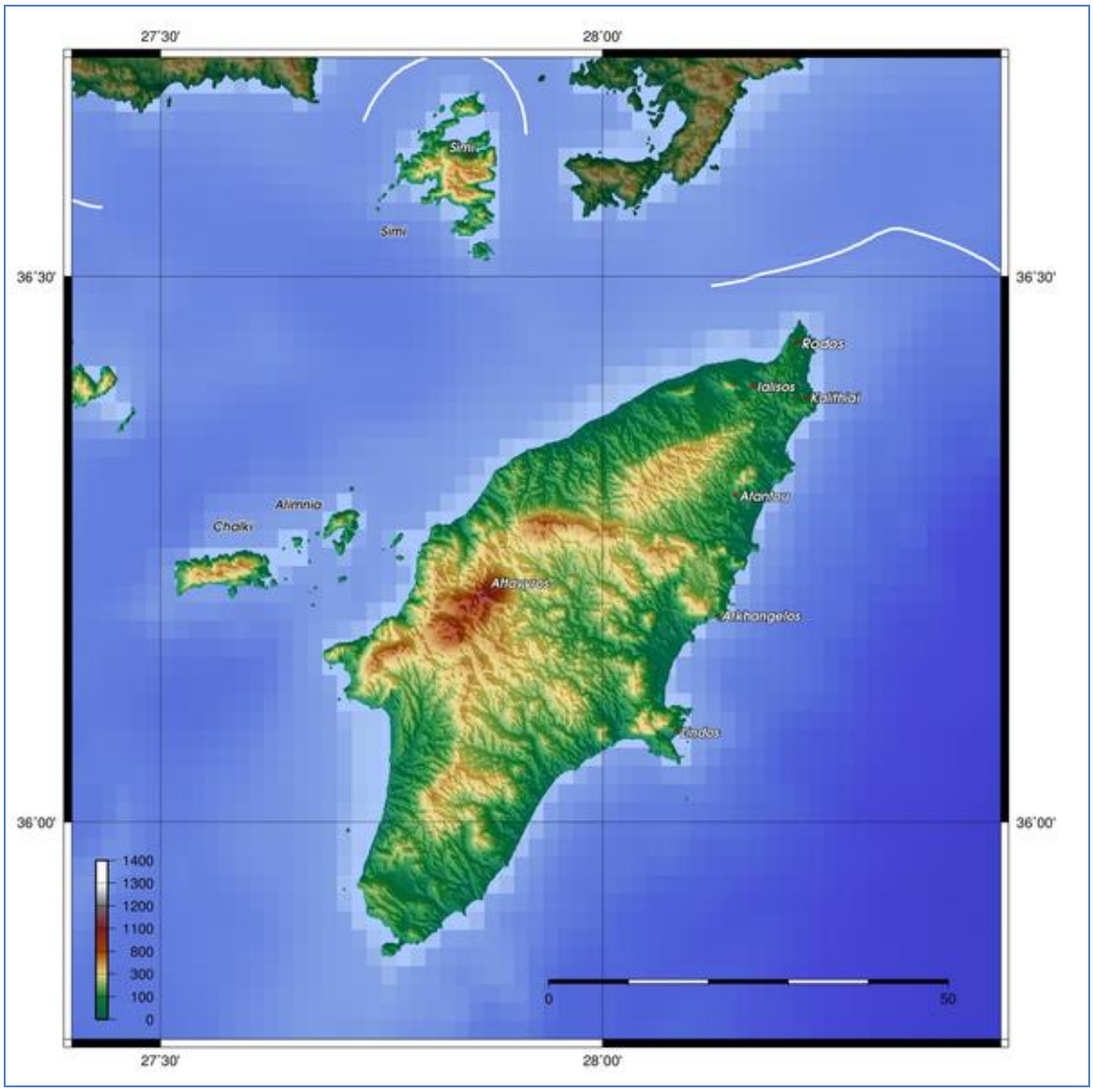

Figure 20. Topographic map of Rhodes Island in Greece (Rhodos topo.png)

In Figure 21, the wetland called "Butterfly Stream" is distinguished by the polygon in yellow [56]. The wetland is part of NATURA 2000 protected area with code GR4210006, named "Rhodes - Prophet Elias - Seven springs - Butterflies - Streams" [57].

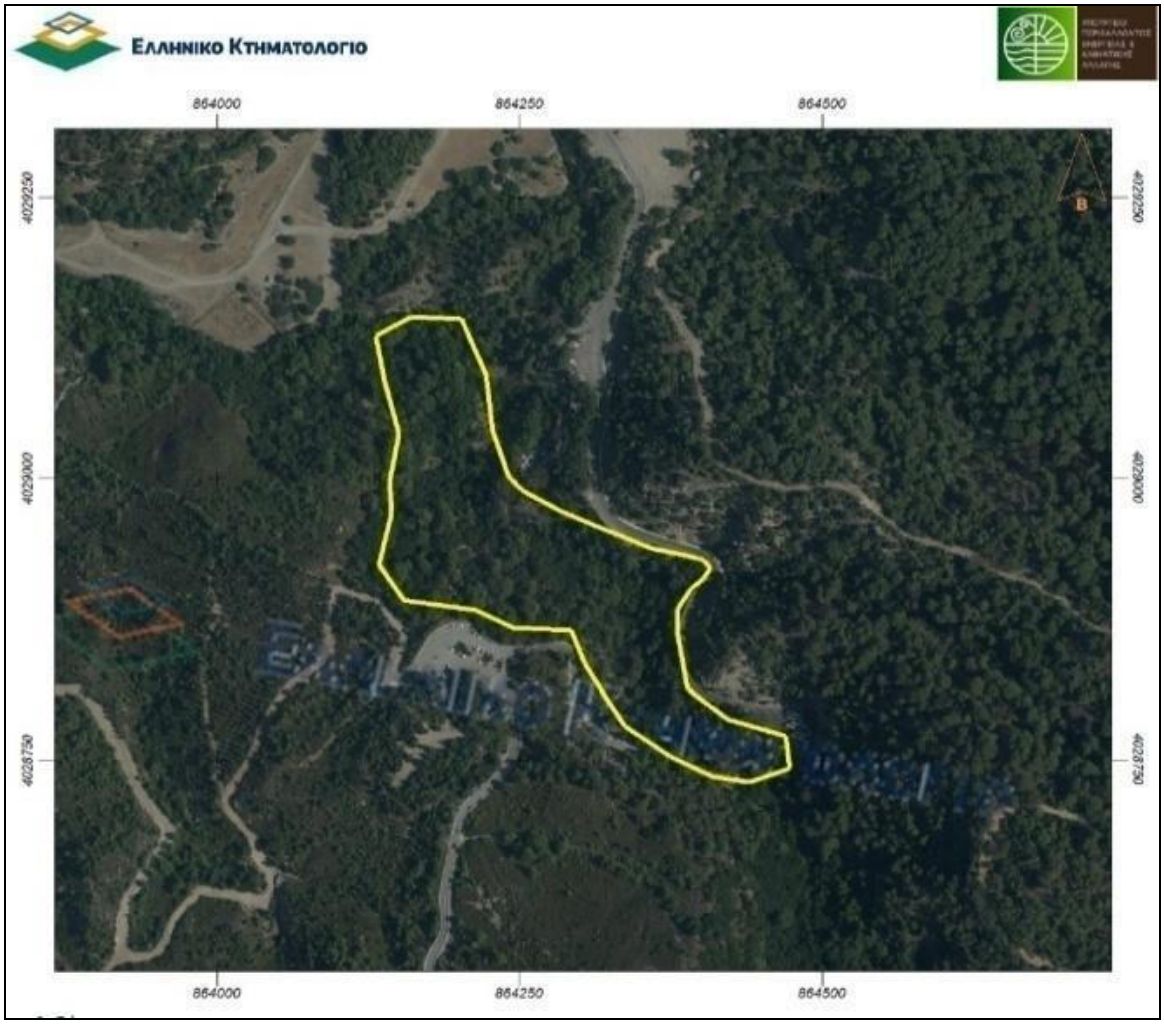

Figure 21. The wetland of "Butterfly Stream" in Rhodes Island is distinguished by the polygon in yellow [56]

Figure 22, provides with the map by EMSR526 Copernicus Emergency Management Service, marking the area affected by the fire; the "Valley of Butterflies" is indicated [58].

Figure 22. A fire burst out in the Rhodes island of Greece on the 1st of August 2021, according to EMSR526 Copernicus Emergency Management Service; the area affected by the fire is indicated in the map, together with the position of the "Valley of Butterflies" [58]

4.2.2 Vegetation - Land use Data

The major part of the Rhodes Island is covered by pine forests and other vegetation spices. More specifically [59]:

- The sparse pine forests cover an area of 347,000 acres.
- The bushy areas with a strong and frequent presence of young tracheae pine cover about 270,000 acres.
- The other agricultural areas cover about 267,000 acres.
- Grassland areas cover about 157,500 acres.
- The bushy areas cover about of 105,000 acres.
- The dense forests of rough pine cover an area of 94,000 acres.

- The extensive areas of olive groves cover 71,500 acres.
- The vineyards cover an area of 8,300 acres.
- The cypress trees cover an area of 6,000 acres.
- The fruit trees cover an area of 5,900 acres.

Concerning the building environment, the structured areas and settlements cover more than 25,000 acres.

From the above, it appears that from the total area of the island (1,410,000 acres):

- 58 58% is covered with forests and forest areas
- 28% is covered with agricultural lands and crops of various species, and
- 12% is covered with grasslands, barren and low bush areas.

.

It has to be noted that pine trees are considered extremely flammable and that high load of thermal radiation is released during their combustion [60].

The total burnt area at Psinthos during the wildfire in Rhodes Island as recorded by the EMSR526 Copernicus Emergency Management Service on the 2nd of August, was about 2.900 acres, including forests, heterogeneous agricultural areas, shrub and/or herbaceous vegetation and other [58].

4.2.3 Meteorological Data

Rhodes has a long, dry, hot-summer with mild winters which is common for the Mediterranean Basin.

It should be mentioned that the summer of 2021 was one of the hottest and driest of the recent years, not only for Greece but for many Mediterranean Countries and other countries worldwide. According to Figure 1, the final days of July and early August of 2021 were some of the most intense in terms of heat recorded in Europe; temperatures reached the 40 °C or 45 °C.

Based on the meteorological data recorded at the Center of Rhodes between 24/7/2021 to 1/8/2021 (Table 1), it seems that the prolonged high temperatures and the low relative humidity had contributed to significant reduce of the vegetation moisture content, making them flammable; it is noted that on the 1st of August the wildfire burst out near the "Valley of Butterflies".

Table 1. Temperature and Relative humidity data recorded at the Center of Rhodes between 24/7/2021 to 1/8/2021 (Source: National Observatory of Athens)

Date	Average Temperature (^{0}C)	Maximum Temperature (^{0}C)	Maximum Relative Humidity	Minimum Relative Humidity
24/7/2021	27.1	29.7	73	54
25/7/2021	27	31.1	81	53
26/7/2021	27.7	30.9	80	48
27/7/2021	29.3	33.7	69	41
28/7/2021	30.8	34.3	73	33
29/7/2021	31	35.4	72	35
30/7/2021	31.6	35.8	55	32
31/7/2021	32.5	37.1	51	29
1/8/2021	32.3	36	56	31

In Table 2, the data relevant to the wind intensity and direction are provided, as recorded on the 1st of August by a local station situated at the airport of Rhodes, close to the affected area of the "Valley of Butterflies".

Table 2. Wind intensity and direction recorded on the 1st of August by a local station situated at the airport of Rhodes, nearby the affected area of the "Butterfies Valley".

Year	Month	Date	Time (Local)	Direction (^{0})	Intensity (Beaufort)	Max Intensity during 3-h (Beaufort)
2021	8	1	09	Southwest	3	3
2021	8	1	12	Southwest	3	4
2021	8	1	15	Southwest	4	5
2021	8	1	18	Southwest	4	5

It should be stated that the factors of the wind and the flammability of vegetation significantly affect the expansion and scale of a wildfire.

4.2.4 Fire Danger Map

A very high fire risk (category 4, highest category 5) was expected on Sunday, 1st of August in Rhodes according to the fire risk forecast map issued by the General Secretariat for Civil Protection (Figure 23); the Rhodes Island is colored with orange.

The risk of fire was also at category 4 for the next day of the wildfire, on the 2nd of August, not only for the Rhodes Island but for the majority of the Greek territory (Figure 24).

The two fire risk maps are indicative of the emergency situation that Greece was at that period of time concerning the wildfire risk.

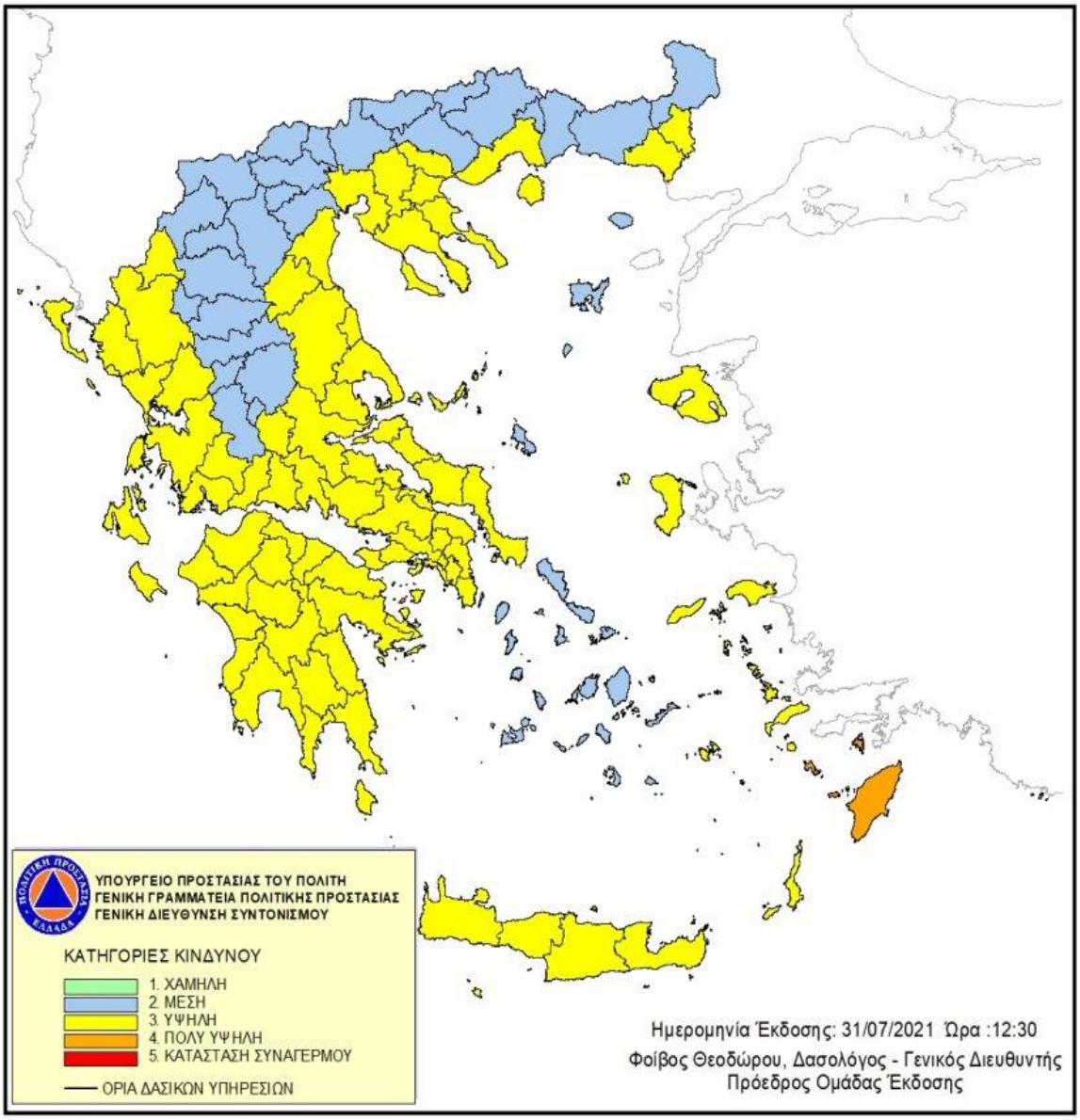

Figure 23. A very high fire risk (category 4) was expected on the 1st of August Rhodes according to the fire risk forecast map issued by the General Secretariat for Civil Protection; Rhodes Island is colored with orange (Source: General Secretariat for Civil Protection, Greece) [38]

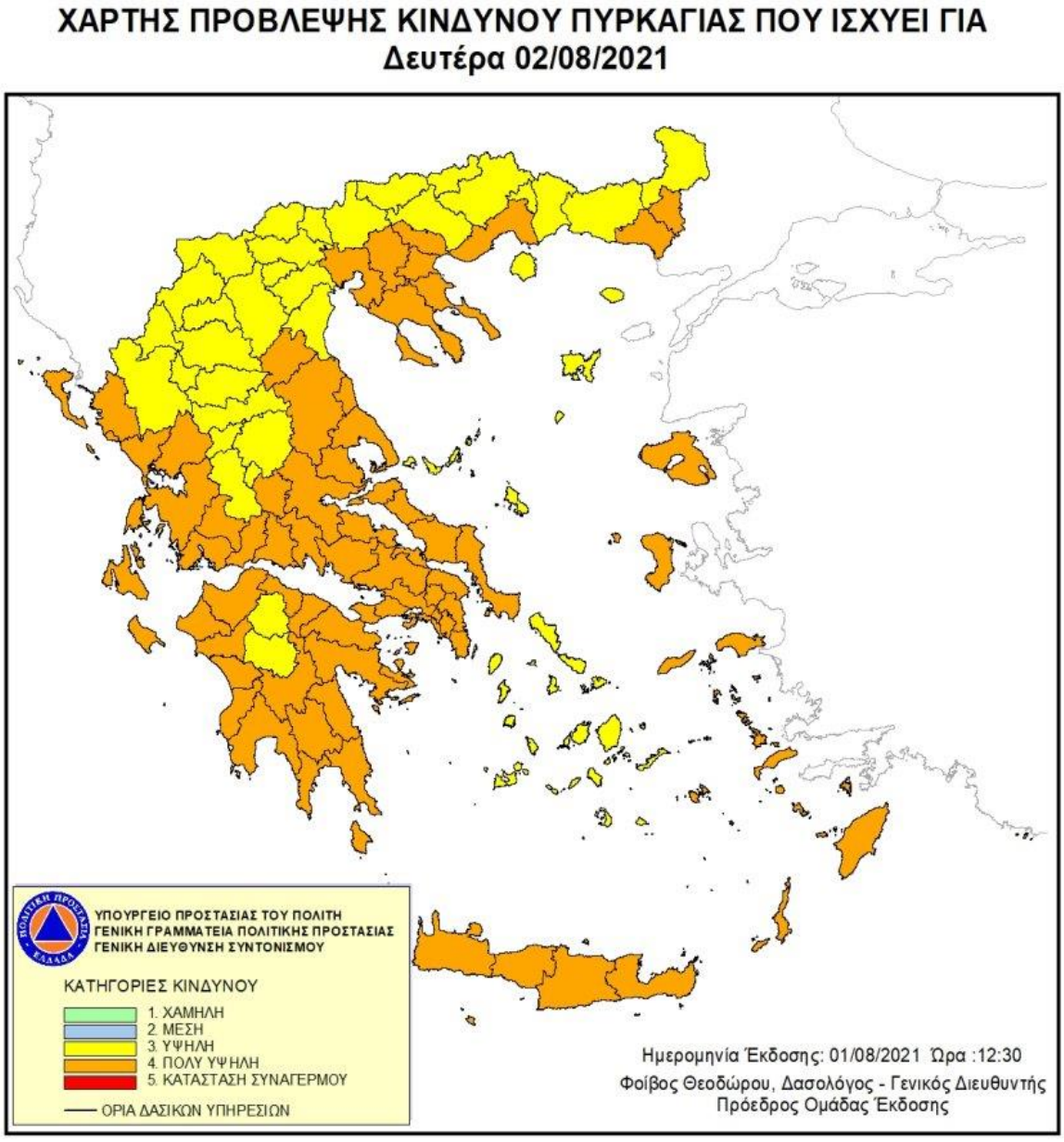

Figure 24. A very high fire risk (category 4) was expected on the 2st of August Rhodes according to the fire risk forecast map issued by the General Secretariat for Civil Protection; Rhodes Island and the majority of the Greek territory is colored with orange (Source: General Secretariat for Civil Protection, Greece) [38]

4.2.5 The timeline of the Wildfire Event – Evacuation of the "Valley of Butterflies"

According to the Copernicus Emergency Management Service [58], on the 1st of August 2021, at 17:38 local time a fire was initiated in the Rhodes Island, which is situated in the North Aegean District of Greece. The wildfire spread, burning down large forest and rural areas.

Psinthos village and the "Valley of Butterflies" (Figure 22) have been evacuated for precautionary reasons; the same for a nearby military campus at Kalamonas area. Due to the wildfire's intensity, the half of the island of Rhodes stayed without electricity power for many hours on Sunday, 1st of August [61].

Figure 25. A wildfire burst out on the 1st of August 2021 in the Rhodes Island; the "Valley of Butterflies" was evacuated for precautionary reasons (Photo Credits: Civil Protection at Municipality of Rhodes)

Specifically, the "Valley of Butterflies" has been evacuated by local visitors and tourists because the direction of the fire front at that time was towards the

"Valley" area; the fire front appeared to be quite dangerous (Figure 25) due to the intensity of the winds that prevailed, combined with the high temperatures and the low relative humidity of the previous days (see Tables 1 and 2).

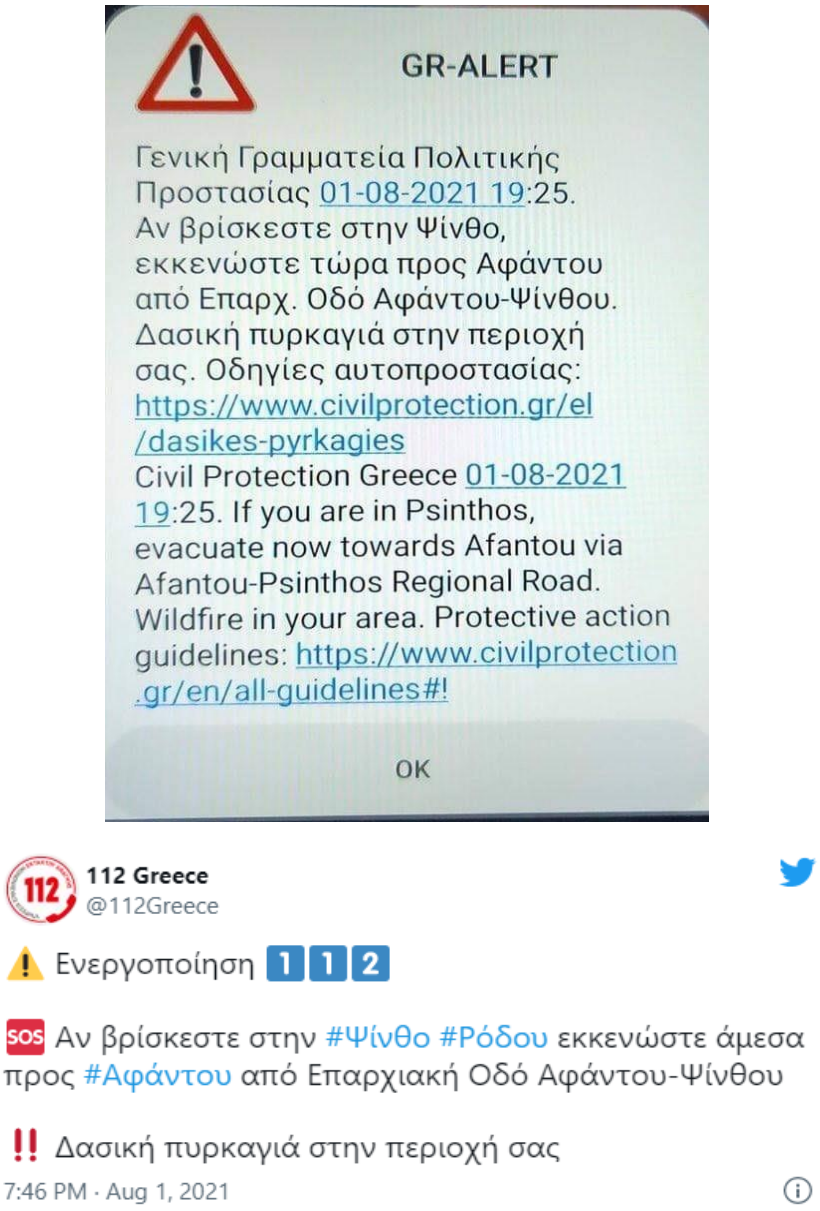

Figure 26. The European Emergency number 112 has been activated by the General Secretariat for Civil Protection on the 1st of August 2021 in the Rhodes Island; a warning message was sent to the people at the affected areas [61]

Due to the emergency situation, about two hours after the fire ignition, emergency messages were sent via the European Emergency number 112 by the General Secretariat for Civil Protection to the people that were close to the affected areas, so that to warn them about the wildfire and guide them on how to evacuate towards safe places (Figure 26).

Figure 27. Satellite image by NASA/NOAA showing the smoke dispersion due to the wildfires recorded on the 1st of August 2021 focusing on the Rhodes Island.

It should be mentioned that significant quantity of smoke was produced that was visible by NASA/NOAA satellites (Figure 27) resulting to reduced air quality. In Figure 28, the smoke haze is clearly seen over the city of Rhodes.

Figure 28. The smoke haze over the city of Rhodes due to the wildfire of the 1st of August (Photo Credits: Civil Protection at Municipality of Rhodes)

The possible health effects due to the wildfire smoke exposure are presented in paragraph 2.2. The wildfire event in Rhodes burst out during the COVID-19 pandemic, hence a potential additive or synergistic effect of both hazards had to be considered.

Foreign and local visitors of the “Butterflies Valley” evacuated the area with the help of the well trained fire safety personnel of the “Valley”, who guided the people to safe places under the general instructions by the competent local authorities. Protective masks were used by the majority of the evacuees due to the COVID-19 situation.

The evacuation of the “Valley” was decided early enough, not only due to the possible threat of the wildfire burning at the nearby Psinthos village, but also due to the dense smoke produced which affected the whole area (Figures 22, 27).

It should also be mentioned that the evacuation of the “Valley of Butterflies” was implemented according to a specific fire safety plan that was available prior the wildfire (Figure 29). A number of fire prevention measures were also taken before the opening of the “Valley” at the beginning of the touristic period;

cleaning the “Valley’s” surroundings from dead fuel vegetation and relevant preventive measures.

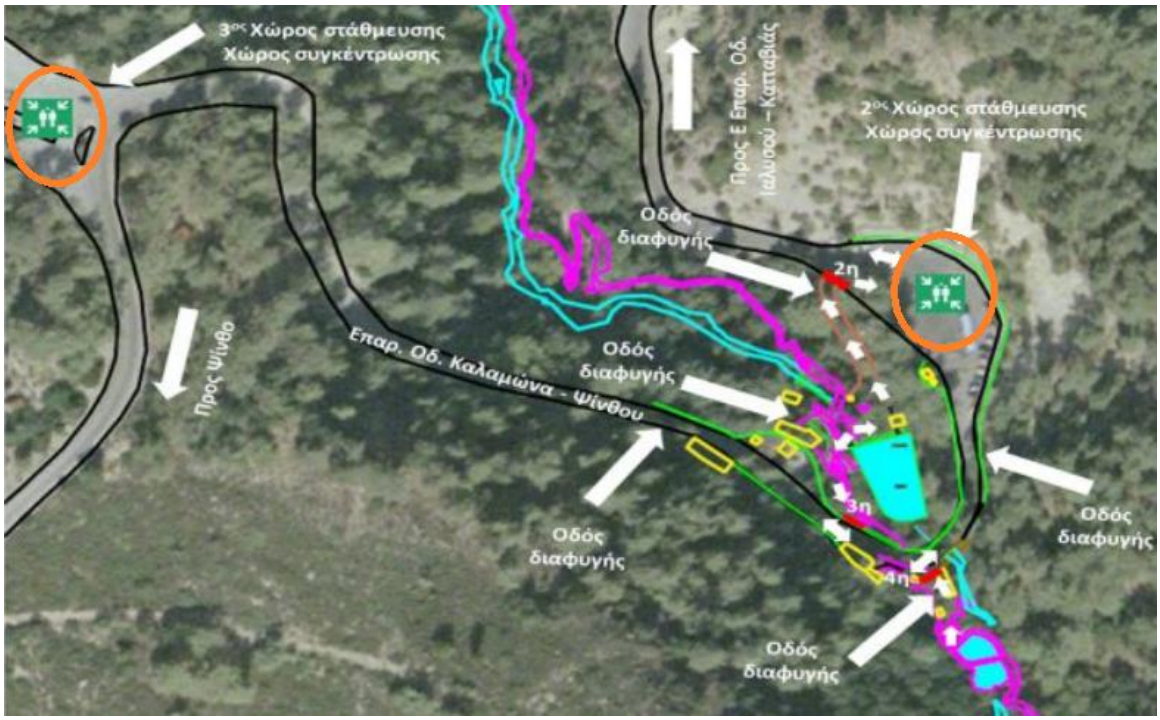

Figure 29. The evacuation of the “Butterflies Valley” on the 1s of August was conducted based on a specific Fire Escape Plan; the white arrows indicate the escape routes, while the instant shelters are shown in orange circle (Credits: Civil Protection at Municipality of Rhodes, Fire Safety Plan of the “Valley of Butterflies”)

Moreover, the “Valley” is equipped with its own exterior fire sprinkler system situated at the perimeter. Based on the Fire Risk Map of the 1st of August that was issued by the General Secretariat for Civil Protection on the 31/7/2021 (Figure 23), the fire safety team of the “Valley” was instructed by the local Civil Protection authority to use the fire sprinkler system on the 1st of August for prevention, due to the very high fire risk; they sprinkled the area frequently during the whole day, starting from early in the morning.

4.2.6 Operational sources used

According to the Greek Fire Service, 103 firefighters with 20 vehicles were operating in the area, assisted by 6 ground force group, six (6) helicopters and three (3) planes [58]; the Beriev-200 plane that was sent for reinforcement to Greece by Russia is shown while operating in the Rhodes wildfire on the 1st of August in Figure 30.

Figure 30. The Beriev-200 plane that was sent for reinforcement to Greece by Russia was used for the wildfire suppression at the Rhodes Island in the 1st of August 2021 [61]

The work of the fire brigade was supported by many volunteer firefighters, the army and local authorities [61].

5. Lessons Learned

Chapter 5, aims to summarize what has been argued in the previous Chapters, concerning the multi-hazard risk approach and the role of community engagement as substantial elements of effective emergency management, having as a reference the experiences obtained during a recent wildfire event amidst pandemic crisis; namely, the evacuation of the “Valley of Butterflies” in the Rhodes Island on the 1st of August 2021.

The lessons learned are drafted as follows:

1. Management of Complex Emergencies

In case of complex emergencies like the one during the Rhodes Island wildfire amidst the pandemic, it seems that there is a need of prioritization of risks. Specifically, in our case study the population needed first of all to be safely transferred and gathered to the respective refuge areas in order to be secured upon the wildfire threat. However, due to the pandemic they also needed to wear protective masks and keep the safe distances based on the specific hygiene protocols. It appears that during a complex emergency there is a need of a ***“risk triage”*** in order to confront the various multiple threats, giving priority each time to the most intensive one; multi-hazard risk assessment.

It should also be mentioned that during the Rhodes wildfire the total assessment of health risk had to be conducted by considering both the exposure to the wildfire smoke and the possible COVID-19 health impacts, as described in paragraph 2.3.

2. Inclusive Risk Communication - Early Warning Systems

Risk communication generally includes the range of communication capacities required via the preparedness, response and recovery phases of a major event, so that to strengthen coping capacity of the community involved. Specifically for

the Rhodes' wildfire, the "Valley of Butterflies" is considered a very attractive sightseeing for many native or foreign visitors and tourists from all around the world. Hence, the means and modalities of risk communication that need to be selected for a place like that are crucial, so that the emergency messages to be accessible for all and at due time. During the evacuation of the "Valley of Butterflies" a loud speaker system was used for the early warning of all the visitors of the "Valley", providing them with specific instructions on how to reach safe places. Specifically, the emergency messages were transmitted in three different languages. At the same time, members of the well-trained personnel of the "Valley" were standing at critical sites of the "Valley" for guiding the people towards the refuge areas, ready to give them instructions in various languages if needed.

In general, accessible broadcasting is vital especially for the more vulnerable ones, e.g. the people with disabilities or people with difficulties like the older ones, as documented in paragraph 3.3. Early Warning Systems that are "people-centered" can empower individuals and communities, including also people with disabilities to act in sufficient time and in an appropriate way so that to reduce the possibility of personal injury, loss of life or property damage. Access to information, in terms of inclusive information broadcasting is a fundamental right of all the people and should be part of disaster risk management policies.

3. Community Engagement - The Role of Volunteers

As thoroughly described in Chapter 3, empowerment of community engagement is the disaster management cycle is vital for reinforcing sustainable community resilience. Due to the emerging risks like the recent viral pandemic, the need of active citizens' role seems more urgent than ever. In this work, key steps towards enhancing community engagement are provided, focusing on preparedness and response upon "Wildfires and Wildfire Smoke impacts", specifically for the populations situated in the "Wildland Urban Interface" (WUI). Indicative tools and practices from around the world under the schema of "Get prepared", "Get

informed” and “Get involved”, are presented here for promoting public awareness and fire safety culture.

Based on the experiences of the recent wildfire in the Rhodes Island, which is considered a WUI fire, it proved that the involvement of the volunteers, such as the volunteer fire-fighters was really important for the early wildfire control and mitigation. It should be noted that since the electricity cut due to the wildfire had caused significant problems during the response phase, the role of the volunteers together with the rest of the fire-fighters was critical. However, it has to be emphasized that these volunteers have been officially trained by the relevant bodies like the Civil Protection authority, in order to avoid any possible accidents during the operation or to prevent any type of confusion in the emergency management procedure.

4. Vulnerability of Populations – Building Disaster Resilience through Inclusive Emergency Preparedness and Response

In general, the term vulnerability is directly correlated with the coping capacity of people, meaning the ability of using available skills and resources to manage adverse conditions, risks or disasters. In that context, the tourists or foreign visitors of the “Butterflies Valley” could be considered as a vulnerable group in case that early warning and understandable messages were not sent on-time to guide them during the evacuation. This is usually the case for the people with disabilities which make them vulnerable in an emergency; they often lack access to inclusive disaster risk reduction information or guidelines.

However, even if accessible broadcasting is available as previously referred, another important factor that affects in general the vulnerability of populations is the risk perception, in terms of how easy the people can understand the severity of an emergency situation, be persuaded and follow the instructions given by the competent authorities; e.g. evacuate a place or a building when in danger without any objection. Building a safety culture among the whole community is needed to

reduce any type of vulnerabilities; e.g. inclusive training upon disaster risks for enhancing peoples' risk perception, emphasizing on children and young people, as well as on people with disabilities considering the specific types of impairment.

In the above context, a policy shift towards inclusive engagement of the community in the preparedness and response seems crucial for building disaster resilience. Moreover, preparation of targeted response plans and implementation of inclusive evacuation exercises are considered quite important for building emergency preparedness and response of a community upon emerging risks.

5. Data Files of Wildfire Events

In this work, there was an attempt to gather a number of data regarding a wildfire event that took place in the Rhodes Island on the 1st of August 2021, threatening the "Valley of Butterflies"; namely, geographical, vegetation - land use and meteorological data, as well as the resources used for suppressing the fire.

Quality, accuracy and variety of data are the key elements for preparing prevention measures, for developing guidelines, as well as for improving tactics and enhancing strategies. Of course, more details on each type of data needs to be included, e.g. the terrain of burned areas, on-site environmental measurements, acute and long-term health impacts assessment, or other relevant data. In any case, data files can contribute to better organizing and managing the information relevant to big wildfire events, upgrading the future preparedness and response procedures.

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