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SafeGreece new technologies & civil protection

REGION OF CENTRAL MACEDONIA

Regional Development Fund of Central Macedonia

TEE | TKM

Natural Hazards Society

SafeThessaloniki 2022

new technologies & civil protection

29.09 – 01.10

Supported by:

HELLENIC REPUBLIC
Ministry for Climate Crisis and Civil Protection

ΠΕΡΙΦΕΡΕΙΑ ΚΡΗΤΗΣ
REGION OF CRETE

E.P.P.O
Earthquake Planning & Protection Organisation

Under the Auspices of:

REGION OF CENTRAL MACEDONIA

E.P.P.O
Earthquake Planning & Protection Organisation

CITY OF THESSALONIKI

proceedings

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about

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REGION OF CENTRAL MACEDONIA

TECHNICAL CHAMBER OF GREECE | SECTION OF CENTRAL MACEDONIA

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Under the auspices of:

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topics

Special Sessions

- **Geohazards with emphasis on cascading effects,** e.g. earthquakes-tsunamis, earthquakes-landslides etc.
- **COVID-19:** studies, actions, best practices, consequences, challenges
- **Multi-hazard Crisis Management**
- **Prediction and Forecasting / Early Warning Systems:** (meteorology, climate change, earthquakes, tsunamis etc.): technology, applications, crisis management, methods, success-stories, lessons learned, social dimensions
- **Standardization**

Regular 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
- **Marine, Road, and Air Accidents:** Prevention and management, lessons learned
- **Innovative technology and methods** on disaster study, prevention and management (Decision Support Systems, 3D-Printing, Artificial Intelligence, Applications, Remote Sensing etc)
- **Climate Change/Crisis** and its impact on the environment and human communities
- **Human Activity** and its impact on Natural Phenomena (Hydrocarbon Research, Mining etc)
- **Biodiversity:** the impact of Climate Change/Crisis and destructive Phenomena on Biodiversity
- **Security:** Critical Infrastructure protection from malicious actions, terrorist acts management, Cyberprotection
- **Crises Management Issues**

- **Institutional & Legislative Framework** for Civil Protection
- **Training:** to citizens, volunteers, teachers, students, staff
- **Search & Rescue, Humanitarian Aid**
- **Civil Protection & Media:** Information dissemination and interactions between the stakeholders and the media
- **Civil Protection - Insularity - Tourism**
- **Civil Protection & People with Special Needs / Third Age**
- **Civil Protection & Cultural Heritage**
- **Volunteering: Role, Work, Institutional Framework, Challenges**
- **Economic dimension of disasters, crises, prevention**
- Civil Protection & **GDPR** (EU General Data Protection Regulation)
- **Cross-border dimensions: International, European and Mediterranean Programmes & Civil Protection Synergies**

thanks to:

Profile

Satways Ltd. is a privately held organization founded in May 2006 and is based in Athens, Greece. The company is dedicated to develop integrated Geospatial command and control solutions for Security and Public Safety applications for police, coast guard, emergency medical service, civil protection and fire & rescue operations, critical public infrastructure protection, transportation security and border monitoring.

With core technology built on open standards, we offer an unmatched range of mission critical enterprise solutions empowering governments and businesses around the world to make better and faster operational decisions.

Our product line includes C2 and C3I enterprise software packages that respond to different operational requirements of Public Safety Agencies such as Distributed Geospatial Data management, Operational Resources Tracking, Incident Management and dispatch, Physical Security Information Management and Natural & Technological Hazards Crisis Management respectively. The common goal though, is to provide effective decision support, to simplify operations, to provide a Common Operational Picture (COP) and collaboration tools across organizations, to collect and disseminate data in the field and to coordinate response units and system users.

Satways is ISO 9001:2008 certified for the development of geospatial command and control products and solutions.

Mission

Our mission is to provide integrated solutions for the Security and Safety business sectors that enable the fusion, orchestration and seamless access of vast amounts of complex data from disparate information sources, tools and methods to coordinate the interaction between people, technologies, and responses. Through advanced software, and hardware we facilitate our customers to command, control assets and infrastructure by combining distributed software technologies, mobile data and geomatics with superior voice and data communication networks. SATWAYS is committed to delivering next generation geospatial security solutions to people, businesses and governments. We seek to earn the respect and trust of our customers through a total commitment to their success, industry expertise, and technical innovation.

Commitment

We are committed to enhance the operational efficiency of our customers by providing them with affordable, modular and expandable solutions that meet their business requirements and ensure the future value of their investments. Today's diverse voice and data networks demand ICT solutions that leverage existing infrastructure and adapt to the business goals of each customer. We consider each customer as a unique case and our solutions unique characteristics is the flexibility to map different business rules, operations and policies under a common platform reducing the implementation time of cost-efficient solutions.

Expertise and Experience

Our expertise lies in delivering end-to-end integrated solutions, in implementing large scale turn-key projects and in providing a wide range of engineering professional services. Our competitive advantage is based on our experience to deliver Nation-wide mission critical civil security and safety projects. Our products have been designed and developed to accommodate incongruent information sources, vast amounts of data, multi-agency and multi-site installations and a multitude of voice and data networks. Our Vision is to apply our insight of public safety and security issues, policies and approaches to the enterprise security management market that includes border monitoring, transportation and critical infrastructure protection.

Solutions

Our product lines include software systems for Incident Command and Response, Decision support, telematics, physical security, mobile data as well as state-of-the- art decision support tools. Our advanced and cost-effective solutions enable our customers to preserve operational integrity, to harness the power of geospatial information systems and to concentrate on operations rather that complex ICT integration and interoperability issues.

www.satways.net

DISASTER RESILIENCE DRIC DEFKALION INNOVATION CLUSTER

DRIC Defkalion brings together businesses, scientific research organisations, and technology companies focused on developing products, systems, and services for the management and response to natural disasters and emergencies in the field of civil protection.
The cluster aims to join forces, enhance know-how, and put into practice experience to advance knowledge in the disaster risk management area, introduce new products & services to the market, and intermediate research results, such as product prototypes and patents.

Activities

- Research and Networking
- DRIC Defkalion Expansion
- Education and Training
- Commercial Development & Cooperation
- Innovation and Technology

Co-financed by Greece and the European Union

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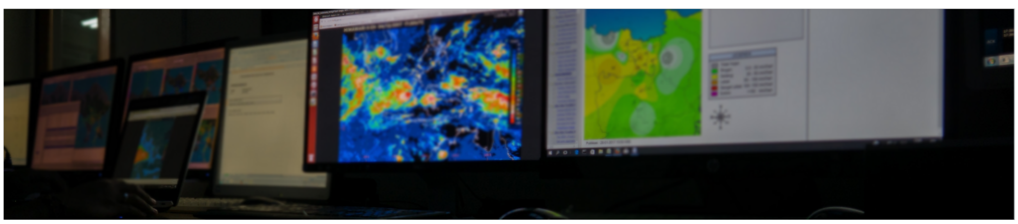

An Interdisciplinary Partnership of Greek SMEs, Industries, Research Institutes & Universities for the Protection & Safety against Environmental Risks

www.dric-defkalion.org   info@dric-defkalion.org

agenda

29.09

OPENING

Hall A

09:00 - 10:00	**Registrations**
10:00 – 10:45	**Welcome Greetings** **Gerasimos Papadopoulos**, *EU and UNESCO Scientific Collaborator, SafeGreece President* **Georgios Tsakoumis**, *Technical Chamber of Greece, Section of Central Macedonia, President* **Athanassios Ganas**, Geological Society of Greece, President **Efthymios Lekkas**, *Earthquake Planning and Protection Organization of Greece, President* **Konstantinos Zervas,** *City of Thessaloniki, Mayor* **Apostolos Tzitzikostas**, *Region of Central Macedonia, Governor | Regional Development Fund of Central Macedonia, President* **Stavros Kalafatis**, *Deputy Minister of the Interior* **Christos Stylianides**, *Minister of Climate Crisis & Civil Protection*
	Keynote Lectures
10:45 – 11:15	**Gerasimos Papadopoulos,** *EU and UNESCO Scientific Collaborator, SafeGreece President* **Earthquakes and Culture**
11:15 – 11:45	**Efthymios Lekkas,** *Earthquake Planning and Protection Organization of Greece, President* **Seismic risk & vulnerability of structures and infrastructure. Special data from the Greek and international area**
11:45 – 12:30	**Break**

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Sessions 1.1 & 1.2

29.09

Hall A

12:30 - 13:00 **Invited Talk | Chair: Gerasimos Papadopoulos**

Maria-Ana Vianna Baptista
ICG NEAMTWS, Chair | Universidade de Lisboa, Professor
An Overview of Tsunami Early Warning in the NEAM Region

Hall A

Chair: **Assimina Kourou, Georgios Vergos**

13:00 Charalampos Stergiadis, Nikolaos Chinopoulos, **Christos Bimpitsos** | **Region of Central Macedonia, Greece**
Civil Protection Innovative Actions and Technologies in the Region of Central Macedonia

13:15 **George Mouzakis**, **Melachroini Daniilaki** | **Region of Central Macedonia, Greece**
The Environmental Impacts from Technological and Natech Disasters

13:30 Stavros Kalogiannidis, Fotios Chatzitheodoridis Stamatis Kontsas, Ermelinda Toska, **Despoina Savvidou**, Konstantinos Metaxas | **University of Western Macedonia, Greece**
Disaster Resiliency Strategies and Local Government Units

Hall B

Chair: **Maria Manousaki, Ioannis Koukouvelas**

13:00 **Katerina-Navsika Katsetsiadou**, Ioanna Triantafyllou, Gerassimos A. Papadopoulos, Efthymios Lekkas, Stylianos Lozios, Emmanouel Vassilakis | **National & Kapodistrian University of Athens, Greece**
Crowdsourcing Data Interpretation for the Response to the First Public Tsunami Alert in the Mediterranean Sea, after the October 30th 2020 Earthquake (Mw7.0), Samos, Greece

13:15 Christos Makris, Yannis Androulidakis, Zisis Mallios, **Vasilis Baltikas**, Yannis Krestenitis | **Aristotle University of Thessaloniki, Greece**
Towards an Operational Forecast Model for Coastal Inundation due to Storm Surges: Application During Ianos Medicane

13:30 **Georgios Papavasileiou**, Theodore M. Giannaros | **National Observatory of Athens, Greece**
Critical Fire Weather Patterns of Greece: Forecasting Fire Weather Conditions in the Medium-Range

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Time		
13:45	**Ermioni Gialiti** | **Region of Crete, Greece** *Autonomous Geospatial Infrastructures and their Contribution to the Local Vulnerability Estimation. Case Study: Comparing Wildfires of The Years 2021 – 2022 in Crete Island*	**Stefanos Stefanidis,** Georgia Kalantzi, Konstantinos Karystinakis, Vasileios Alexandridis, Athanasios Partozis | **Omikron S.A., Greece** Oflood: a Module of the LocalPro Platform for Dynamic Flash Flood Forecasting at Local Scale

14:00 – 15:00 **Break**

Sessions 1.3 & 1.4

29.09

	Hall A	Hall B
Chair:	**Dim. Menemenlis, Kon/nos Kokolakis**	**Anastasia Triantafyllou, Vassilios Lekidis**
15:00	**Michalis Sioutas**, Vassilis Lekidis, Constantinos Kokolakis | **Technical Chamber of Greece/ Section of Central Macedonia, Greece** *Climate Change and Severe Weather Events in Thessaloniki*	**Kyriazis Pitilakis**, Anastasia Kiratzi, Stelios Siskos, Stavroula Fotopoulou, Stella Karafagka, Christos Petridis, Maria Manakou, Kostas Liakakis, Konstantinos Kozalakis, Kostas Ziozos, Dimitris Pitilakis, Christos Spandonidis, Fotis Giannopoulos | **Aristotle University of Thessaloniki; Prisma Electronics SA Greece** *SAFESCHOOLS: Earthquake Early Warning and Real-Time Seismic Risk Assessment System for School Buildings*
15:15	**Dimitris Pitilakis**, Chiara Amendola, | **Aristotle University of Thessaloniki, Greece** *Urban-Scale Seismic Risk Assessment: the Case of Thessaloniki*	Christos Makris, **Vasilis Baltikas**, Yiannis Kontos, Yannis Androulidakis, Nikolaos Nagkoulis, Theofanis Karambas | **Aristotle University of Thessaloniki; National Technical University of Athens; MarineTraffic, Greece** *ACCU-WAVES: an Operational System for Wave Forecasts Supporting Ship Navigation Around and Inside Seaports*
15:30	Charalampos Stergiadis, **Anastasia Stergiadou**, Orfeas Psillas , Dimitrios Moutsopoulos | **Aristotle University of Thessaloniki; Region of Central Macedonia Greece** *Optimal Route Selection for Forest Fire Suppression (Case Study: Peri-Urban Forest of Thessaloniki, Greece)*	**Christos Kontopoulos**, Vassiliki Charalampopoulou, Anastasios Tzepkenlis, Nikos Grammalidis, Dimitra Kitisiou, Zoe Pataki, Anastasia Patera, Theodoros Nitis | **Geosystems Hellas S.A.; University of the Aegean Greece** *EPIPELAGIC: an Integrated Decision Support System Using Satellite and in-situ Data for Coastal Area Hazard Mitigation and Resilience to Natural Disasters*

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15:45	**Theodore M. Giannaros,** Antonios Bezes, Stavros Dafis, Eleni Dragozi, Athanassios Karagiannidis, Koletsis, Vassiliki Kotroni, Georgios Kyros, Konstantinos Lagouvardos, Georgios Papavasileiou | **National Observatory of Athens, Greece** *FIRESCOPE: a Fire Weather Information and Early Warning System Supporting the Shift From Suppression to Prevention in Europe and Greece*	**Ioannis Dokas**, Konstantinos Chouvardas, Apostolos Zeleskidis, Stavroula Charalabidou, Apostolos Vasileiou, Giorgos Mallinis, Christos Akratos, Eugenia Bezirtzoglou, Constantinos Chalioris, Lazaros Iliadis, Vasileios Margaris, Anastasia Paschalidou, Aggelos Protopapas, Nikolaos Klimis | **Democritus University of Thrace; Aristotle University of Thessaloniki;** Region of East Macedonia; Institute of Engineering Seismology and Earthquake Engineering **Greece** *The Risk and Resilience Assessment Center of the East Macedonia and Thrace Region: a New Multihazard Research Center for Risk and Resilience Assessment Studies*
16:00	**Kostas Kalabokidis**, Palaiologos Palaiologou, Olga Roussou | **University of the Aegean, Agricultural University of Athens Greece** *Fuels Management at the Landscape Scale for Wildfire Mitigation*	**Athanassios Ganas**, Ioannis Karamitros, George Mavropoulos, Dimitrios Anastasiou, Theodoros Athanassopoulos, Konstantinos Nikolakopoulos, Aggeliki Kyriou, Christos Kontopoulos, Vasiliki Charalampopoulou, Varvara Tsironi | **National Observatory of Athens;** University of Patras; **ES Systems; GEOSYSTEMS HELLAS, Greece** *A New Low-Cost GNSS and Strong Motion Instrument for Monitoring of Slopes and Critical Infrastructures Within the Greek "Supersite"*
16:15	**Giannis Kontos**, **Anastastia Mavridaki** | **Marathon Data, Greece** *ArcGIS: The Today and Tomorrow Necessary Technology*	**Alexia Tsouni**, Constantinos Loupasakis, Stavroula Sigourou, Vassiliki Pagana, Paraskevas Tsangaratos, Charalampos (Haris) Kontoes | **National Observatory of Athens; National Technical University of Athens Greece** *Fast-Track Assessment of Flood-Erosion-Landslide Risks in Fire-Stricken River Basins of the Region of Attica*
16:30	**Vana Giavi** | **totalview, Greece** *Choosing the Right Satellite Constellation for Wildfires, Floods and Other Civil Protection Events.* *Plan for Mitigation, Monitor for Readiness, Focus for Responsiveness, Scan for Assessment.* *Update on Latest Space Technology Products and Services*	**Paraskevi Georgiadou**, Dimitra Pinotsi, Theoni Koukoulaki, Konstantina Kapsali | **Hellenic Institute for Occupational Health and Safety, Greece** *New Challenges of Multi-Hazard Emergency Preparedness*

16:45 – 17:15 **Break**

Sessions 1.5 & 1.6

29.09

Hall A

Chair: Vassilios Martzaklis, Ilias Argyris

17:15

Aspasia Karamanou, Dimitrios Malliaros, Georgia - Christina Dreliosi | **Region of North Aegean, Greece; Strasbourg National School of Architecture, France**
Evacuation in WUI Fires: Understanding Public Attitudes and Perceptions in Preparedness Planning

17:30

Palaiologos Palaiologou, Kostas Kalabokidis | **Agricultural University of Athens; University of the Aegean, Greece**
The Complex Problem of WildFire Management in the Municipality of Dionysos, Attica, Greece

17:45

Georgios Sakkas, Vassiliki Varela, Iosif Vourvachis, Alexandros Giordanis, Stelios Andreadis, **Ilias Gialampoukidis**, Stefanos Vrochidis, Ioannis Kompatsiaris, Konstantinos Demestichas, Spyridon Kaloudis, Roula Kechri, Konstantinos Meletis | **Centre for Research & Technology Hellas; Hellenic Rescue Team; Centre for Research & Technology Hellas; Agricultural University of Athens; Region of Attica, Greece**
SILVANUS: An Integrated Technological and Information Platform for Wildfire Management – North Evia pilot area

Hall B

Chair: Nikolaos Vorrias, Katerina-Navsika Katsetsiadou

17:15

Kanella Valkanou, **Efthimios Karymbalis**, Konstantinos Tsanakas | **Harokopio University, Athens, Greece, Greece**
GIS-Based Morphometric Analysis for the Prioritization of Erosion-Prone Watersheds in Evia Island, Greece

17:30

Charalambos Kontoes, Anastasios Anastasiadis, **Georgios Panagopoulos**, Constantinos Loupasakis, Konstantinos Chousianitis, Nikolaos Stathopoulos, Emmanouil Kirtas, Evi Riga, Kyriazis Pitilakis, Christos Karakostas, Sotiria Stefanidou, Konstantinos Papatheodorou, Elissavet Chatzicharalampous, Agavni Kaitantzian, Eleni Grigorakou | **International National Observatory of Athens; Hellenic University; Aristotle University of Thessaloniki; Institute of Engineering Seismology and Earthquake Engineering Greece**
Seismic Risk Assessment in the Region of Attica

17:45

Sotiris Valkaniotis, Maria Taftsoglou, George Papathanassiou, Elisavet-Isavella Koutsoupaki, Dimitris Sotiriadis, Konstantinos Mpantralexis, Eleni Petala, Nikos Klimis, Ioannis Dokas | **Democritus University of Thrace; Aristotle University of Thessaloniki, Greece**
Towards a Complete Landslide Inventory for Assessing Landslide Hazard and Risk in East Macedonia and Thrace Region, Greece

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18:00

Dimitrios Menemenlis, Palaiologos Palaiologou, Kostas Kalabokidis | **University of the Aegean; Agricultural University of Athens, Greece**
Structure Vulnerability to Wildfires in the Wildland-Urban Interface of Ixia, Rhodes Island, Greece

Anna Karatzetzou, **Olga Markogiannaki**, Sotiria Stefanidou | **Aristotle University of Thessaloniki; Techniki Anaptixi ATEBE; 3REDI Engineering Solutions, Greece**
Equake: A Module of the LocalPro Platform for Seismic Risk Assessment At Local Scale

18:15

Konstantinos Lymperopoulos, Issaak Parcharidis | **Harokopio University of Athens; Hellenic Army, Greece**
An Approach to Forest Fires in Wildland-Urban Interface Areas: a Case Study from Attica Region (Greece)

Constantine A. Antoniades, **Dimitra Mavrommati**, Antonios Antoniades, Aikaterini Tsoukala | **National & Kapodistrian University of Athens; Regional Union of Municipalities of Crete Greece**
Municipal Waste Landfill [Dump site] at Thira Island (Santorini) - Impact on environment - Administrations Negligence to Situate a Legal and Environmentally Friendly Residue Municipal Waste Landfill (RMWL) – Greek Ombudsman Intervention – Proposal for Locating a RMWL on the Island

18:30

Margarita Bachantourian, Kostas Kalabokidis, Palaiologos Palaiologou | **Hellenic Forest Service, University of the Aegean, Agricultural University of Athens, Greece**
Evaluation of a Forest Fuel Management Plan Using Simulation Modeling in a Mediterranean Wildland-Urban Interface

Stelios Bollanos, Emmanouela Ieronymidi, **Theofilos Valsamidis** | **Planetek Hellas, Greece**
Rheticus – Earth Observation based predictive analytics for Civil Protection in Smart Cities

Workshop

09:00- 11:00

Hall A

30.09

"Civil Protection and Challenges – FIRE-IN national Hub – Greece – The Greek Agenda"

The workshop is addressed to practitioners, local and regional authorities, civil protection agencies, research and academic organizations, industry and standardization bodies. The workshop is moderated by the Center for Security Studies, partner of the FIRE-IN project.
The agenda of the workshop consists of a brief presentation of the project results, presentation of recent natural disasters events and a discussion on current and future capabilities on incident command organization, community involvement and risk reduction. These capabilities will be discussed from the point of view of:

- Disaster management challenges in Greece
- Solutions related to these challenges
- Priorities recognized.

The overall goal of the workshop is to create and deliver a "Hellenic Agenda" to the European Commission for future research programming, harmonized with the needs of other EU countries. 7
Workshop agenda:
09:00 - 09:15: Greetings
09:15 – 10:00:

- Opening presentation: FIRE-IN National Hub – Greece – The Hellenic Agenda (Vagia Pelekanou and Georgios Sakkas, KEMEA)
- Recent experience from Greece: Lessons learned from the megafire of Northern Evia in the summer 2021 (George Eftychidis, Satways ltd)
- Recent experience from Cyprus: Arakapas Wildfire Incident – Lesson to be Learned (Nikolaos Kamakiotis, Associated FIRE-IN expert)

10:00-11:00: Open discussion
The workshop is moderated by the Center for Security Studies (KEMEA) Research associates: **Georgios Sakkas, Vassiliki Varela** and **Vagia Pelekanou**.

11:00 - 11:30	**Invited Talk |** Chair: Gerasimos Papadopoulos
	Kyriazis Pitilakis *European Association of Earthquake Engineering (EAEE), President | Aristotle University of Thessaloniki, Professor* **Latest Progress in the Seismic Hazard and Risk Assessment of Thessaloniki, Greece**
11:30 – 12:00	**Break**

Hall A

12:00 – 14:30

Seminar: Seismic Protection of School Units

E.P.P.O
Earthquake Planning & Protection Organisation

Organized by **Earthquake Planning and Protection Organization** of Greece in collaboration with **Region of Central Macedonia** and **Central Macedonia Regional Education Directorate** of the Hellenic Ministry of Education and Religious Affairs.

The seminar is addressing to the Principals of School Units of the Metropolitan Unity of Thessaloniki, and aims to train them in issues related to seismic risk, the relevant institutional framework and prevention and preparedness actions in the school environment.

The Seminar will also be broadcast online, covering teachers whose physical presence is impossible.

SEMINAR AGENDA

12:00-12:10 | Arrival

12:10-12:40 |Greetings

- **Dr. Stergiadis Charalambos**, Forester, Head of the Autonomous Civil Protection Directorate of the Region of Central Macedonia
- **Akritidis Nikolaos**, member of the Coordination Group of the Crisis Prevention and Management Observatory of the Regional

Hall B

Stavros Kalogiannidis, Ilias Argyris

Poster Session

12:00 – 12:10

Tzanis Fotakis, I. Brellas1, Aikaterini Papatheodorou, George Petrakis, Achilles Tripolitsiotis, Panagiotis Partsinevelos | **Technical University of Crete, Greece**

SANDMAP: an Educational Platform to Enhance Crisis Management Spatial Interaction

12:10 – 12:20

Ioannis Kapris, Areti Plessa, Nikos Passas, Miranda Dandoulaki | **Region of Attica, Greece**

Civil Protection Field Exercises for Forest Fire Preparedness at Local Level: the Experience of Region Of Attica, Greece, During the 2022 Fire Season

12:20 – 12:30

Irene Chrysafis, Giorgos Mallinis, Vassileios Giannakopoulos, Ioannis Dokas | **Democritus University of Thrace, Greece**

Fire Risk Assessment in the Region of East Macedonia and Thrace

12:30 – 12:40

Vasiliki G. Kousteni, Vasileios Martzaklis | **National and Kapodistrian University of Athens, Greece**

Deadly Fire in Mati, 2018: Tragic Faces and Facts

12:40 – 12:50

Stefanos Stefanidis, Vasileios Alexandridis | **Aristotle University of Thessaloniki, Greece**

Wildfire Effects on Soil Erosion and Hydrology in a Typical Mediterranean Wildland – Urban Interface: the Case of South Athens, Greece

12:50 – 13:00

Stylianos Bitharis, Ion Karolos, Konstantinos Bellos, **Christos Pikridas**, Vassilios Tsioukas | **Aristotle University of Thessaloniki, Greece**

The Contribution of 3D Digital Documentation to the Safety of Industrial Facilities

13:00 – 13:10

Zoe Nivolianitou | **NCSR "DEMOKRITOS", Greece**

Can Environment be Damaged by Closed or Abandoned Industrial or Chemical Sites?

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Directorate of Education of Central Macedonia

12:40-13:15 | Lecture
Risk Management in School Units
Prof. Efthymios Lekkas, E.P.P.O. President

13:15-13:45 | Lecture
Earthquakes and School Buildings
Fotis Karagiannis, Civil Engineer, E.P.P.O. Education - Information Department

13:45-14:20 | Lecture
Seismic Risk and Preparedness of School Units. Experiences and Lessons Learned. Skills Workshops
Dr. Assimina Kourou, Geologist, E.P.P.O. Acting Head of Social Seismic Defense Directorate

14:20-14:30 | Discussion

13:10 – 13:20
Antonios Karteris, Georgios Tzanos, **Lazaros Papadopoulos**, Konstantina Remoundou, Theodoros Alexakis, Nikolaos Peppes, Konstantinos Demestichas, Dimitrios Soudris | **National Technical University of Athens, Greece**
PRAETORIAN: Protection of Critical Infrastructures from advanced combined cyber and physical threats

13:20 – 13:30
Ilias Petrou, Kyriaki Psistaki, Ioannis Dokas, Anastasia Paschalidou | **University of Ioannina, Democritus University of Thrace, Greece**
Studying The Toxic and Thermal Radiation Threat from Hypothetical Industrial Accidents

13:30 – 14:30
Break

Special Session

Standardization

30.09

Hall A

Chair: **Ioannis Chasiotis, Lefteris Ouzounoglou, Ilias Argyris, Aikaterini Poustourli**

14:45 **Ioannis Chasiotis,** Nikolaos Stefanou, Danai Kazantzidou-Firtinidou, Georgios Sakkas , Aikaterini Valouma, Leonidas Perlepes, Giorgios Eftychidis, Diana Iorga, Aikaterini Poustourli | **Satways Ltd., Greece; Hellenic Police, Greece; Romanian Standards Association – ASRO, Romania**
Emergency Response Planning: Efficiency through Standardisation

15:00 **Aikaterini Valouma,** Leonidas Perlepes, Ioannis Chasiotis, Speranta Stomff, Janny Nijsingh, Coen Vaarkamp, Aikaterini Poustourli | **Satways Ltd., Greece; Romanian Standards Association – ASRO, Romania; Veiligheidsregio Ijsselland, Netherlands**
Emergency Management - Exchanging of Building and Infrastructure Damage Information

15:15 **Leonidas Perlepes,** Ioannis Chasiotis, Aikaterini Valouma, Giorgios Eftychidis, Antonis Kostaridis, Dimitris Diagourtas, Cristina Popa, Aikaterini Poustourli | **Satways Ltd., Greece; Romanian Standards Association – ASRO, Romania**
Collaborative Emergency Response – The Pathway to Standardisation

15:30 **Danai Kazantzidou-Firtinidou**, Georgios Sakkas, Nikolaos Stefanou, Ioannis Tsaloukidis, Andreea-Lorena Salajan | **Center for Security Studies, Greece; Hellenic Police, Greece; Austrian Standards, Austria**
Standardization in Evaluation of Exercises for Crisis Management

10

15:45 **Georgios Sakkas**, Danai Kazantzidou-Firtinidou, Ioannis Tsaloukidis, Efstathios Skarlatos, Vassiliki Varela, Ioannis Tsaloukidis | **Center for Security Studies, Greece**
Critical Infrastructure Protection: Standardisation and Exercises

16:00 Spyridon C. Athanasiadis, **Panagiotis Michalis**, Eleftherios Ouzounglou, Lazaros Karagiannidis, Angelos Amditis | **Institute of Communication and Computer Systems, Greece**
Specifications for Digital Scenarios to Enhance Acquisition of Triage Information During Search and Rescue Operations

16:15 – 16:45 **Panel Discussion | Moderator: Aikaterini Poustourli**
Panelists: Philippe Quevauviller [EC DG HOME F2], George Pallis [T4i engineering], Lazaros Karagiannidis [ICCS], Anastasia Moumtzidou [CERTH], Nikolaos Stefanou [Hellenic Police]
Aim: to address the need to bring together Greek actors with an interest in standardization of crisis and emergency management systems and procedures; plus the need for cooperation among them.

16:45 – 17:15 **Break**

17:15 - 17:45 **Invited Talk | Chair: Gerasimos Papadopoulos**

Achilleas G. Samaras
Democritus University of Thrace, Assistant Professor
The Role of Advanced Numerical Models in Civil Protection Against Natural and Climate Hazards in Coastal Areas

Sessions 2.1 & 2.2

30.09

	Hall A	Hall B
Chair:	**Christos Pikridas, Pinelopi Ralli**	**Kostas Kalabokidis, Issaak Parcharidis**
17:45	Antonios Antoniades, **Panagiota Fragalioti**, Constantine Antoniades | **National & Kapodistrian University of Athens, Greece** *Natural Disasters & Climate Crisis in Greece from 2000 to July 2022*	**Panagiotis Michalis**, Orestis Sampson, Vangelis Tsougiannis, Eleftherios Ouzounoglou and Angelos Amditis | **Institute of Communication and Computer Systems, Greece** *AEOLIAN: a New Crowdsourcing Solution to Enhance Preparedness and Response to Natural and Anthropogenic Hazards*
18:00	**Vasilki Charalampopoulou**, Constantine Spyrakos, Christos Kontopoulos, Charilaos Maniatakis, Charalampos Saroglou, Alexandros Paraskeuas, Benedetta Antonielli, Francesca Bozzano, Alessio Di Iorio, Renzo Carlucci | **Geosystems Hellas SA, Greece; National Technical University of Athens, Greece; Sapienza Università di Roma, Italy;** *The Historic City of Nafplion: an Approach to Estimating the Effects of Geohazards on the Built Environment*	**George D. Romosios**, Vaios Zygouris | **Aristotle University of Thessaloniki, Greece; Hellenic Firemen School, Greece** *Simulation of a Small Warehouse Fire Using the B-Risk Software*
18:15	**Efstratios-Aimilios Katris**, Triantafyllos Falaras, Issaak Parcharidis | **Harokopio University of Athens, Greece** *An Integrated Approach Using Optical and SAR Multi-Temporal Data, Geospatial Technology and Web-GIS Visualization for Cultural Heritage Site Monitoring: the Case of Mantinea Site*	**Miltiadis Athanasiou**, Triantafyllos Bouchounas, **Elias Tziritis**, Evangelia Korakaki, Gavriil Xanthopoulos, Stamatia Sitara | **Wildfire Management Consulting and Training; Gigonis Ecospatial Services; Hellenic Agricultural Organization "Demeter"; WWF Greece; Chios Voluntary Action Team – OMIKRON, Greece** *Prescribed Burning In Greece: Pilot Application In Chios Island*
18:30	**Maria Manousaki**, Efthymios Lekkas, Konstantinos Kyriakopoulos, Spyridon Mavroulis, Stavros Meletlidis | **Earthquake Planning and Protection Organization** *Cumbre Vieja Eruption, 2021: Volcanic Crisis Management. The Greek Scientific Mission*	Charalampos Kontoes, Melpomeni Zoka, Anastasia Yfantidou, Martha Kokkalidou, Michail Tsoutsos, Stella Girtsou, **Nikolaos Stathopoulos** | **National Observatory of Athens, Greece** *Fire Risk Assessment and Management Planning at a Building Block Level: the Case of Kaki Thallasa, Attica Region, Greece*

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18:45

Panagiota Fragalioti, **Constantine A. Antoniades** | **National and Kapodistrian University of Athens, Greece**
Civil Protection Innovative a Critical Approach on Provisions of the National Civil Protection Law – Implementation, Thoughts and Proposals – Part I (general)

Dimitrios Menemenlis, Vasilios Savvas, Evangelia Chatzidaki, Venia Fraraki, Fotios Meletis, Iliana Papatheodoraki, Kaiti Skandalidi, Natalia Stamataki, Ioannis Stamatiadis | **University of the Aegean; 3rd General High School of Rhodes, Greece**
FIRESAT- Portable Atmospheric Measurement System for Pre – and Post – Wildfire Monitoring

19:00

Panagiota Fragalioti, **Constantine A. Antoniades** | **National and Kapodistrian University of Athens, Greece**
Civil Protection Innovative a Critical Approach on Provisions of the National Civil Protection Law – Implementation, Thoughts and Proposals – Part II (article review)

Georgios Eftychidis, **Nikolaos Kamakiotis**, Vassiliki Varela | **Center for Security Studies, Greece; Public Safety Incident Analyst", Larnaca, Cyprus**
Comparative Analysis of two Extreme Wildfire Incidents: N. Voutzas/ Mati-Greece-2018 & Arakapas-Cyprus-2021

19:15

Ioanna Filandra, Constantine A. Antoniades | **Ministry of Environment and Energy; National and Kapodistrian University of Athens, Greece**
The Distinct Importance of "Interoperability" among all Involved Parties & the Catalytic Role of Climate Crisis in the Management of Forest Fires

Petros Argyriou, Vasilios Martzaklis | **National and Kapodistrian University of Athens, Greece**
Parameterization and Reliability Modelization of a Support Operation by Earthmoving Machinery During a Forest Wildfire

19:30

Konstantinos Kokolakis | **Decentralized Administration of Macedonia, Civil Protection Division, former Director**
Forest Fire Prevention, Preparedness and Response Planning 2022

Lazaros S. Papadopoulos, Christos V. Komninos | **Hellenic Fire Corps; Firemen School, Greece**
Firefighting Vehicles Modification Project: Self-Protection and Fire Protection

Sessions 3.1 & 3.2

01.10

Hall A		Hall B
Chair:	**Nikolaos Vorrias, Dim. Menemenlis**	**Anastasia Triantafyllou, Vassilios Lekidis**
09:30	**Ioannis Koukouvelas**, Konstantinos Nikolakopoulos, Aggeliki Kyriou | **University of Patras, Greece** *Analysis of Geohazards Using Low-Cost Innovative Methods*	**Konstantinos Papatheodorou**, E. Kirtas, K. Ntouros, G. Panagopoulos, P. Gakos, N. Theodoulidis, N. Klimis | **International Hellenic University; Institute of Engineering Seismology & Earthquake Engineering; Democritus University of Thrace, Greece** *Education & Tools to Support Public Response in Earthquake Emergencies: the Redact Educational Hub*
09:45	**Stavroula Sigourou**, Vaso Pagana, Panayiotis Dimitriadis, Alexia Tsouni, Theano Iliopoulou, G.-Fivos Sargentis, Romanos Ioannidis, Efthymios Chardavellas, Dimitra Dimitrakopoulou, Nikos Mamasis, Charalampos (Haris) Kontoes, Demetris Koutsoyiannis | **National Observatory of Athens; National Technical University of Athens, Greece** *Flood Risk Assessment in the Region of Attica*	**Dimitrios Tzioutzios**, Miranda Dandoulaki, Ana Maria Cruz | **Kyoto University, Japan** *Exploring How Citizens Communicate about Natech Risk Through a Comparative Study and a Serious Game*
10:00	**Eleni Tzanou**, Antonios Chatzigiannis, Charalampos Skoulikaris, Georgios M. Tsakoumis | **International Hellenic University; Consortis; Aristotle University of Thessaloniki, Greece** *Perfomance and Interoperability Assessment of Flood Protection Intervention Meaures and Action Plan in the Strymon River Basin, Greece*	**George Hatzivasiliadis**, Ioannis - Aggelos Chatzivasiliadis, Manolis Tasiopoulos | **IVRSC – XVR HELLAS TEAM, Greece** *Comparative Field Advantages of Executive Training Using a Special Digital Training Platform (XVR) with Virtual Reality Simulation in Virtual Exercise Scenario Environments For Protection and Security*

13

10:15

Despoina Kanteler, Evangelos Katsaros, Anastasios C. Andronikidis, Amalia Kouskoura, Yiannis Bakouros | **University of Western Macedonia, Greece**
Cross Border Emergency Management in the Balkans

Stavros Kalogiannidis, Ioannis Papadomarkakis, Olympia Papaevangelou, Zacharias Karantonis
Eirini Eleni Nikolaou | **University of Western Macedonia; Ministy of Education Greece**
Convergence of Public and Educational Systems for Better Catastrophe Preparation

10:30

Stavros Kalogiannidis, Ioannis Amanatidis, Vaios Zygouris, Manos Parastatidis, **Despoina Savvidou**, Dimitrios Kalfas | **University of Western Macedonia, Greece**
The Contribution of Cyber Security to Improved Civil Protection. European Viewpoint

Georgios Tzanetis, Panagiota Masa, Spyridon Kintzios, Stefanos Vrochidis, Ioannis Kompatsiaris, Anna Triantafylloy, Athanasios Liatifiis, Alexandros Giordanis, Iosif Vourvachis | **Centre for Research and Technology; University of Western Macedonia; Hellenic Rescue Team, Greece**
STRONG: an Advanced First Responders Training Approach

10:45

Christos Stefanis, Elpida Giorgi, Konstantinos Kalentzis, Athanasios Tselemponis, Evangelia Nena, Christina Tsigalou, Christos Kontogiorgis, Yiannis Kourkoutas, Ekaterini Chatzaki, Ioannis Dokas, Theodoros C. Constantinidis, Eugenia Bezirtzoglou | **Democritus University of Thrace, Greece**
Epidemiological Surveillance Reports on Covid-19 in Greece. Sentiment Analysis and Public Perception Based on Machine Learning and Artificial Neural Network

Iosif Vourvachis, Alexandros Giordanis, Quynh Nguyen, Lina Gyllencreutz, Helmut Schrom-Feiertag | **Hellenic Rescue Team, Greece; AIT Austrian Institute of Technology GmbH, Austria; Umeå University, Sweden**
MED1stMR: an integrated Training Using a Mixed Reality Approach Featuring Haptic Feedback for Enhanced Realism - EUO's Requirements

11:00 - 11:30 **Invited Talk | Chair: Gerasimos Papadopoulos**

Motti Zohar
University of Haifa, Senior Lecturer
Spatial Approaches for Analyzing Historical Earthquakes Associated with the Dead Sea Transform

11:30 – 12:00 **Break**

Sessions 3.3 & 3.4

01.10

	Hall A	Hall B
Chair:	Vassilios Martzaklis, Konstantinos Kokolakis	Kon/nos Chouvardas, Mich. Papastergiou
12:00	**Alexios Vlachopoulos, Aspasia Tzeletopoulou**, Harris Georgiou, Pantelis Linardatos, George Diles, Thomas Papadimos, Zoe Vasileiou, Spyros Kintzios, Angelos Amditis, Nantia Skepetari | **Hellenic Rescue Team of Attica; EXUS Innovation, Centre for Research and Technology; Institute of Communication and Computer, Greece** *Field Trials of Information Fusion, Expert Reasoning, Social Media Exploitation and Worksite Operations in SAR Missions – INGENIOUS (EU Horizon 2020)*	**Yannis Krestenitis,** Yannis Androulidakis | **Aristotle University of Thessaloniki, Greece** *Interannual and Spatial Distribution of Marine Heat Waves In Aegean, Ionian and Cretan Seas*
12:15	Evangelos Katsadouros, Panagiotis Kasnesis, Dimitrios G. Kogias, Charalampos Z. Patrikakis, Alexios Vlachopoulos, **Aspasia Tzeletopoulou**, **Harris Georgiou** | **University of West Attica; Hellenic Rescue Team of Attica, Greece** *Smart Textiles and Biometrics/ Movement Data Fusion in Deep Learning for Search and Rescue Operations – FASTER (EU Horizon 2020)*	**Georgia Kalousi,** Manon Besset, Virginie Lafon, Aurelie Dehouck, Konstantinos Mytakidis | **Terra Spatium SA, Athens, Greece; i-Sea, Bordeaux, France** *Watching Out Large-Scale Waterline and Coastal Changes in Greece, the Space for Shore Project, Under ESA's Coastal Erosion Project*
12:30	**Lorenzo Nerantzis**, Iosif Vourcachis, Christodoulos Santorinaios, Loukas Ilias, Christos Ntanos, Ioannis Benekos | **Hellenic Rescue Team; National Technical University of Athens; Centre for Research & Technology, Greece** *Search and Rescue: Emerging technologies for the Early location of Entrapped victims under Collapsed Structures and Advanced Wearables for risk assessment and First Responder's Safety in SAR operations*	**Anastasia I. Triantafyllou,** Georgios S. Vergos, Georgios M. Tsakoumis | **Consortis; Aristotle University of Thessaloniki, Greece** *Development of an Integrated Observatory System for Preventing and Managing the Risk of Coastal Erosion Due to the Impact of Climate Change through the Utilization of Earth Observation Data*

12:45 **Dimitrios Iliadis,** Ioanna Gkika, Dimitrios Uzunidis, Iosif Vourvachis, Petros Drakoulis, Konstantinos Konstantoudakis, Panagiotis Kasnesis, Christos Chatzigeorgiou | **Hellenic Rescue Team; Centre for Research and Technology; University of West Attica, Greece**
Visual Computing and Radar Tools for Improved Situational Awareness in Search and Rescue Operations

Paschalis Koutalakis, Anastasia Theodori, Christiana Konstantinidou, Ioannis Toskas | **Transport Authority of Thessaloniki S.A., Greece**
Statistical Analysis of Road Traffic Accidents Involving Public Buses

13:00 **Panagiotis Partsinevelos**, Georgios Petrakis, Angelos Antonopoulos, Efstathios Bikos, Dimitris Chadziparaschis, Michalis Galanis, Achilles Tripolitsiotis | **Technical University of Crete, Greece**
Unleashing the Uncrewed Autonomous Systems Potential for Civil Protection

Michalis Tsitotas, **Vassilios Lekidis**, Ioannis Moschonas | **Technical Chamber of Greece/ Section of Central Macedonia, Greece**
Structural Safety of Bridges, One Concise and Effective Way of Screening Old Bridges

13:15 **Efstathios Skarlatos,** Konstantinos Apostolou, Vagia Pelekanou | **Center for Security Studies, Greece**
Use of Unmanned Aerial Systems for the Protection of Public Spaces: Positives and Threats

Maria Taftsoglou, Sotirios Valkaniotis, George Papathanassiou, Nikolaos Klimis, Ioannis Dokas | **Democritus University of Thrace; Aristotle University of Thessaloniki, Greece**
Critical Infrastructures Constructed Upon Susceptible to Liquefaction Sediments: the Case Study of Nestos River

13:30 **Aspasia Tzeletopoulou,** Alexios Vlachopoulos, Harris Georgiou, Dionne Sloof, Katerina Galanopoulou, Jens Lind, Margaux Faber | **Hellenic Rescue Team of Attica, Greece; Crisisplan B.V. (CPLAN), Netherlands; Sodertorns Branforsvarsforbund (SBFF), Sweden; Inconito (INC), France**
First pilot testing of Tactical Communication System, Symbiotic Operation Control Module, Smart UGVs and Smart UAVs at the Stockholm metro station – INTREPID (EU Horizon 2020)

13:45 **Panagiota Masa**, Georgios Tzanetis, Spyridon Kintzios, Georgios Meditskos, Stefanos Vrochidis, Iosif Vourvachis, Lorenzo Nerantzis, Ioannis Kompatsiaris | **Centre for Research and Technology; Aristotle University of Thessaloniki; Hellenic Rescue Team, Greece**
Ontology-Based Technologies for Disaster Preparedness, Response and Recovery

14:00 Marios Bakratsas, Anastasia Moumtzidou, **Ilias Gialampoukidis,** Ioannis Lioumbas, Dimitris Iliadis, Caterina Christodoulou, Matina Katsiapi, Iosif Vourvachis, Stefanos Vrochidis, Ioannis Kompatsiaris | **Centre for Research and Technology Hellas, Greece**
Assisting First Responders in Water-Borne Hazards in Northern Greece through Pathocert Solutions

14:15 – 14:30 **Closing**

SafeThessaloniki 2022

new technologies & civil protection

29.09 – 01.10

proceedings

invited talks

AN OVERVIEW OF TSUNAMI EARLY WARNING IN THE NEAM REGION

Maria Ana Baptista
[1] *Instituto Dom Luiz, Faculdadede de Ciências da Universidade de Lisboa, also @ ISEL, IPL (Portugal)*
(E-mail: mavbaptista@gmail.com)

ABSTRACT

Tsunamis are high-impact natural disasters. The 2004 Boxing Day tsunami killed over 250,000 people in the Indian Ocean.
The coasts of Europe, the North East Atlantic, Mediterranean and Connected Seas (NEAM region) are home to all three types of tsunami sources: earthquakes, volcanoes and mega-landslides.
The highly populated shoreline with the continuous growth of tourism and economic activity increases the potential losses caused by tsunamis. Tsunami waves can reach the shore minutes after an earthquake, a volcanic eruption or a submarine-landslide. Local citizens and occasional tourists reveal a low level of tsunami aware-ness and do not recognize the natural signs of an approaching tsunami
In the aftermath of the massive tsunami on 26 December 2004 the Intergovernmental Oceanographic Commission of UNESCO (IOC-UNESCO) received a mandate from the international community to form The Intergovernmental Coordination Group for the Tsunami Early Warning and Mitigation System in the North-eastern Atlantic, the Mediterranean and connected seas (ICG/NEAMTWS). Ten years ago in 2012, France established its national tsunami warning system and became the first Tsunami Service provider and four other countries followed France: Greece, Portugal and Turkey.
The main activities of the group focus on providing civil protection personnel in all member states with a basic understanding of the early warning elements and features of NEAMTWS.

Keywords: Tsunami, Warning, NE Atlantic, Mediterranean

LATEST PROGRESS IN THE SEISMIC HAZARD AND RISK ASSESSMENT OF THESSALONIKI, GREECE

Extended Summary

Kyriazis Pitilakis[1], Evi Riga[2], Stefania Apostolaki[3]
[1, 2,3] Department of Civil Engineering, Aristotle University of Thessaloniki (Greece).
(E-mail: kpitilak@civil.auth.gr, eviriga@civil.auth.gr, aestefan@civil.auth.gr)

ABSTRACT
This paper shortly presents the latest developments on the seismic hazard and risk assessment of the city of Thessaloniki, Greece, using the two most recent European Seismic Hazard and Risk Models (ESHM20 and ESRM20 respectively), which were released in December 2021. We briefly present the new hazard zonation map that has been proposed for Greece based on ESHM20 [1], as well as an improved soil classification scheme with associated soil amplification factors, both appropriate for potential inclusion in the Greek National Annex that will accompany the revised Eurocode 8. We then investigate the impact of the new map on the seismic hazard and risk of Thessaloniki, a city which is very well-documented with respect to building stock and soil conditions. Comparisons of the seismic hazard results obtained when using the zonation/soil classification of the proposal for the National Annex and those of the current regulations are given in terms of spatial distribution of spectral acceleration values at different periods and elastic response spectra for the different soil conditions of Thessaloniki. The estimated physical damage and economic losses are also presented and discussed.

Keywords: Thessaloniki, seismic hazard, seismic risk, ESHM20, hazard map

1. INTRODUCTION

Greece is the most seismically active region in Europe, and therefore the European country with the highest seismic hazard. The seismic hazard zonation map for Greece for a return period of 475 years provided by the Greek Seismic Code EAK [2] includes three seismic hazard zones with peak ground acceleration (PGA) values at soil surface of 0.16 g, 0.24 g and 0.36 g. The same zonation was adopted by the National Annex of Eurocode 8, with the same PGA values representing in this case the reference hazard for rock site conditions, which are to be amplified by the present EC8 soil amplification factors [3]. However, in the last two decades, a significant progress has been made towards the improvement of the seismic hazard maps worldwide, and particularly in Europe, with the most recent advancement being the fully probabilistic European Seismic Hazard Model 2020, ESHM20 [1], built upon recently compiled and fully cross-border harmonized datasets, information, and models. In this paper we present a new seismic hazard map for Greece, which has been based on the results of ESHM20 [1], as well as a new classification scheme based on the work by Pitilakis et al. [4], both for potential inclusion in the Greek National Annex which will accompany the revised Eurocode 8. The proposal presented herein is then applied to assess the seismic hazard and risk for Thessaloniki, Greece, a city which is very well-documented with respect to building stock properties and soil conditions. The results, given in terms of spatial distribution of spectral acceleration values at different periods, elastic response spectra for different soil conditions, as well as estimated damage and economic losses, are compared with those obtained using the current seismic codes in Greece (EAK [2] and EC8 [3]), in order to investigate the impact of a potential adoption of the proposed zonation and classification by the Greek National Annex of EC8.

2. NEW SEISMIC HAZARD MAP AND SOIL CLASSIFICATION SCHEME

The herein proposed zonation for rock sites (V_s>800m/s) for a return period of 475 years includes five zones with PGA values ranging between 0.13g and 0.37g (Figure 1). For each zone the parameters $S_{\alpha,475}$ and $S_{\beta,475}$ are provided in Table 1, which are the two seismic hazard parameters adopted in the revised Eurocode 8. $S_{\alpha,475}$ is the maximum response spectral acceleration corresponding to the constant acceleration range of the horizontal elastic response spectrum, while $S_{\beta,475}$ is the spectral acceleration at the vibration period T_β=1 s of the horizontal elastic response spectrum, both specified on site category A (rock site conditions) and for a return period of 475 years. Also, in Table 1 the short-period cut-off associated with the zero-period spectral acceleration, T_A, the lower and the upper corner periods of the constant spectral acceleration range, T_B and T_c respectively, and the corner period at the beginning of the constant displacement response range of the spectrum, T_D, are presented for the five recommended zones and for rock site conditions.

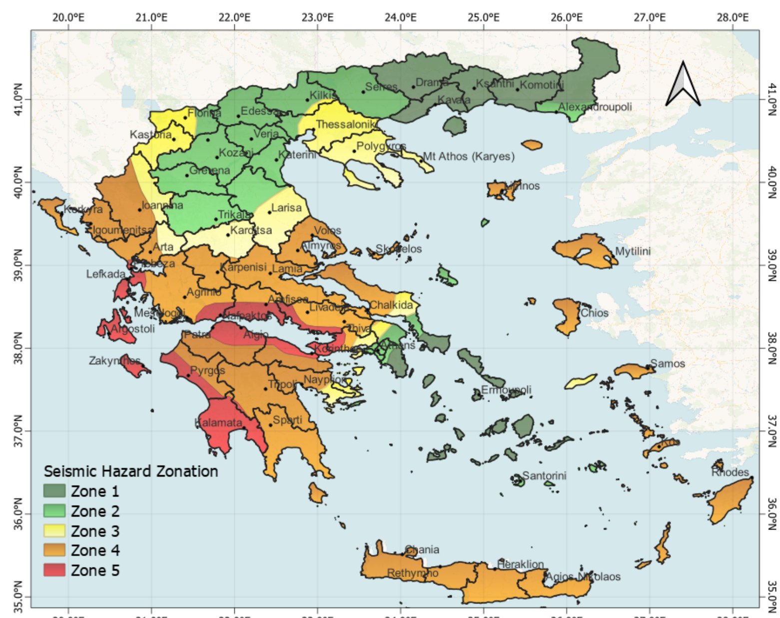

Figure 1. Proposed seismic hazard zonation map for Greece

Table 1. Proposed values of the parameters of the elastic response spectra of the revised EC8 for rock site conditions and for a return period of 475 years per seismic zone

Seismic Zone	PGA (g)	$S_{\alpha,475}$ (g)	$S_{\beta,475}$ (g)	T_A (sec)	T_B (sec)	T_C (sec)	T_D (sec)
1	0.16	0.32	0.13	0.02	0.10	0.41	2.00
2	0.19	0.47	0.15	0.02	0.08	0.32	2.47
3	0.23	0.58	0.18	0.02	0.08	0.31	2.77
4	0.29	0.73	0.25	0.02	0.09	0.34	3.45
5	0.37	0.92	0.34	0.02	0.09	0.37	4.34

The proposed soil classification scheme [4] (Figure 2) introduces the approximate depth to seismic bedrock, H_{800}, and equivalent shear wave velocity $V_{s,H}$ (equal to $V_{s,30}$ in most cases) as main classification parameters, and the fundamental period T of the site as a supplementary parameter, allowing to better distinguish between specific subclasses. For the proposed site classes, appropriate intensity-dependent site amplification factors F_α and F_β are provided [4], which amplify $S_{\alpha,475}$ and $S_{\beta,475}$ respectively.

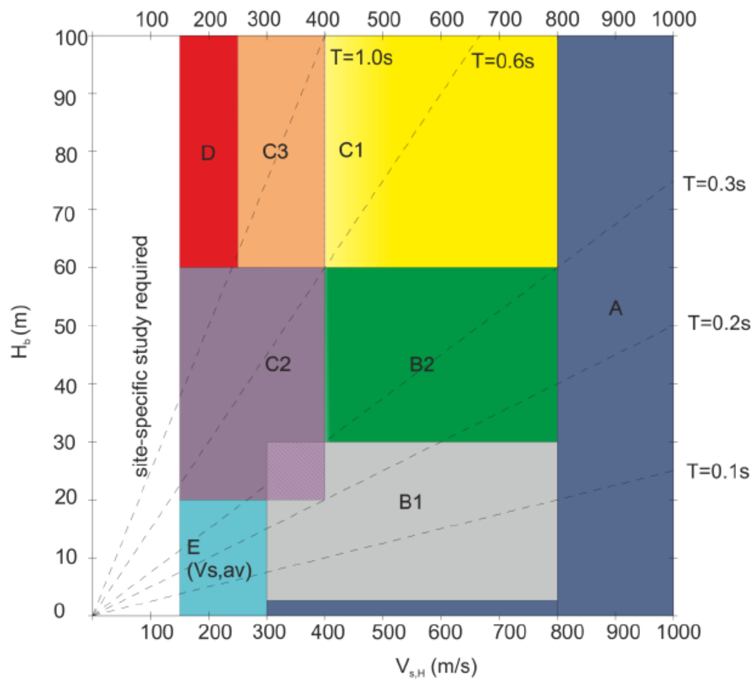

Figure 2. Schematic illustration of the proposed soil classification scheme

3. IMPACT ON THE SEISMIC HAZARD AND RISK OF THESSALONIKI

To estimate the impact of a potential adoption of the proposed hazard map and classification scheme by the Greek National Annex of the revised EC8, we assessed the seismic hazard and risk of Thessaloniki, Greece using for the seismic hazard (a) EAK 2003 [2], (b) current EC8 [3] and (c) the proposal for the National Annex presented herein. For the seismic risk analyses, we used the building taxonomy and fragility/ vulnerability curves by the European Seismic Risk Model ESRM20 [5]. We used the OpenQuake-Engine [6] to perform the scenario-type seismic risk analyses.

Aggregate results for the estimated damage of the residential buildings of Thessaloniki are given in Table 2. The overall conclusion is that the discrepancies at city scale are quite limited. Although the aggregate damages are comparable, in specific municipalities the current proposal results in increased percentages for extensive and complete damages, as shown in Figure 3. This is reflected also in the estimated economic losses, with the estimated aggregate losses for the residential buildings ranging between 5 and 6 billion €.

Table 2. Percentages of buildings per damage state for the residential building stock of Thessaloniki (T=475 years)

Code	No damage	Slight	Moderate	Extensive	Complete
EAK	59.5 %	19.5 %	8.2 %	4.5 %	8.3 %
EC8	59.4 %	20.5 %	8.7 %	4.5 %	7.0 %
New Proposal for National Annex	52.2 %	23.8 %	10.0 %	5.1 %	8.9 %

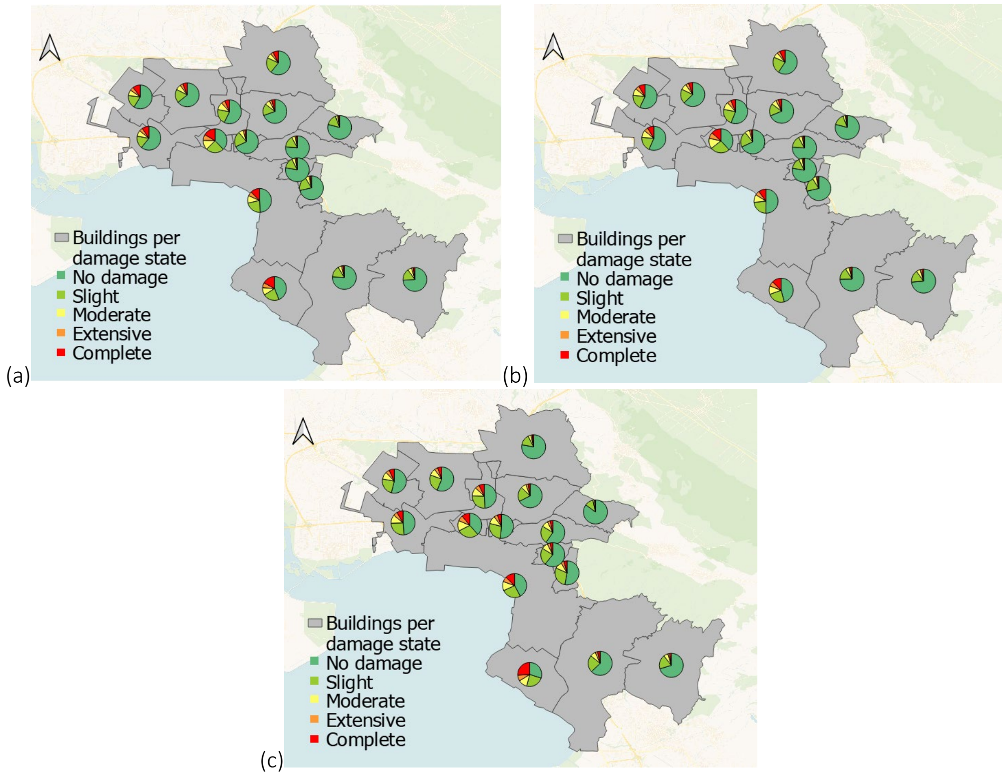

Figure 3. Percentages of buildings per damage state for the residential building stock of Thessaloniki per municipality (T=475 years) using for the seismic hazard (a) EAK 2003, (b) current EC8, (c) the proposal for the Greek National Annex of the revised EC8

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THE ROLE OF ADVANCED NUMERICAL MODELS IN CIVIL PROTECTION AGAINST NATURAL AND CLIMATE HAZARDS IN COASTAL AREAS

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ABSTRACT

Disaster losses due to natural and climate hazards are on the increase around the world. Coastal areas are among the most vulnerable to multiple hazards and host many of the hotspots that drive the aforementioned increase. Building resilient coastal communities is nowadays an imperative need, but it cannot be achieved without bridging the existing gaps between science (i.e. scientific methodology and tools), society and governance. The present work summarizes the authors' experience on the use of advanced numerical models for the simulation of coastal erosion/flooding and the design of coastal protection, and theorises on the role of such tools in hazard assessment and civil protection schemes, proposing a flowchart for the transition to informed decision-making for civil protection against natural and climate hazards in coastal areas.

Keywords: numerical modelling, coastal areas, natural hazards, climate hazards.

1. INTRODUCTION

Coastal zones host approximately one third of the world's population ([1] raises this number to 40%) and, consequently, a large part of the most important infrastructure and economic activities for many countries. The alarming increase of disaster losses due to natural hazards (NH) and climate hazards (CH) in the last couple of decades has brought forward the need for effectively designed adaptation and mitigation measures in order to enhance coastal resilience.

Natural scientists and engineers investigate various natural phenomena that may lead to hazard events, along with the effect of the climate crisis and its observed impacts on the intensity and frequency of occurrence of extremes. Numerical models are essential to the above, as they allow the study of all relevant processes and their interactions at variable scales in space and time. Nowadays, research literature has to present a series of significant advances in understanding, monitoring and forecasting natural and climate hazards, as well as in the design of coastal protection and adaptation measures towards more resilient coastal communities. The above, always taking into consideration that vulnerability (V) and exposure (E) to hazards are the key aspects determining disaster risks and relevant losses, and these are not dependent solely on the characteristics of the hazards themselves [2].

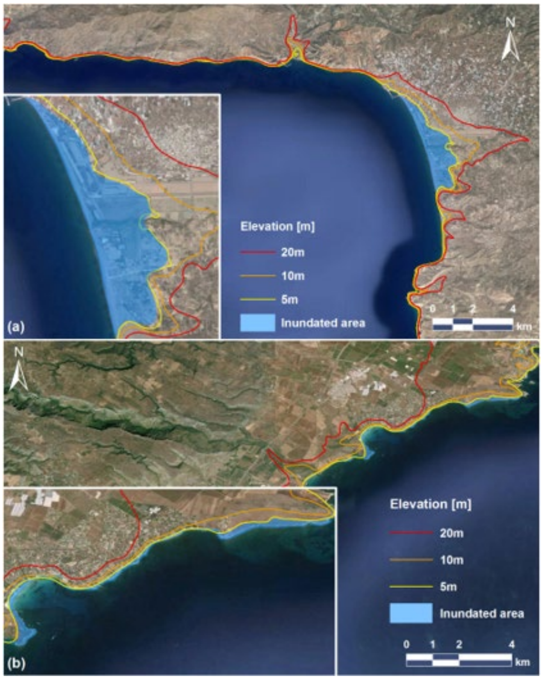
Accordingly, civil protection against NH and CH requires bold steps towards translating the existing scientific knowledge into policy and practice through informed decision-making. This work focuses on coastal areas, summarizes the authors' experience on the use of advanced numerical models for the simulation of coastal erosion/flooding and the design of coastal protection, and theorises on the role of such tools in hazard assessment and civil protection schemes.

2. MODELLING THE IMPACT OF NATURAL AND CLIMATE HAZARDS IN COASTAL ZONES

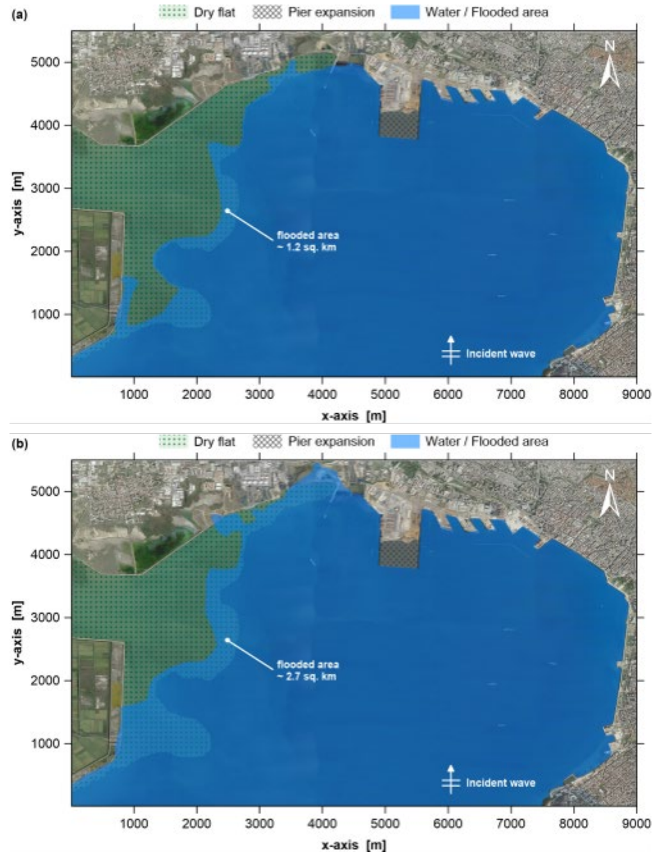
Modelling the impact of NH and CH on coastal erosion and coastal flooding (i.e. the main hazards for coastal areas) involves the representation of a series of relevant processes and their interaction, with scale issues (both temporal and spatial) dictating the use of modular modelling approaches based on varying-complexity nesting schemes and the coupling of interoperable models.
A general modelling flowchart for the realization of a modelling system in the above context would indicatively include moving downscale in space and time from operational oceanography models to large scale circulation and wave generation/propagation models for coastal areas, and then to high resolution wave dynamics, hydrodynamics and morphodynamics models in the nearshore, where wave-sediment-structure interactions, coastal erosion and coastal inundation would be simulated. This general scheme does not exclude adding/removing simulation steps to its lower- and/or higher-resolution ends, or modifying internal model coupling, as these choices depend on data availability and the overall modelling objective.
For example, if the modelling objective includes the study of climatic pressures per se, simulation steps should be added to the lower-resolution end of the aforementioned modelling flowchart in order to include a Regional Climate Model (RCM; one additional step) or a Regional Climate Model and a Global Climate Model as well (RCM + GCM; two additional steps). On the other hand, if the modelling objective includes the study of hazards like earthquake-induced tsunamis, simulation steps should be added to the lower-resolution end of the modelling flowchart in order to include the description of various fault models and the interpretation of sea bottom deformations to sea surface disturbances, that is tsunamis (two additional steps).
Many different realizations of modelling systems for the simulation of coastal wave dynamics and hydrodynamics, coastal erosion, coastal flooding and for the design of coastal protection are to be found in previous works by the authors [3-9]. These include the use of open-source tools like the TELEMAC suite with its various models (i.e. the spectral wave model TOMAWAC and the 2D and 3D hydrodynamics models TELEMAC-2D and TELEMAC-3D, respectively), as well as in-house modelling tools, including a large-scale wave propagation model (WAVE_LS), a nearshore wave transformation module (WAVE_L), a storm-induced circulation model (SICIR), a wave-induced circulation model (WICIR), an advanced nearshore wave propagation model (WAVE_BQ) and a sediment transport and morphology evolution model (SEDTR).
Figure 1 indicatively presents the results of two case studies using the in-house tools listed in the previous: one regarding the simulation of coastal flooding due to earthquake-induced tsunamis ([5]; panel I) and one regarding the simulation of coastal flooding due to climate extremes ([9]; panel II).

3. TOWARDS INFORMED DECISION-MAKING FOR CIVIL PROTECTION IN COASTAL AREAS

As mentioned in Section 1, despite advances in NH/CH understanding, monitoring and forecasting, disaster losses continue to raise at local to global scales and disaster risk reduction (DRR) remains an elusive goal for most civil protection authorities. Considering that most scientific tools are already available to natural scientists and engineers, focus should be set on how to achieve the transition from scientific expertise to informed decision-making at the local, regional and national levels.
Figure 2 presents an indicative flowchart of how such a transition could be achieved. It should be noted that several components of this modular flowchart deserve further elaboration, parts of which could be found in relevant literature (see [10-12] among others). In this work, the authors' objective is to highlight the role of advanced numerical models – like the ones presented in Section 2 – in this and similar approaches. There is a strong case to be made that preparedness and awareness should be



(I)



(II)

Figure 1. I: Inundation maps of two low-lying coastal areas at: **(a)** south-southwest Crete, Greece, and **(b)** east-southeast Sicily, Italy for two earthquake-induced tsunamis generated at respective tsunamigenic sources (Figure adopted from [5]; see publication for details). **II:** Model results for the Bay of Thessaloniki (Greece), indicating the flooded area for two scenarios of climate change- induced wave and storm surge events, namely **(a)** a scenario of southern wave of significant wave height H_s = 1.58 m and peak period T_p = 4.60 sec, and **(b)** a scenario of the same wave combined with a storm surge of height *SSH* = 0.30 m (Figure adopted from [9]; see publication for details).

based primarily on solid, quantitative results of how hazards would impact coastal areas and of how protection measures (technical or managerial) would help mitigate the adverse effects of NH and CH. These results should be based on a few fundamental indicators/parameters that are easy to grasp, like flooded or eroded area/extent, and should be used, afterwards, to perform cost-benefit analyses (CBA) of the various mitigation and adaptation measures that would enhance coastal resilience. Although seemingly intuitive, this is not the typical case in civil protection practice, where policymakers and the public are often presented with either too vague (hard-to-relate) or too technical (hard-to-grasp) aspects of the scientific basis behind hazard risk assessment.

In view of a dire future, the scientific community should intensify its efforts in order to provide comprehensive results that would bring onboard policymakers, stakeholders and the public in adopting solutions for disaster risk reduction that would build resilient communities and protect biodiversity and cultural heritage in coastal areas. Numerical models lie, by default, in the core of relevant approaches; the major challenge ahead is how to bridge the existing gaps between science, society and governance.

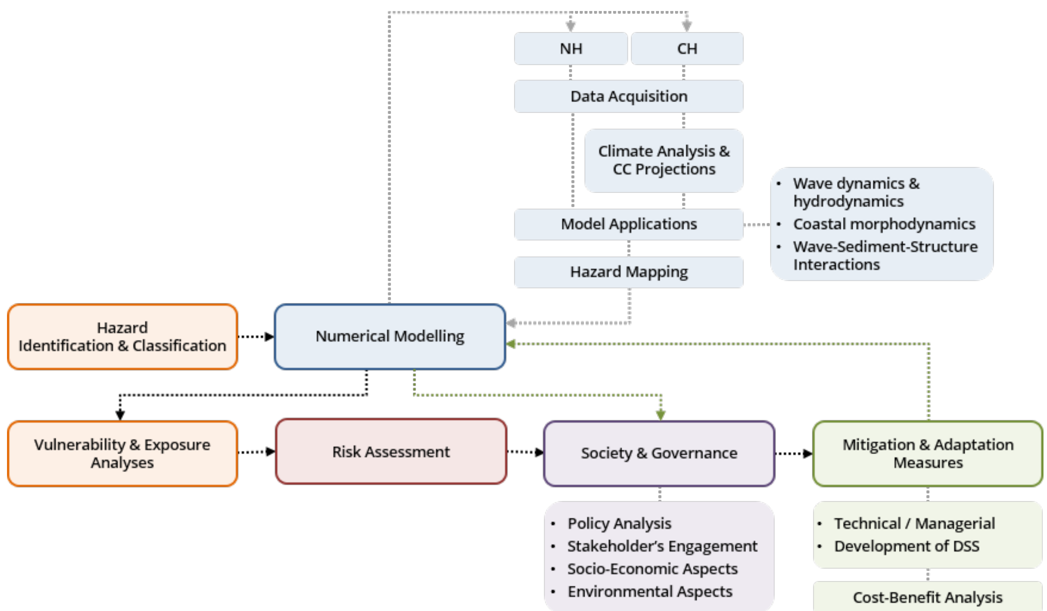


Figure 2. Flowchart for the transition to informed decision-making for civil protection against natural and climate hazards in coastal areas (NH/CH: natural/climate hazards; CC: climate change; DSS: decision support systems).

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SPATIAL APPROACHES FOR ANALYZING HISTORICAL EARTHQUAKES ASSOCIATED WITH THE DEAD SEA TRANSFORM

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ABSTRACT

Historical reports, archaeoseismic evidence and plaeoseismic findings of pre-instrumental earthquakes occured along the Dead Sea Transform (DST) are available for the past 3000 years. Most of them were already collected and organized in various catalogs, reappraisals, and lists. Using spatial interrogation of old visual sources such as drawings, maps and photographs, earthquake damage localities were resolved thus enriching the existing knowledge base and contributing new spatial approaches. Examples are the damage detection and spread in Jerusalem and Tiberias after the 1927 and 1837 earthquakes, respectively. Then, a comprehensive and consistent compilation of the historical seismicity associated with the DST as an integral seismogenic unit was spatially and temporaly examined. The compilation resulted in 208 reliable historical and post-19th century instrumental earthquakes (from the mid-8th century BCE until 2015 CE), and 112 doubtful ones. Characterization of the temporal and spatial patterns of DST seismicity, classified into 4 geographical sub-zones, was implemented. Accordingy, it was detected that the occurrence of destructive earthquakes shifts south-to-north along the DST, in which an occurrence of a southern event is followed by consecutive northern destructive activity.

Keywords: Historical earthquakes, damage, Dead Sea Transform, Spatial and temporal analysis

1. INTRODUCTION

Numerous sources of historical earthquakes occured in the Levant, including the damage and effects they caused have been accumulated over the last 3,000 years. They include historical accounts, archaeoseismic remains and paleoseismc findings. Most of them, were already collected and organized in various catalouges, reappraisals, and lists [e.g., 1, 2-4]. In many cases, the damage description extracted form these sources can be used to conclude siesmic intensities [5] asisting in concluding earthquake charecteristics (e.g., location and magnitude) [6, 7]. Among the historcal sources, one can list numerus visual sources such as old drawings, maps, photographs and air-photos [8] which can be spatialy interogated for resolving earthquakes damage. The rapid development of imagery software and GIScience (Geographic Information Science) enable us a suitable framework for developing new methodologies targeted at tracking past earthquake damage [e.g., 9, 10]. Furthermore, they also foster the ability to examine and detect spatial and temporal patterns, clusters and repating activity associated with a seismogenic unit [11]. Accordingly, the objectives of the study are: (1) Saptial interrrogation of visual sources to resolve earthquake damage; and (2) Spatial and temporal examination of historical earthquakes to increase our understanding of the Levantine seismic behavior.

2. METHOD AND DATA

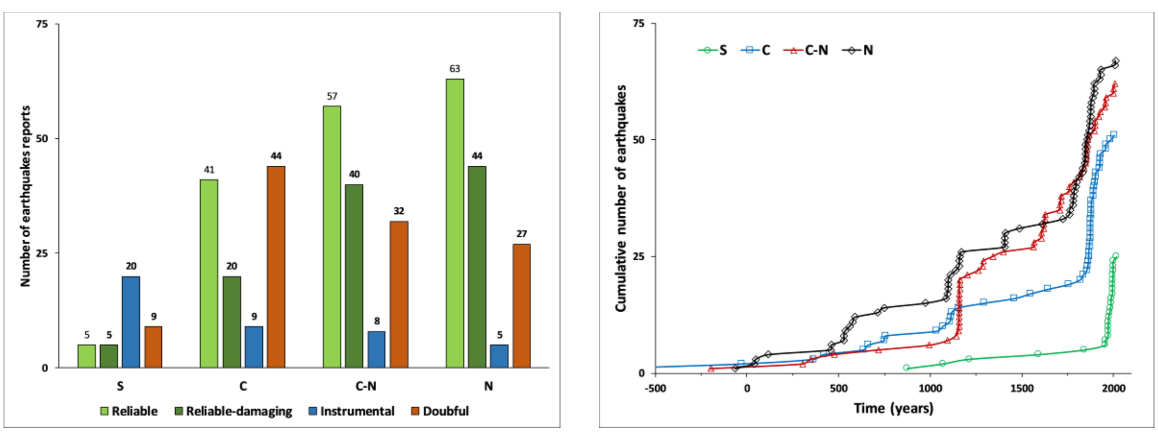
For the task of resolving earthqauke damage, existing archives of various visual sources were exploited. The suitable visual sources were compiled with textual reports, archeological data and field surveys. For the 1927 earthquake [12] hitting Jerusalem, the spread of metal iron anchors using old photographs was inspected. These were installed on damaged walls after the earthquake to prevent their further deterioration and thus proxy of damaged structures (Figure 1a). Some of the photographs, the anchors appear so small and well embedded within their surroundings that without considerable magnification accompanied by detailed field surveys their detection was almost impossible. For the 1837 earthquake [13] in Tiberias, nearly 50 drawings, maps and photographs were examined and compiled with written accounts (Figure 1b). Precise digitations of the shape of Tiberias's main features were made in a GIS-based framework and three-dimensional models prior and after the 1837 earthquake were established. The models allow for 360˚ areal and vertical examination enabling full evaluation of the damage. The rest of the earthquake entries and the resulted damage was collected and compiled using modern and early catalogues, reappraisals and focused investigations of specific events to establish a complete and reliable database for the spatial and temporal inspection.

(**a**) (**b**)

Figure 1. Data used for resolving damage: (**a**) Iron anchor on collapsing walls in Jerusalem after the 1927 earthquake (photograph: M.Z); (**b**) an old drawing of Bernatz (1839) portraying the damage to Tiberias walls after the 1837 earthquake [14]

3. RESULTS AND DISCUSSION

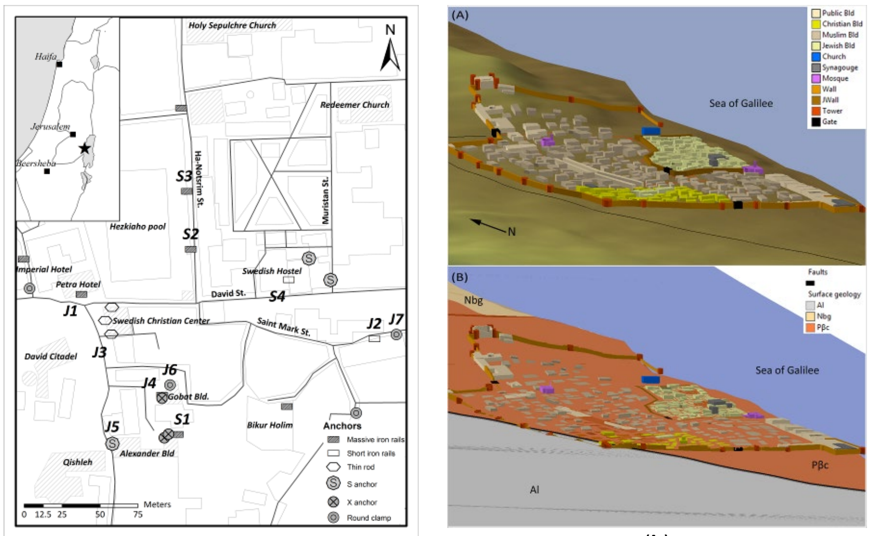
Three lists of were compiled (Figures 2a, 2b): (1) 208 reliable earthquakes associated with DST activity (excluding foreshocks and aftershocks) together with the 42 M ≥ 5 instrumental earthquakes (between 1903 and 2015); (2) 112 doubtful events; that is, duplications, conflicting interpretations of the historical records, fake events or questionable earthquakes that to date remain unauthenticated; (3) 71 reliable events that affected or damaged regions close to the DST but their most reported damage zone is far away from any DST zone. In accordance with the damage spread, each of the earthquakes were associated with a sub geographic zone of the DST (South, Center, Center-north and North) (Figure 4).



(**a**) (**b**)

Figure 2. (**a**) Classification of earthquakes (excluding foreshocks and aftershocks) into DST zones (S, C, C-N, and N): (1) reliable earthquakes; (2) reliable damaging earthquakes; (3) instrumental earthquakes (1903–2015 C.E.); and (4) doubtful earthquakes; (**b**) Cumulative reports of reliable earthquakes occurred between 198 B.C.E. and 2015 C.E. classified into the DST zones.

The damage distribution in Jerusalem and in Tiberias after the 1927 and 1837 earthquskes is presented in Figures 3a and 3b, respectively. Using georeferenced visual sources and spatial analysis of the details they contain it was possible to portary the damage in high resulution. In Jerusalem, in the Christiam quarter alone, more than 10 new damage localities were detected while in Tiberias, a complete damage reconstruction using GIS models was achived.



(**a**) (**b**)

Figure 3. High resolution damage spread: (**a**) 1927, Jerusalem; (**b**) 1837, Tiberias.

Classifying the DST into four zones indicates 5, 41, 57, and 63 earthquakes (excluding foreshocks and aftershocks) in the S, C, C-N, and N zones (Figure 4). With Chi-square tests, it was found that a single earthquake sequence, that is followed by chronological successive earthquake in a different zone, appears 88%, 83%, 67%, and 59% of the total sequences of the S, C, C-N, and N zones, respectively.

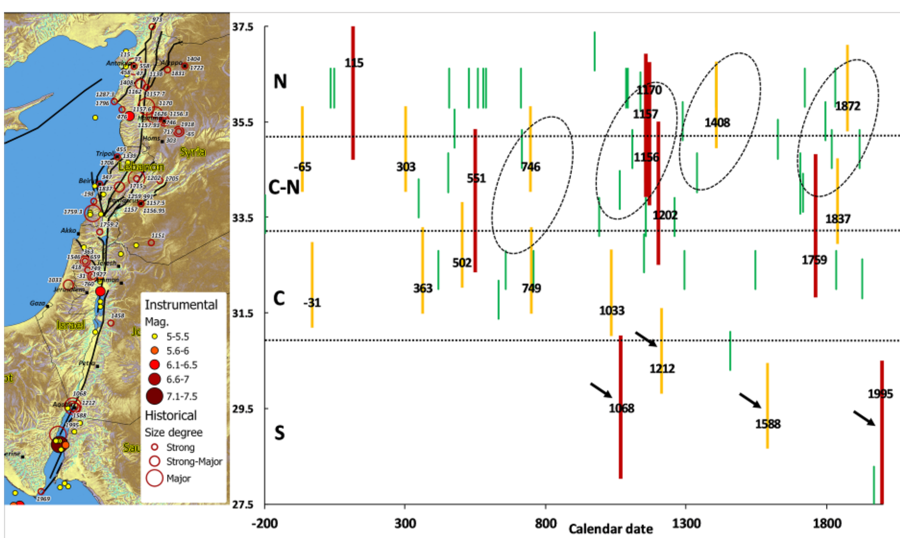


Figure 4. (**a**) Inferred most reported damage zone (MRDZ) locations of historical earthquakes. The epicenter of instrumental earthquakes (post-19th century) is positioned together with adjacent magnitude. (**b**) Spatial and temporal distribution of earthquakes during the last three millennia. Strong, Strong-major, and Major earthquakes are scaled in length and noted by green, orange, and red vertical lines, respectively, with center points aligned with map location to the left.

Furthermore, in S and C zones there are no sequences greater than two successive earthquakes. Additionally, 41%, 36%, 14%, and 13% of the successive earthquakes at the same zone occur in the N, C-N, C, and S zones, respectively. That is, the northern seismic activity in the C-N and N zones is more clustered than in the S and C zones.

4. CONCLUSIONS

Two examples of earthquake damage analysis were presented. Considering the lack of data associated with pre-instrumental earthquakes, further interrogation of visual sources should be fosterd to increase our knowledge base.

The observed south–north shifts of DST activity implies of a postulated alternation pattern of strong seismicity. For further investigation, the spread of the damage of each earthquake should be evaluated accurately and then tied to a potential triggering tectonic segment.

The study conducted and the database established may serve as a base for future studies of the DST as a complete tectonic unit. Further interdisciplinary efforts should be made particularly in resolving the full scope and severity of the resulted damage, which may assist substantially in refining the presented results.

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CIVIL PROTECTION INNOVATIVE ACTIONS AND TECHNOLOGIES IN THE REGION OF CENTRAL MACEDONIA

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ABSTRACT
The frequency and extent of natural and technological disasters, because of climate change, overpopulation, and other causes, makes it necessary to take measures and implement civil protection prevention actions by public organizations. The present paper presents a series of innovative actions and technologies designed and implemented by the Autonomous Civil Protection Directorate the Central Macedonia Region (ACPD, RCM), with the aim of effective and on time civil protection prevention. The specific actions, which are inter-linked and complementary to each other, aim at creating the necessary civil protection infrastructure, at raising public awareness as well as at activating the human resources that participate in emergency prevention and management actions (executives, volunteers, citizens). Through the implementation of these actions, it is achieved the continuous improvement of the operational competence of the Central Macedonia Region for dealing with civil protection crises and new opportunities are created for more targeted investments in the specific sector in the coming future. Through the implementation of the actions which are funded by the European Union and other funds it is safeguarded the European social cohesion and integration. Also, cooperation, synergy, creation of added value and support with the appropriate infrastructures for the local and regional civil protection mechanism are ensured while, at the same time, important goals are achieved for the promotion of smart Development and Agenda 2030.

Keywords: civil protection, public policies, innovative technologies, drones, training

1. INTRODUCTION – AIMS OF CIVIL PROTECTION ACTIONS

Nowadays, civil protection issues are an important priority for all public organizations towards the planning and implementation of their policies. A series of major natural disasters that have hit Greece in the last five years led the Greek state and, in particular, the Local and Regional Government Organizations to the inclusion of preventive civil protection actions with the aim of effective and on-time protection of citizens, natural and cultural heritage from natural and other disasters. In this context, the Autonomous Directorate of Civil Protection (ACPD) of the Region of Central Macedonia (RCM), implemented a series of various actions for the creation of the necessary civil protection infrastructures and the awareness of citizens on matters of civil protection. In this context, the ACPD proceeded with the supply and development of modern technology systems for the effective prevention and appropriate management of civil protection emergencies. Part of the equipment and technological investments was provided to agencies participating in the regional emergency management mechanism (voluntary organisations, military, forest protection and firefighting services). These actions are also included in the context of extroversion and innovation promoted by RCM, with the aim of Smart Development [1] promoted by the European Union, but also the achievement of Sustainable Development goals, following the UN Agenda

2030 [2] for which the Greek state is committed. To a large extent, maintaining the competitiveness of local economies and social cohesion depend on the initiatives and actions taken by public organizations in the context of their planning and the implementation of their development programs.

Pursuing an integrated approach to the planning of civil protection preventive actions, ACPD has chosen the implementation of a series of complementary actions which essure the availability of the necessary civil protection infrastructure alongside the motivation and activation of human resources (executives, volunteers and citizens). This is a prerequisite for the appropriate crisis management from natural, technological and other common disasters. This paper presents five (5) selected actions implemented by RCM and the expected benefits from their implementation in the context of sustainable development. The specific actions are the following:

1. Participation in an international research program on the use of Drones in the prevention and response of emergency situations ("Novel integrated solutions of operating a fleet of drones with multiple synchronized missions for disaster responses").
2. Supply of portable electronic, mechanical and personal equipment to deal with emergency needs with the beneficiaries being volunteer organizations of the RCM, the officers of the Civil Protection Services as well as the "EMAK" (Special Disaster Response Unit based in Thessaloniki).
3. Supply of a specially designed vehicle, fully equipped to function as the Mobile Operations Center in emergency situations.
4. For the protection of the urban forests of Thessaloniki, supply and pilot installation of an "integrated autonomous fire detection system for the forest area of Sheikh Su".
5. In the context of raising awareness of civil protection issues for the educational staff of the school units of the RCM, ACPD officials made a series of presentations under the general title "Prevention and response to natural disasters and school security issues".

The above actions were implemented in a particularly crucial period, experiencing the effects of climate change, but also the recent pandemic of COVID-19 and the need to upgrade and reorganize the Mechanism of Civil Protection in our country which was instituted with the Plan "National Mechanism of Crisis Management and Risk Management" (Law 4662/2020). In the next section, more information is given on the technical characteristics of the actions and the expected benefits from their implementation in the context of an integrated civil protection approach.

2. CONTENT AND ACTICIPATED RESULTS OF THE ACTIONS

The first innovative action implemented by ACPD concerns the participation of the RCM in the international project "Novel Integrated Solution of Operating a Fleet of Drones with Multiple Synchronized Missions for Disaster Responses", with the acronym RESPONDRONE which was implemented within the framework of the HORIZON 2020 Program. Overall, it is a project with many innovative packages of action with great practical value for the participating partners, who are an international group coming from many different institutions (Universities, Research Institutes, Public Services, Local and Regional Government, etc.). Specifically, the project involves twenty partners from twelve countries around the world, led by the "Deutsches Zentrum Fuer Luf und Raumfahrt EV", from

Germany. The time frame for the implementation of the project is thirty-six months. The aim of the project is to utilize modern technology and in particular drones for the prevention and effective response to natural disasters. More specifically, the RESPONDRONE project, through the implementation of its various actions (development of technological innovations, study of the nature of disasters and the conditions of management and cooperation, training, etc.), contributes to the understanding of the nature of emergency situations and in the continuous improvement of the operational readiness of the project partners. Specific emphasis is placed on the operational readiness of the Regions, which are also the end users of the project's actions. This is achieved by providing useful information on how to manage natural disasters and valid data that is provided in real time. An important element of the project is that its design focuses on the real needs and requirements of the agencies involved in emergency management, allowing their effective and efficient cooperation at the local, regional and international level. It is known that emergency situations, as well as pollution and/or contamination phenomena, do not "know" borders and their effective treatment needs to be done through international and interdisciplinary collaborations.

The second important action implemented by ACPD was the supply of equipment and materials for the executives and members of Volunteer Civil Protection Teams. In particular, the ACPD, through the Regional Operational Program and EU funding, implemented the project "Supply of personal equipment and stage material to deal with emergency Civil Protection needs", with a budget of over 650,000 euros. The procurement concerned the equipment for the members of Voluntary Organizations which are recognized by the Greek General Secretariat of Civil Protection and are activated in civil protection actions within the administrative territory of the RCM. The supply included items such as: clothing, safety helmets, flashlights, safety glasses, face masks for protection against flames, safety boots, special pacifiers, transport bags, etc. For the Special Disaster Response Team (“EMAK”) personnel, chemical protection equipment and high-temperature jackets were included. Also, the supply of 137 tents was included to strengthen the operational readiness of the ACPD and Hospitals of the 3rd and 4th Health Regions of the Ministry of Health.

The next action implemented by ACPD was the supply of a specially equipped vehicle which is used as a mobile operational center during the management of emergency situations, with a budget of over 1,880,000 euros. This vehicle is equipped with communication equipment to ensure communication in remote areas, using different transmission media such as optical fibers and satellites. It also has a stable base of voice, data and video communication, with thirty wireless, heavy-duty, telephone devices (4G/LTE), for the safe communication with rescuers and persons operating in the field during the management of civil protection crises.

Another action of procurement and installation of modern equipment, with the aim of preventing forest fires, was the "Integrated Autonomous Fire Detection System for the Forest Area of Sheikh Shu". This specific system aims at the effective prevention, monitoring and timely detection (localization) of forest fires in the vulnerable area of the sub-urban forest ecosystems of Thessaloniki. Monitoring and prevention today is done exclusively by patrols and observation of volunteers using the existing fire pits. Through the supply and installation of this system, the early detection of a forest fire is facilitated with the help of technology, during the day and night, all year round. The autonomous system uses LIDAR-type sensors to locate potential fire hotspots and gather useful information, such as the possible direction of the fire, to help management decisions and instructions for immediate action. The system covers an area of 70 square kilometers.

Another important action of ACPD was the education and awareness cultivation of students, teachers and professors on the important issues of civil protection. The action was implemented through special presentations which were carried out within the school units, but also through distance learning (tele-training), during the period of implementation of the COVID-19 prevention measures. The main focus of the presentations is the easy-to-understand presentation of self-protection measures from emergencies, natural disasters and severe weather phenomena. Particular emphasis is placed on the informed use of the European three-digit emergency number "112". By training students and their teachers, the cognitive and psychological preparation of local communities is achieved for the prevention and appropriate response to natural and technological disasters in the near future. The action started as a pilot project in the Regional Unit of Pieria, in 2018, through a specific program of presentations and lectures on civil protection issues for primary school students (after relevant approval from the Ministry of Education & Religion). The awareness cultivation of students and their teachers continued, under the auspices of the Regional Directorate of Education of Central Macedonia and the general title "Prevention and response to natural disasters and school safety issues". Investing in education and, above all, in raising the awareness of young students, is an important adding-value and multiplying factor for the appropriate and on-going preparedness of local communities in the crucial issues of civil protection (basic principle of the "snowball" method).

3. CONCLUSIONS – PROPOSALS FOR FUTURE ACTION

Public sector organizations have always looked for new, innovative, and creative, ways to fulfil their mission [3]. The lack of appropriate infrastructure and the limited use of modern technologies for the prevention and proper management of emergency situations is a diachronic problem in civil protection. Through the implementation of the above and other innovative actions and projects undertaken by the Division of Civil Protection of the Regional Government of Central Macedonia, it is initiated a new era in civil protection for the effective and efficient cooperation among the members of the local and regional civil protection mechanism. Future actions to further strengthen civil protection in the Region of Central Macedonia can be aimed at exploiting economies of scale and the apprpriate use of new technologies for the exchange of information and cooperation in real time, which is the most critical factor for the successful response to crises.

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THE ENVIRONMENTAL IMPACTS FROM TECHNOLOGICAL AND NATECH DISASTERS

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ABSTRACT
Our presentation is about the impact on the environment after a technological or NaTech disaster. By evaluating the effects of safety studies, up until now the assessment of thermal radiation, overpressure or leakage into the environment of a flammable or toxic substance and the corresponding extent of the disasters was carried out. With the implementation of JMD.1915/2018, the effects on the subsoil, the atmosphere and the underground/surface waters are now being assessed, and we therefore know the way to best react for the restoration to the pre-disaster situation.
Our presentation will provide a guide for investigating these environmental impacts.

Keywords: Environmental Impacts, Seveso, National Guidelines, Assessment of Environmental Risk Scenarios

1. INTRODUCTION

The guidelines and suggestions are for informational purposes for:

1. The authorized Environmental Licensing services, with respect to:
• Determining the minimum requirements for the assessment of the possible environmental impacts of the sensitivity of a Project or Activitiy and the risks of serious accidents and natural disasters,
• Determining the appropriate measures for projects vulnerable to serious accidents and/or natural disasters with adverse effects on the environment.
2. The researchers for the assessment and evaluation of the sensitivity of the projects against serious accidents and disasters and the completion of the Environmental Studies, which they prepare, with similar content.
Additional EU studies have been taken into account for the compilation of the mentioned framework of guidelines/instructions,[1] [2] [3] which can be used for further study

2. LEGAL FRAMEWORK

1. Legislative Decree 1915/26-01-2018 (Government Gazette 304B/02-02-2018) "Amendment of Decree No. 48963/2012 (B' 2703) Decree No. 167563/2013 (B' 964) JMD. and No. 170225/2014 (B΄135) MD, which have been issued under the authority of Law 4014/2011 (A'209) in compliance with Directive 2014/52/EU "on the amendment of the 2011 application /92/EU on the assessment of the effects of certain public and private projects on the environment" of the information and the Council of 16 April 2014". It refers to the expected environmental consequences resulting from the sensitivity of the project to risks of serious accidents or disasters related to the project.

2.Official Gazette 5688/12-03-2018 (Government Gazette 988B/21-03-2018) "Amendment of the annexes of Law 4014/2011 (A'209), in accordance with Article 36A of this Law, in compliance with the Directive. 2014/52/EU "amending Directive 2011/92/EU on the assessment of the effects of certain public-private projects on the environment" of the European Parliament and of the Council of 16 April 2014".

3. MD A.P. 170225/20-1-2014 "Specification of the contents of the files for environmental licensing of projects and activities of Category A" of the decision of the Minister of Environment, Energy and Climate Change with no. 1958/2012 (B΄ 21) as applicable, in accordance with article 11 of Law 4014/2011 (A΄ 209), as well as any other relevant details" etc.

4. JMD. 172058/2016 (Government Gazette 354/B/17.2.2016) Determination of rules, measures and conditions for dealing with risks from large-scale accidents in facilities or units, due to the existence of dangerous substances, in compliance with the provisions of 2012/18/EU. "to address the risks of major accidents involving dangerous substances and to amend and subsequently repeal Council application 96/82/EC" of the Council and the Council of 4 July 2012. Replacement of no. 12044/613/2007 (B΄376), as corrected (B΄2259/2007).

It is noted that in Directive 2014/52/EU, paragraph 15 states:
To ensure a high level of environmental protection, preventive actions need to be taken for certain projects which, due to their vulnerability to serious accidents, or natural disasters such as floods, sea level rise or earthquakes, are likely to have serious negative effects to the environment. For such projects, it is important to consider their vulnerability (exposure and adaptability) to major accidents and/or disasters, the risk of such accidents or disasters occurring, and the consequences in terms of the potential for serious adverse effects on the environment. In order to avoid duplication, it should be possible to use the relevant information available and obtained through risk assessments carried out through European legislation, such as Directive 2012/18/EU of the European Parliament and of the Council and Directive 2009/71/Euratom of the Council, or through relevant assessments carried out under national legislation, provided that the requirements of this Directive are met.

3. SCOPE

The guidelines concern new projects and activities that are subject to an environmental impact assessment (EIA submission) and existing ones when the approved environmental conditions are amended or renewed, in accordance with Law 4014/11 and (3) the relevant MD.

The guidelines concern all projects and activities that are subject to environmental licensing of category A΄ (Subcategories A1 and A2) as referred to in (3) the relevant MD. Projects and activities of category B of (3) related are not subject to (1) and (2) related MLAs.

Indicative of some projects and activities and not exhaustive, in order to understand the possible environmental effects, some cases of projects or activities that are vulnerable to accidents and natural disasters, and their potential impacts, are presented as examples:

1. Project or activity (eg industrial facility or port) where LPG storage takes place near an archaeological site or cultural monument.
• Possible environmental impact on Soil, Air, Water recipients e.g. deterioration/destruction of the cultural monument due to overpressure from an accident.

2. Project or activity (e.g. industrial facility or port or airport) where petroleum or hazardous chemical storage takes place near a Natura site.
• Possible environmental impact on Soil, Air, Water recipients e.g. ecological effects (e.g. on protected species, avifauna) due to an oil spill (soil, water receiver, sea) from an accident.

3. Project or activity (eg industrial facility or port or airport) where petroleum or hazardous chemical storage takes place near water intake points.
• Possible environmental impact on Soil, Air, Water recipients e.g. effects on the quality of pumped water due to an oil spill (subsoil) from an accident

4. Project or activity where transport of dangerous (toxic, flammable, potentially explosive) substances takes place by road, or by rail or through pipelines, near a sensitive recipient (e.g. archaeological site, cultural monument, Natura area).
• Possible environmental impact on Soil, Air, Water recipients e.g. to the sensitive recipient from an accident (fire, explosion, toxic spill, etc.).

5. Project or activity sensitive to Natural Disasters (e.g. Landfills, mining activities, Sewage Treatment Facility, temporary storage/waste management facilities).
• Potential environmental impact. in Soil, Air, Water receivers e.g. Effects on receivers (soil, air, water receiver).

6. Project or activity with a potential fire accident (Landfills, Waste Management Units, industrial facilities, storage activities/hazardous material transport projects)
• Potential environmental impact. in Soil, Air, Water receivers e.g. potential discharge of contaminated fire extinguishing water with effects on receivers (soil, water receivers) etc.

At this point we mention that there are 24 SEVESO III uppertier establishments step in the Thessaloniki urban complex of 1 million homes with a history of Technological Accidents.

4. ASSESSMENT OF ENVIRONMENTAL RISK FROM SERIOUS ACCIDENTS OR NATURAL DISASTERS

C.1. Starting point
The starting point for the scope and methodology of this assessment is that the proposed project or activity must be designed, constructed and operated in accordance with current international best practice, resulting in the possibility of a serious accident occurring due to its construction or operation and its vulnerability to natural disasters, to be very small. It is noted that for the risk to manifest, the following three components must be present: a) Source of hazard - Source of hazard, b) Pathway between source and recipient - Pathway and c) Receiver of the risk – Receptor

C.2. Assessment of Environmental Risk Scenarios from Serious Accidents or Natural Disasters
The environmental study must contain information on:
Serious Accident Scenarios (SCA) or Natural Disasters (FC) with possible environmental ones, such as:
• the methodology used to determine which SCA/FC are likely to cause environmental conditions
• how FC can cause SCA or
•an event within the project or due to the project may cause a natural disaster (eg fire in a facility adjacent to a forest).
Natural Disasters can include fires, earthquakes, floods, landslides, high tides, rising groundwater levels, high winds, high rainfall, extreme cold and hot weather, as well as climate change-related disasters. A natural disaster does not necessarily directly cause an Serious Accident Scenarios (SCA) but could trigger a primary event leading to an SCA (e.g. at Fukushima Daiichi the earthquake caused a tsunami which damaged the reactor cooling system, resulting in the known nuclearaccident).
The following is the proposed methodology for the Assessment of Environmental Risk Scenarios from Serious Accidents or Natural Disasters:

C.3. Critical Points for Assessing Environmental Risk Scenarios From Major Accidents or Natural Disasters

1) Potential sources of risk that can cause significant environmental impacts (serious accidents and natural disasters). 2) Identification and determination of hazardous substances involved in possible accidents/natural disasters. 3) Monitoring, prevention, control and containment measures. 4) Description, assessment and evaluation of the potentially significant expected negative effects of the project on the environment, resulting from the project's sensitivity to risks of serious accidents or disasters. 5) Determination of recipients who may suffer consequences in the wider area of the project or activity for individual scenarios. 6) Determination of control and response measures.

C.4. Evaluation Methodology of the Environmental Risk Scenarios examined
The assessment of the risk of a major accident and/or natural disaster examines all the factors specified in the Directive, i.e. population and human health, biodiversity, land, soil, water, air, climate and material goods, cultural heritage and landscape and is related to the likelihood of the impact occurring
Assessment of the likelihood of threats occurring: The evaluation of the probability of occurrence of threats is done by probability assessment. The risk classification table has five scales with categories extremely improbable (occur only in exceptional cases once every 500 years), very improbable (may occur once every 100-500 years), unlikely**,** randomly recorded accidents, likely regular recorded accidents, and Very likely (accidents that occur more than once each year)

Environmental impact assessment: The importance of the environmental impacts is determined according to the Table that will be presented and includes five scales of classification of environmental impacts according to the impact such as human health, economy, well-being, natural environment, infrastructure, social environment.

Assessment and acceptance or non-acceptance of the risk: Probabilities and impact estimates are multiplied to form a risk score for risk assessment. The hazard table is color coded to provide a broad indication of the nature of each hazard. The red zone represents "high risk" scenarios, the orange zone represents "medium risk" scenarios and the green zone represents "low risk" scenarios

5. CONCLUSION

The General Guidelines and Proposals for the Assessment and Evaluation of the Impacts on the Environment from the Vulnerability of Projects or Activities to Risks of Serious Accidents and Natural Disasters ensure a high level of protection both for human health and the protection of the environment, by properly following the legislative framework, along with the constant inspections by the governing authorities.

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DISASTER RESILIENCY STRATEGIES AND LOCAL GOVERNMENT UNITS

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ABSTRACT

This article looks at the role of the government in making Greece more resilient to disasters and more stable economically. A descriptive study was done, and data from different government leaders in Kozani, Greece, will be gathered to learn more about the role of the government in building disaster-resilience and economic sustainability. The study proved that the government's focus on building disaster-resilience has a positive effect on the economy's long-term health. Governments are mostly able to build disaster-resilience and stable economies through leadership, working with civil society, and working with other countries.

Keywords: Disaster resiliency, Economic sustainability, Government focus areas and disaster management

1. INTRODUCTION

1.1 Background to the study

Europe is one of the places where natural disasters happen the most often (D'Alfonso, 2022). The poorest people and places are hurt the most by these disasters. The goal of the 2030 Agenda for Sustainable Development is to reach everyone. This is to make sure that no one is left behind (Benson, 2016; Pal et al., 2021). (D'Alfonso, 2022) If governments want to protect their most vulnerable citizens, they need to make sure that their national development plans are based on disaster resilience. Even though there were fewer disasters in 2016 than in previous years, they still had a big effect. They killed 4,987 people, affected 35 million people, and caused an estimated $77 billion in damage. The main reason people died was because of flooding, which took 3,250 lives. Since 1970, the number of deaths has changed a lot from year to year, but on average, 43,000 people have died each year. This is mostly because of earthquakes, storms, and floods. Since 1970, people who live in Europe are five times more likely to die in a natural disaster than people who live elsewhere. Disasters can also cause damage on a large scale. Between 1970 and 2016, Europe's assets went down in value by $1,3 trillion. earthquakes, tsunamis, storms, droughts, and floods caused almost all of this. This kind of harm has been getting worse over time. This is partly because as GDP goes up, more physical assets are at risk (Ayyub et al., 2015).

1.2 Purpose of the study

The study sought to assess the role of the government in developing disaster resiliency and economic sustainability. The study is also based on different specific objectives that include the following;

1. To establish the key focus areas of government in developing disaster resiliency
2. To explore the different aspects of economic sustainability in regard to disaster resiliency
3. To establish the relationship between government focus on developing disaster resiliency and economic sustainability

Research hypothesis

H1: Government's focus in developing disaster resiliency positively affects economic sustainability.

2. LITERATURE REVIEW

The word "resilience" has been used in writing since the 1960s, but its theoretical foundations are still being worked on. This phrase can be used in many different ways and can mean different things depending on the context. It comes from research on the dynamics of complex systems. Even though it comes from the environmental and physical sciences, the word has been used and accepted by the social sciences, such as economics and urban and regional studies. In reality, the idea of resilience is used a lot these days to study how spatial economic systems work and to talk about how they respond to shocks and changes in the economy. Resilience is the ability of a system to stay stable in the face of a wide range of threats, such as natural disasters, climate-related disasters, terrorist attacks, war, social unrest, and economic shocks. From the point of view of complex adaptive systems, you can't just describe such a multidimensional term as the ability to resist or recover by going back to a previous state of equilibrium. It also includes the ideas of re-orientation and renewal, which refer to the ability of a system to self-adapt, reorganize, and change its path of development (ESCAP, 2017; Pal et al., 2021; Tobin, 1999). Because of these things, it seems like a good thing for a spatial system to be resilient. Different parts of the system, such as the way the economy is set up, the amount of social capital, and how the system is run, may show resilience-related variables. Both empirical and theoretical research find it hard to come up with a large number of tangible and generally applicable/appropriate aspects of resilience. This is because the structure of their interdependencies depends on the site itself and, as a result, they lead to unexpected dynamics. But a large number of studies on resilience have shown that variety is important as a sign of the diversity and redundancy of the system's parts (number and type of institutions, sectors, and firms; presence of natural resource endowments; access to new knowledge; etc.). People also talk a lot about the system's natural abilities to adapt and organize themselves, such as openness, social learning and memory, modularity and connection, institutional and organizational inertia and change, adaptive governance systems, etc. Lastly, business networks, innovation systems, and entrepreneurship are important for staying competitive because they lead to breakthroughs and/or open up new markets. However, they may also be used to create other viable options.

3. METHODOLOGY

3.1 Research design, Target population, Sample size

The study utilised a descriptive research method whereby quantitative tools will be used to collect data associated with the role of the government in developing disaster resiliency and economic sustainability. This research design is basically an inquiry in which quantitative data is gathered and evaluated to characterize a particular phenomena in terms of current trends, current occurrences, and current connections between various variables. The mixed methods research design helped to effectively generalize the different findings concerning the role of the government in developing disaster resiliency and economic sustainability. The study targeted the different accessible local government leaders in Kozani Greece. The population was based on to establish the most appropriate sample for the study. The study utilized a primary sample of 160 study participants who were local government leaders in Kozani Greece.

4. RESULTS

The majority of the study participants (44.7%) identified education on disaster resiliency as the key focus area of government in developing disaster resiliency, followed by establishing disaster warning systems (22.6%), increasing the capacity of international disaster relief and assistance (21.3%), and 11.4% of the participants identified disaster reduction diplomacy as a key focus area of government in developing disaster resiliency. The majority of the participants (36.9%) identified government support as the key strategy to improved civil protection, followed by public involvement (29.4%), favorable policies (20.6%), and only 13.1 % indicated that strong international relations are a good strategy to improve civil protection. The majority of the participants (41.4%) indicated that Long-term *economic* growth is the key aspect of economic sustainability, followed by Environmental conservation (32.9%) and then improved standards of living (25.7%).

5. CONCLUSION

Based on how things are done in Europe and Greece in particular, this article has explained what the government's role is when it comes to being ready for disasters and keeping the economy strong. In political, economic, cultural, and social development, the government improves its own functions in disaster risk governance by leading, planning, promoting, and improving disaster resilience. This is also good for society as a whole. This is what the government tries to do by bringing together organizations, resources, culture, and social management. It also improves the efficiency and benefits of using resources for disaster resilience and plays a role in collaborating and integrating disaster resilience and its effect on economic sustainability. The government works to reduce disasters through diplomacy, sets up a financial guarantee system in case of a disaster, and improves education and research on disaster resilience. In times of disaster, the government helps people around the world by making international disaster relief more effective. The Chinese way of dealing with disaster risks, which is mostly state-centered, is still mostly shaped by the government. The government does not have the only role in being ready for disasters. Only if the government fulfills its leading, collaborating, integrating, and international humanitarian roles in the system of disaster resilience, while also recognizing the importance of business, communities, and the public in disaster risk management, will it be possible for the government to improve the structure and functions of the disaster resilience and get the most out of the resources available for disaster reduction. From the wide range of literature and lessons learned from the successful and unsuccessful implementation of countries in Europe, and Greece in particular, there are many ways to learn about what needs to be done to build resilience and work toward achieving sustainable development goals. Risks from disasters make it hard to reach economic sustainability goals, so any government should make preparing for disasters a top priority.

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AUTONOMOUS GEOSPATIAL INFRASTRUCTURES AND THEIR CONTRIBUTION TO THE LOCAL VULNERABILITY ESTIMATION CASE STUDY: COMPARING WILDFIRES OF THE YEARS 2021 – 2022 IN CRETE ISLAND

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ABSTRACT

The increasing difficulty of dealing with natural disasters, is deriving from the escalating severity of climate conditions. The regional authority of Crete, through its Strategic Plan, focuses on Active Environmental Strategy and Effective Governance aiming to obtain the maximum operational efficiency of civil protection.

Prevention, resilience, interoperability and feasibility of new methods, can produce the best results when central and decentralized administrations combine. Useful and reliable data are being provided, creating a new type of citizen who is environmentally aware, fully informed, ready to involve, and with a rational reaction when facing a crisis. The case study of comparing satellite data from 2021 and 2022 wildfires in southern Crete, can prove that local administration when in the edge of technology, can be efficiently working, on reliable, accurate and quickly provided mapping products, even without the contribution of the central state emergency mechanisms.

Keywords: *natural hazards, geospatial data, interoperability, crisis management, vulnerability.*

1. INTRODUCTION

In Crete, as well as in the whole country, there is a vicious circle of at least 3 main types of natural disasters, affecting the islands' morphologically rough territory:

- **1.1.1.** **Wildfires**, directly connected to the Mediterranean ecosystems, that loses 0,6% of its forests, annually. On the other hand, urban fires have been also increased, in a rate of over 80%, within the last 10 years.
- **1.1.2.** Significant disastrous phenomena deriving from wildfires are flash **floods** with rapid evolvement, due to intense stratigraphy. Floods additionally cause runoffs, extended erosion and soil deposits, hazardous mudflows, earth-mass movements, toppling, etc.
- **1.1.3.** So, the subsequently caused **landslides**, result to great amounts of sediments being transferred through loss of the upper fertile soil layer, which is being deposited downstream. At the end of this long pathway, 9 billion tons of soil/year end up in the sea!

Anticipating these phenomena, as a part of its Strategic Management Plan, Crete's Regional Governance has developed the Geospatial Data Infrastructure "GIS Crete [1]", which combines open satellite information with the primary constructed data from the Region Public Authority. Apart from administrative purposes, and improvement of the services provided to citizens, GIS Crete has offered a great opportunity of optimum crisis management planning.

2. STRATEGIC PLANS FOR DISASTER MANAGEMENT

According to the global consideration of Disaster Management, **Risk** is the possibility of a hazardous event to happen, depending on the social vulnerability of a particular area. Meanwhile, "hazard" represents the possibility of the event occurrence and not the event itself. This leads to a strong conclusion: while natural hazards are inevitable, the Risk of disaster can be avoided, if early noticed and wisely confronted. Especially focusing on vulnerability estimation (the main parameter for recovery treatment), GIS Crete earth monitoring, can depict in almost real time, the polygons of harmed area, as well as the variety of land use, according to the current legislation.

Each disastrous event highlights the geographical and cultural characteristics of the affected area. Every successful strategy for the reduction of natural disasters, has to be tailored to the specific conditions of the particular region, the main idea that governs the administrative authority of Crete.

3. GEOSPATIAL DATA SOLUTIONS, IMPLEMENTED BY REGIONAL GOVERNANCE OF CRETE

Within communities, the term "CRISIS" is being perceived as an urgent threat that has to be coped under conditions of uncertainty. Since there is no "ONE BEST SOLUTION" in facing natural hazards, the vulnerability of each region, is being estimated separately, implementing the most suitable method. According to this, the main principles of Crete's Regional Governance Strategy, are those of increasing environmental awareness, and civil protection effectiveness, by utilizing geospatial info & open data, referring to Crete.

3.1. GIS CRETE – GEOSPATIAL DATA

In GIS Crete, the revolutionary way of superimposing individual thematic maps, can produce a synthesis of Natural environment multi-thematic maps (rivers, protected areas, geology, land use, natural hazard areas, atmospheric parameters, habitats, marine areas) combined with Urban design (administration units, transport networks, infrastructure, health & safety utilities).
The final web-GIS product, covers the whole area of the island, including over 1400 data layers. Through complete interoperability with public services, research institutes, ministries, regions & municipalities, GIS Crete aims to the highest benefit of the end users.

3.1.1. How GIS Crete is linked to Civil Protection

When logged in the library of www.gis.crete.gov.gr , series of "Civil Protection Maps" [2] are provided in a scope of 3 phases:

I. Prevention: During the whole fire-danger period of each year, restriction areas are designated in prefectural interactive maps uploaded. An istruction adressed to the users, gives information about the prohibited district zones, during days with danger index 4 & 5. Citizens can locate these areas, by downloading the map given, identifying the restriction borders.
II. Enterprise use: during a crisis, with an urgent need for communication, GIS maps must be able to deliver answers to questions like: "where is each team, where should they lead to, how do they get access, and also instructions for escape roads, shelters etc"
III. Combining available data from Copernicus Emergency Management Service (EMSR) with primary data from GIS Crete monitoring, an accurate evaluation of damaged areas is provided. Through this agile application, the land burnt is depicted, before & after the wildfire event, by producing a frames' timeline. So, even if Copernicus EMSR is not activated – a framework of time series, via sentinel monitoring will be always available ad hoc.

3.1.2. GIS Crete Autonomous rapid evaluation

Apart from administrative purposes, enhancing prevention & preparedness objective, Crete Region has been using efficiently for the last 2 years, the GIS CRETE earth monitoring system, reporting qualitative and quantitative information in the post-disaster phase. Thus, depicting damaged areas in Corine land-use maps, can be used for an number of purposes such as financial compensation, vulnerability estimation, earth retaining, etc.

Case study

Part 1: Wildfires during summer 2022

In July's 15, 2022 fire event in Melabes Southern Crete, "**Copernicus rapid mapping – code EMSR593**" was activated by Greek central Authority, providing products for any use[3]. Here is the time sequence that followed:

- 15/7/2022 the wildfire started
- 17/7/2022 Activation request A744 [4]
- 17/7/2022 Activation code EMSR 593
- 18/7/2022 publication: FIRST ESTIMATION MAP (as of 16/7)
- 18/7/2022 publication: OVERVIEW MAP 01 (as of 18/7)
- 18/7/2022 publication: DETAIL MAP 02 (as of 18/7)
- 20/7/2022 publication: OVERVIEW MAP 01 (as of 19/7)
- 20/7/2022 publication: DETAIL MAP 02 (as of 19/7)
- 28/7/2022 FULL REPORT OF PRODUCTS [5]

At the same time, GIS Crete earth monitoring system, as instantly decided, provided maps of burnt areas (19/7, 20/7), almost simultaneously with Copernicus announcements. This gave the opportunity to the Regional Authority to be more flexible in terms of public communication and land-use damage registration, compensation to the beneficiaries, fast-track restoration, etc.

The time sequence for GIS Crete actions was as following:

- 15/7/2022 the wildfire started (17/7/2022 got noticed for Copernicus activation)
- 19/7/2022 publication (as of 18/7, see fig.1)
- 20/7/2022 publication (as of 20/7) & officially given to public authorities (land use & forest)

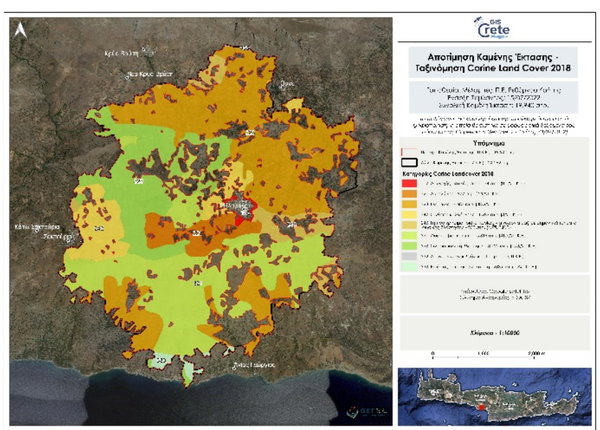

Fig.1
GIS Crete – burnt area estimation map, according to Corine Land Cover Legislation

Map published on 19/7/2022
(situation as of 18/7/2022)

Part 2: Wildfires during summer 2021

Copernicus emergency management system was not activated from the central authority of Greece during the fire events of 1-7 July 2021. Despite this fact, Regional Governance of Crete, was able to depict and estimate all six cases, almost in real time, through EO Browser function (see fig.2).

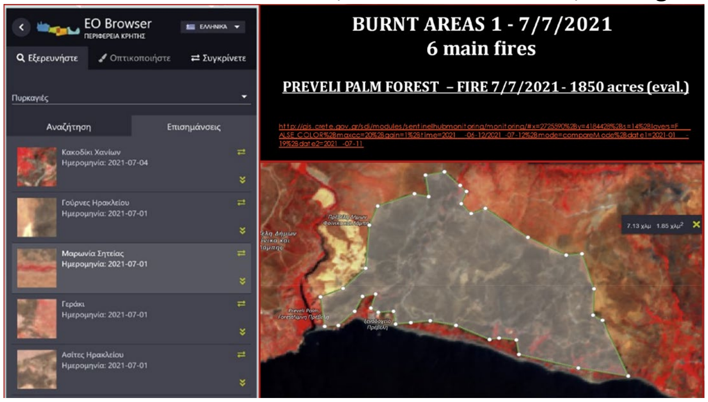

Fig.2
Autonomous estimation of total areas burnt (without using Copernicus EMSR activation), during 1-7 July 2022 wildfires in Crete, using Earth Observation Browser infrastructure.

A particular example of Kakodiki in Chania Perfecture is given, where within a few hours, the data of the main fire incident was available, as well as all the simultaneous fire-events occurred.

In Kakodiki, the total harmed area (in acres) was accurately estimated. According to the CORINE land cover legislation, the system also registered the type of land burnt (by percentage of forest land, agricultural use, etc. that had been destroyed).

Apart from wildfires described, evaluation function of GIS Crete, can also produce information of other natural hazard datasets, such as the floods in Malia Crete, during November 2020. Flooded areas which are designated as polygons, allow authorized users to know the exact properties affected, the protection measures ought to be taken, and the areas of high vulnerability, for the design and strategy decisions in the future.

4. TAKING OPERATIONAL ACTIONS FURTHER

In every natural hazard, it is of high importance, having adequate data to evaluate the vulnerability of a particular region, so that local authorities can work on resilience, recovery and prevention of the society harmed. The tools developed by decentralized governance, induce the ability of risk assesment, without restrictions linking to central state’s time processes.

In other words, when regional authorities have the expertise and the initiative to act locally, this raises the effectiveness of the response, without depending on national decisions of “what is critical”. For every society, in every place, “critical” is the indigenous issue.

In terms of crisis management, independent based solutions, are always more suitable, because at any given moment of the disaster, it is “hometown that matters”.

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3. COPERNICUS EMERGENCY MANAGEMENT SERVICE | Copernicus EMS - Mapping
4. A744_EMSR593_170722 – Copernicus EMSR activation notification
5. A_989_EMSR593_280722 - provision of final cartographic products

CROWDSOURCING DATA INTERPRETATION FOR THE RESPONSE TO THE FIRST PUBLIC TSUNAMI ALERT IN THE MEDITERRANEAN SEA, AFTER THE OCTOBER 30TH 2020 EARTHQUAKE (MW7.0), SAMOS, GREECE

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ABSTRACT
On 30 October 2020, 11:51 UTC, a large shallow earthquake of moment magnitude M_w7.0 ruptured the eastern Aegean Sea area and affected several Greek islands, mainly Samos, as well as the Izmir area, western Turkey. A moderate damaging tsunami followed the earthquake and inundated many coastal zones in the area. At 12:15 UTC, the Greek Civil Protection sent a tsunami SMS alert through the single European emergency phone number 112 to the eastern Aegean Sea Greek islands residents. It has been the first time that a tsunami warning was publicly issued in the frame of the North-East Atlantic and Mediterranean Tsunami Warning System (NEAMTWS/IOC/UNESCO) since this became operational. Through an on-line questionnaire survey conducted soon after the event, we investigated the impact of the tsunami 112 alert message to the population. The aim of this study is to assess the 112 number effectiveness as a tool for tsunami early warning, to look after possible weaknesses that may need future improvements and to better understand the level of tsunami risk awareness among the population. The response received from 344 citizens clearly indicates that the particular tsunami alert in general had positive impact to the message recipients, but highlights several weaknesses of the tsunami emergency management chain in Greece and demonstrates some aspects of the 112 system that need improvement.

Keywords: Samos 2020 earthquake and tsunami, east Aegean Sea, tsunami early warning, European emergency number 112, questionnaire survey, public response to alert

1. INTRODUCTION

The establishment of the Tsunami Early Warning and Mitigation System in the North-Eastern Atlantic, the Mediterranean and Connected Seas (NEAMTWS/IOC/UNESCO) was decided in the aftermath of the Boxing Day 2004 mega tsunami in Indian Ocean. It is a synergetic initiative of more than 40 country members coordinated by the Intergovernmental Coordination Group (ICG) in the frame of the UNESCO Intergovernmental Oceanographic Commission (IOC). Currently the NEAMTWS is based on five national monitoring centers (France, Greece, Italy, Turkey, and Portugal), all being accredited as Tsunami Service Providers (TSPs) for seismic tsunamis only.
In July 1991 the Council of the European Union adopted a decision, according to which, the Members States were requested to introduce the single European emergency number 112 for emergency services [1]. Article 110 of the European Electronic Communication Code (11 December 2018) required that as of June 2022 public authorities in the country-members should be capable to use telecommunication networks for alerting the population through 112 in cases of ongoing crises or upcoming threats [2]. In Greece, the 112 service was fully activated in its incoming and outgoing components on 1 January 2020, after a 10-month trial period. Until 30 October 2020, it had been used by the Hellenic General Secretary

for Civil Protection (GSCP) in several emergency cases (wildfires, floods, severe weather phenomena, COVID-19, dangerous gas leak) as a mean of alert messaging and dissemination of protection instructions. On 30 October 2020, 11:51:27 UTC (13:51:27 local time), a large shallow earthquake measuring Mw7.0 ruptured the eastern Aegean Sea area offshore to the north of the island of Samos, Greece, and close to the western coast of Turkey [3]. Soon after the earthquake, the GSCP, Greece, issued a short tsunami SMS alert utilizing the European emergency telephone number 112. The target area of the message covered Greek islands situated in the east Aegean Sea area [4]. The tsunami was observed in many Greek islands of the east Aegean Sea as well as in several coastal zones of western Turkey [4,5].

Figure 1. Events timeline (UTC) beginning with the 30 October 2020 earthquake [4]

2. MATERIALS AND METHODS

The feedback gathering and control measures is part of the incident management process (ISO 22320:2018-5.3) [6]. Post-alert feedback from message recipients help emergency organizations better understand how the public responds to messages and how emergency services could be improved. The National Academies of Sciences, USA, has specified a set of criteria to assess the usefulness of various metrics of a post-alert feedback gathered from message recipients: coverage, message engagement, action taken, latency and translation effectiveness [7].

Based on the events time flow, on the message text and on an on-line questionnaire survey, we perform assessment of the Samos 2020 tsunami alert SMS in the context of the above five criteria. The on-line questionnaire survey was written in Greek, published on 30 November 2020 at the "Environmental, Disasters, and Crisis Management Strategies" Postgraduate Program website (National and Kapodistrian

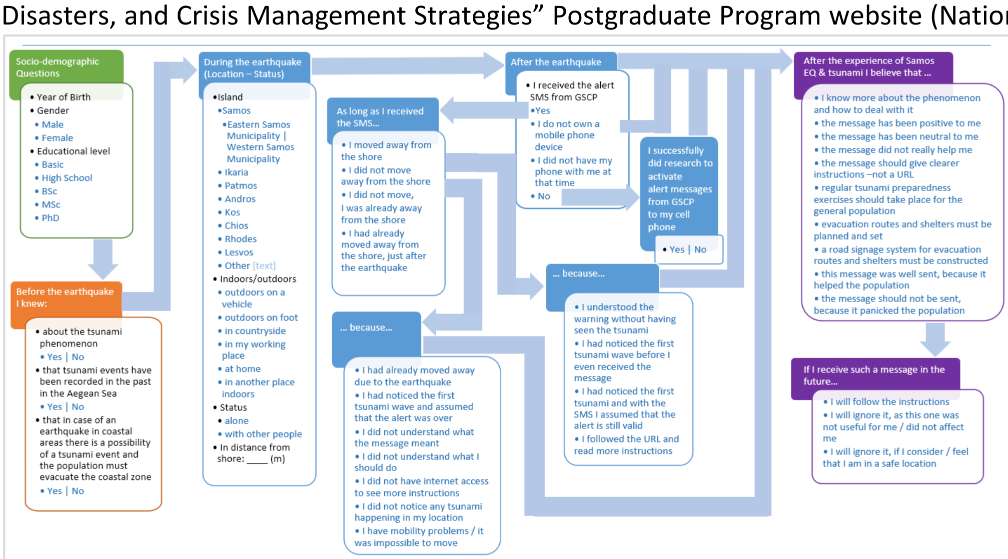

Figure 2. Questionnaire Survey Structure

University of Athens, Greece) [8] and remained active for 76 days. All questions were conducted in a true/false or multiple-choice format and, where necessary, in a cascade mode. (Fig. 2).

3. RESULTS AND DISCUSSION

The majority of the respondents, i.e. 306/344 or 89%, declared aware about the tsunami phenomenon in general but only 195 of them (57%) replied they are aware that tsunami events occurred in the past in the Aegean Sea. The majority of respondents (310/344, 90%) declared aware that in case of an earthquake shaking felt in coastal areas the population should evacuate since a tsunami wave may arrive.

2.1 Coverage

The total number of people that responded the questionnaire survey equals to 344. During the earthquake, 337 out of 344, were located within the message target area but most of them (306/337; 91%) in Samos island.

A coverage/target indicator could be the ratio of the people that received the message to those who theoretically should had receive it, which was found 256/337 or 76%. Further investigation is needed to check the reasons leading to this message transmission gap, as well as the 7 out-of-target transmission.

2.2 Message Engagement

194 (76%) declared that during the event they were not alone, which may indicate possible follow-up message spreading and engagement. On the other hand, 42 out of 75 (56%) respondents that declared they did not receive the message stated that they did not look for the cause behind it, which, however, could be helpful for receiving future alert messages.

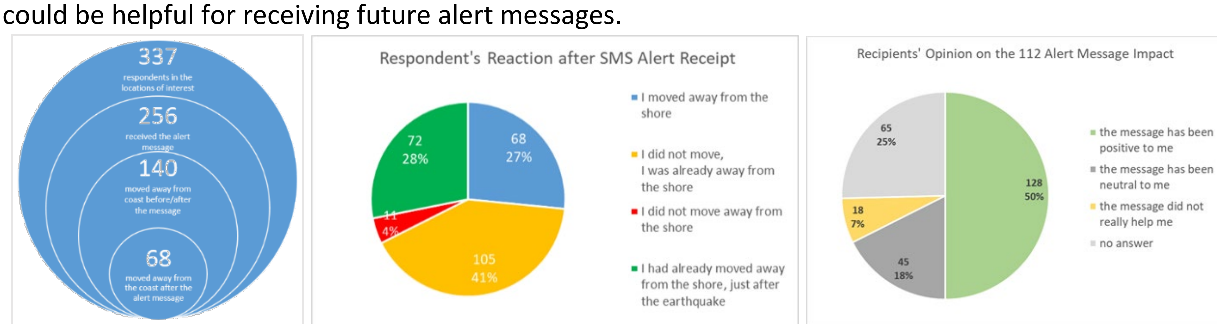

Figure 3. Schematic effectiveness of the 112 tsunami alert message according to the survey (left). Reaction to the alert message of the 256 (center). Self-assessment of the 256 respondents as regards the impact the tsunami alert SMS had to them (right)

2.3 Action Taken

An impact/influence indicator of the tsunami alert message could be the ratio, c, of the people consent to the message instruction to those who actually received it. However, such a calculation should take into account the respondent's distance, d, from the shore. Considering the proximity to the shore, we considered two options: (1) $d1 \leq 100$ m, which is the actual maximum tsunami run-in observed in Vathy town in the 30 October 2020 tsunami case, and (2) $d2 \leq 500$ m, which include distances considerably longer than d1. The impact/influence indicator equals to $c1=0.67$ and $c2=0.40$ for d1 and d2, respectively. Taking into account that the persons who evacuated had no idea what would be the actual tsunami run-in distance, these percentages underline that a remarkable number of respondents had a common sense of the tsunami threat immediately after the causative earthquake of 2020. From another perspective, different impact/influence indicators could rely on a self-assessment approach by the respondents (Fig. 4, right). 50% of the 256 message recipients evaluated that the message had a positive impact to them, while only 45 out of 256 (18%) stated that the message had no impact to them. Only 18 out of 256 (7%) respondents declared that the alert message did not help them (Figure 3).

2.4 Latency

Only 21% (3/14) of the message recipients did not evacuated, without considering their location away from the coastline, supported that the 13 minutes delay in the alert message reception influenced their reaction decision. The delay between the NOA alert and the 112 SMS transmission could get shorter, especially when the potential tsunami sources are lying in the near-field domain (e.g. Aegean Sea).

2.5. Translation effectiveness

Despite the fact that the term "tsunami" is typically used in all the relevant documents prepared in the frame of NEAMTWS/IOC/UNESCO and people is familiar with it, it is missing in both the Greek and English versions of the alert SMS; the term "high waves" was used instead. The English version of the message includes a URL leading to guidelines for protection against a series of natural hazards. In this webpage, however, there is no reference neither to "high waves" nor to "tsunamis". In the Greek version of the message, the URL leads to a sub-webpage where the term "tsunami" is used and the term "high waves" is missing. Moreover, the Greek version of the message calls the public to stay informed by the mass media, which is missing from the English version, perhaps by purpose. The English version contains also a typo, i.e. "dange" instead of "danger". Furthermore, a cancel or end-message had never been sent.

4. CONCLUSIONS

The population has generally welcomed the tsunami alert message. Most of the respondents replied that tsunami preparedness drills as well as the establishment of evacuation routes, shelters and evacuation signage are needed for the tsunami risk reduction planning future improvement. These results signify a good level of awareness regarding the tsunami risk in the area and realization of the evacuation planning need. There is need for further improvements of both the population awareness and the alert procedure itself. Standardization of message content and transmitting procedures could decrease the response/transmitting time, increase the people trust to the alert messages and alert message efficiency.

ACKNOWLEDGEMENTS

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TOWARDS AN OPERATIONAL FORECAST MODEL FOR COASTAL INUNDATION DUE TO STORM SURGES: APPLICATION DURING IANOS MEDICANE

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ABSTRACT
This paper presents the application of a numerical model (CoastFLOOD) for the simulation of coastal inundation due to storm surges enhanced by tides. The implementation is based on output of sea level elevation caused by the combined action of storm surges and astronomical tides from operational forecasts with High Resolution Storm Surge (HiReSS) model in the Mediterranean Sea. The presented case study of coastal inundation refers to the littoral floodplain of Livadi coastal inlet at the island of Cephalonia (central Ionian Sea, western Greece), induced by the passage of Ianos Medicane (with Category 2 Hurricane characteristics) in September of 2020. Validation of storm-induced sea level elevation against *in situ* data by tide gauges is also presented *in tandem* with estimations of flooded areas over coastal lowlands. The latter are compared with satellite observations (Sentinel-2 images) producing the Normalized Difference Water Index (NDWI). The seawater run-up extended up to several hundreds of meters inland, depending on hydraulic connectivity between lowland areas, which determined the inundation extents during the storm surge events.

Keywords: coastal inundation, storm surge, Ianos Medicane, operational forecast, numerical modelling

1. INTRODUCTION

The Mediterranean Sea is considered to be a hotspot in reference to impacts of extreme weather events on the coastal zone. Intense storm surge events might threaten lowland coastal areas mainly by inundation effects on littoral floodplains which may cause human casualties, land loss, damages to onshore infrastructure and properties, environmental degradation, etc. Therefore, in the present work, a new coastal inundation module (CoastFLOOD) [1] is implemented in operational forecast/hindcast modes coupled to a tidally enhanced storm surge model (HiReSS) [2] for the proper simulation of large scale storm-induced coastal flooding. The Ianos Medicane [3] case study is investigated in terms of invoked coastal inundation on the littorals of coastal inlets at the island of Cephalonia (central Ionian Sea, western Greece). For this, numerical, in situ, satellite, and GIS land elevation data are combined.

2. METHODOLOGY

Extremely deep atmospheric depressions in the synoptic scale on the Mediterranean basin usually lead to the formation of storm surges on the coastal boundary in local scale, due to two main mechanisms: i) the inverse barometer effect underneath the low-pressure area of the cyclone, and ii) the wind-induced accumulation of seawater masses towards the coast.

2.1. Available Data (Atmospheric Input, GIS Land Elevation, Field and Satellite Observations)

Ianos Medicane, with characteristics similar to a Category 2 hurricane (wind gusts of 160 km/h), propagated over the central Mediterranean in mid-September 2020 [3] and induced damages on both inland and coastal areas, in central and western Greece (Ionian islands and continental coasts), causing extensive flooding, infrastructure destructions, and human casualties. The meteorological forcing is derived from two sources: a) the Numerical Weather Prediction (NWP) system of Aristotle University of Thessaloniki (LMC-AUTH) [4], b) gridded operational analyses of the European Centre for Medium-range Weather Forecasts (ECMWF), employed in forecast and hindcast mode simulations, respectively. Land elevation data were derived by post-processing of available geospatial data from the Digital Elevation Model (DEM) of Hellenic Cadastre (https://www.ktimatologio.gr/en), with a pixel size of 2×2 m^2 available in 4600×3600 m^2 ground plates, with a perimeter overlay of 300 m, in GGRS87 projection. Field measurements of sea level elevation have been collected by available tide-gauge sensors along the coasts of the Ionian Sea, freely provided in 1-minute time-step by the Sea Level Station Monitoring Facility of the Intergovernmental Oceanographic Commission (https://www.iocsealevelmonitoring.org/). The measured data are used to validate the performance of the numerical hydrodynamic simulations and estimate the realistic storm surge intensity during IANOS Medicane [3].

2.2. Numerical Models for Storm Surge and Coastal Inundation

The sea level conditions and characteristics during the Ianos passage over the affected coastal regions were investigated with the use of HiReSS, a 2-D hydrodynamic model for barotropic circulation [2], operating in both forecast and hindcast modes [5]. Herein, we focus on the sea level response due to severe meteorological conditions that mainly determined the ocean circulation and coastal sea level variability during a extreme low-pressure system [6]. HiReSS can predict the Sea Level Anomaly (SLA) and depth-integrated currents, induced by atmospheric forcing, combined with astronomical tide effects [5, 6], being the tool of several operational forecast applications in the Mediterranean Sea (Wave4Us) [7] and around the world (Accu-Waves) [8].

CoastFLOOD [1] is a very high resolution, GIS raster-based, 2-D horizontal, mass balance, coastal inundation model, which is based on the concepts of the established LISFLOOD-FP software [9] for coastal plain flooding on a local scale over selected areas of the littoral land zone in Greece, pertaining parts of urban environment and engineered waterfronts, ports and coastal structures, estuaries, adjacent lagoons, and natural beaches [1]. It is one-way coupled to HiReSS model, fed with output of simulated sea level data as boundary conditions representing the study area’s coastline. We hereby combine this approach with a wet/dry cell assignment technique for flood fronts over steep slopes [10]. The flood routing module makes use of a very fine spatial resolution (dx = dy = 2 m) computational domain based on DEM raster grids (see Section 2.1). CoastFLOOD also incorporates a “static-level” inundation module operating in “bathtub” mode with or without hydraulic connectivity [11, 12].

3. RESULTS

3.1. Model Validation

Figure 1 shows the validation of HiReSS model outputs in operational forecast and hindcast modes against field data of SLA for the Ianos Medicane period. Acceptable to rather high Pearson correlations and coefficients of determination were found, indicating the good model performance in coastal areas.

3.2. Flooded Areas

Maps of Flooded Areas are presented in Figure 2 derived from CoastFLOOD simulations by simple Bathtub, Bathtub with Hydraulic Connectivity (HC), and realistically simulated, Manning-type, inundation flow. The comparison between flood patches by CoastFLOOD model and Sentinel-2 NDWI reveals significant storm-induced run-up of seawater in specific parts of the coastal zone (200 m inland), in agreement with the "wet" areas derived from satellite imagery. Table 1 presents numerical data related to the inundated area ($>6 \cdot 10^5$ m^2).

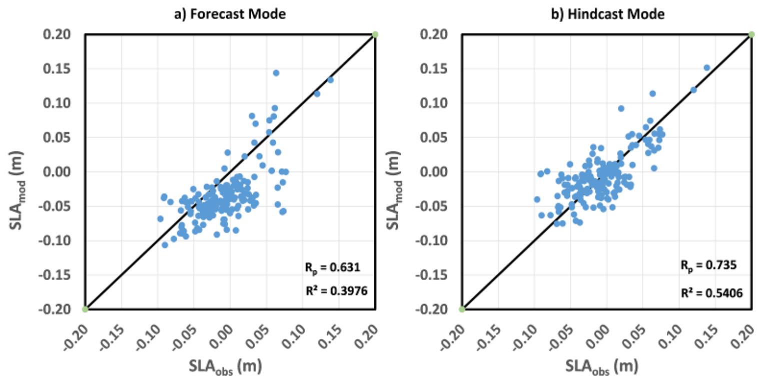

Figure 1. Scatter diagrams of comparisons between HiReSS modelled and field data of SLA (SLA_{mod} and SLA_{obs}, respectively) for September 2020; a) WRF/ARW-fed HiReSS model results in operational forecast mode; b) ECMWF-fed HiReSS model results in hindcast mode. R_P: Pearson correlation, R^2: Coefficient of determination.

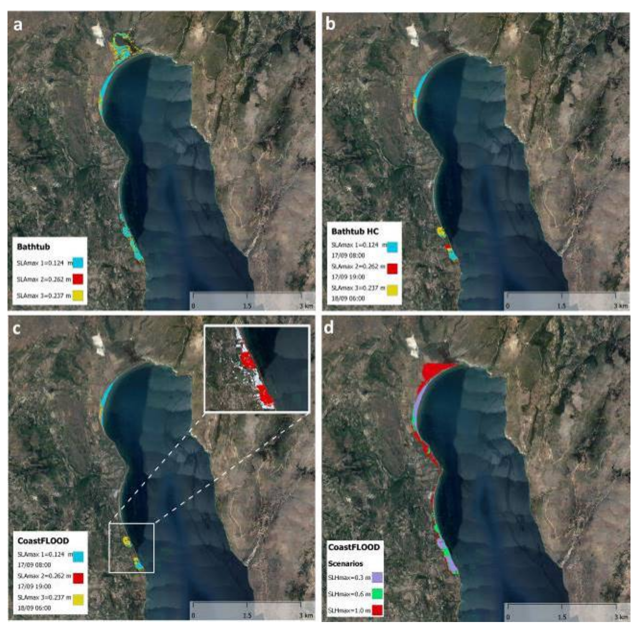

Figure 2. Maps of Flooded Areas derived from 3 CoastFLOOD approaches: (a) simple Bathtub, (b) Bathtub with Hydraulic Connectivity (HC), and (c) realistically simulated inundation Manning-type flow for three characteristic cases (SLA_{max1-3} = 0.124, 0.262, 0.237 m) of IANOS passage over the study area. (d) Potential Flooded Area derived from CoastFLOOD simulations based on three extreme scenarios of storm surge (0.3, 0.6, 1.0 m). Comparison between flood patches by CoastFLOOD model (red hatch) and satellite NDWI ("wet" areas with light blue) is shown in panel c insert.

Table 1. Features of flooded lowlands in the study region: Elevation Class, Total Area (m^2), Normalized Difference Water Index (NDWI) Mean Difference, Flood Difference (m^2), coverage percentage of Flood (%).

Elevation Class	Total Area (m^2)	NDWI Mean Difference	Flood Difference (m^2)	Flood (%)
0 m - 0.3 m	631,556	0.10490	17,168	2.7

4. CONCLUSIONS

A model for coastal flooding simulations fed by an ocean hydrodynamics model *in tandem* with field and satellite observations was used to describe the storm surge-induced coastal inundation processes due to the impact of Ianos Medicane in September 2020. The improvement of atmospheric forcing increases the efficiency of the coastal sea level predictions and thus the quality of littoral flooding estimations. The nested numerical methodology may provide short-term and real-time predictions of the flooding status on a coastal scale, useful to local first level responders during extreme meteorological events.

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CRITICAL FIRE WEATHER PATTERNS OF GREECE: FORECASTING FIRE WEATHER CONDITIONS IN THE MEDIUM-RANGE

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ABSTRACT
In this work we present a fire weather forecasting framework using critical fire weather patterns, developed and applied operationally by the METEO Unit of the National Observatory of Athens within the frame of the "FLAME" project. Identifying and characterising the critical fire weather patterns of a region is of great importance for developing early warning systems and management strategies, as well as for increasing awareness and preparedness of all the involved entities, including both the public and practitioners. Within this fire weather forecasting framework, (a) we define the critical fire weather patterns of Greece, (b) we quantify the key fire weather conditions associated with each one of them and (c) we link each critical fire weather pattern with different levels of fire danger and expected fire behavior. The main advantage of this approach is that it can be used for providing valuable information regarding the upcoming fire weather conditions even up to 10-12 days in advance. The operational use of the critical fire weather patterns started with the beginning of the 2022 fire season in Greece.

Keywords: forecasting, fire weather, fire danger, critical fire weather patterns, early warning

1. INTRODUCTION

Wildfires in Europe are responsible for enormous amounts of damage in both the environment and human property every fire season, while in multiple cases they are also responsible for human losses. Wildfire activity is driven by several factors such as fuels, weather and climate conditions, and the ignition factors. Weather is the most variable parameter of the system and it has been identified to play a key role in both wildfire ignition and behavior. Thus, it becomes obvious that the evaluation of the atmospheric conditions which favor increased fire activity and are conducive to extreme fire behavior is very critical for both the ecosystems and human life. Furthermore, accurate and timely knowledge of fire weather conditions is also critical for civil protection preparedness and fire management.

Fire weather conditions are determined by processes occurring across multiple spatial and temporal scales [1 ,2]. Across longer time scales, such as sub-seasonal to seasonal scales, changes in atmospheric state manifested as changes in basic meteorological variables (e.g. precipitation and temperature) influence the state of the fuels. On the other hand, across shorter time scales, changes in synoptic to mesoscale atmospheric conditions modulate fire weather which can be expressed via changes in temperature, wind speed and humidity. Due to the continuous development and improvement of both the deterministic and probabilistic weather forecasting skill over the last 20 years, currently the large-scale weather conditions can be predicted even up to 10-12 days depending on the season and the respective numerical weather prediction model skill.

Based on this predictability of the large-scale weather patterns, here in this work, we illustrate a fire weather forecasting and early warning framework for Greece, using critical fire weather patterns, which has been developed and applied operationally by the METEO Unit of the National Observatory of Athens

(NOA).

2. CRITICAL FIRE WEATHER PATTERNS

A critical fire weather pattern is defined as the synoptic (large-scale) atmospheric state that creates those atmospheric conditions which promote the occurrence of extreme fire behavior and may result in large and destructive wildfires [3]. The four key weather parameters which are linked to the occurrence of extreme fire behavior are low atmospheric moisture, strong surface winds, atmospheric instability and drought. The first three parameters are highly variable in time and space and can change rapidly, while drought acts on longer timescales ranging from days to months or even years. Therefore, by knowing the synoptic patterns which increase fire danger and could potentially lead to extreme and destructive wildfires, we can estimate with high precision the changes in fire weather conditions many days in advance and provide an early warning. In this work, we define the critical fire weather patterns of Greece and we provide a summary of the main fire weather conditions and fire danger associated with each one of them.

2.1. Atmospheric data and methods

For the definition of the critical fire weather patterns of Greece we apply state-of-the-art machine learning techniques on ERA5 reanalysis atmospheric data [4], provided by the European Center for Medium-range Weather Forecasts (ECMWF). The ERA5 data have a horizontal resolution of 0.25˚ x 0.25˚ and at the initial stage of this work we use the data spanning June – October 1979-2020. We use geopotential height data at 500 hPa in order to define the most representative synoptic weather patterns that influence the weather in Greece. After defining the synoptic patterns we examine the changes in fire weather conditions associated with each one of them as well as their link to fire danger. The link of the synoptic patterns to different levels of fire danger is conducted by using the indices of the Canadian Forest Fire Weather Index System (CFFWIS, [5]) provided also by ECMWF [6]. To determine the fire danger associated with each synoptic pattern we use the days that the CFFWIS indices exceeded the 95th percentile of their distribution. Furthermore, we examine the link of the extreme fire weather indices with burnt areas in Greece during the period from 2000 to 2019 using data provided by the Hellenic Fire Corps.

2.2. Overview of the critical fire weather patterns of Greece

Our analysis revealed 36 primary synoptic weather patterns, grouped into five key fire weather patterns (Figure 1) based on their characteristics with respect to expected fire danger.

The first critical fire weather pattern (Fig. 1a) is characterised by the dominance of a low pressure system centered over the North Atlantic, between the UK and Iceland, covering most of Western, Central and Northern Europe, while on the other hand a high pressure dominates over Eastern and Southeastern Europe. This weather pattern is mainly associated with well below average temperatures, weak winds and wet weather over Greece, resulting in very low fire danger.

The second critical fire weather pattern (Fig. 1b) is characterised by the dominance of a high pressure system centered over the North Atlantic, between the UK and Iceland, covering most of Western, Central and Northern Europe, while on the other hand a low pressure system dominates over Eastern and South/Southeastern Europe. This weather pattern is associated with below average temperatures, weak winds mainly over the eastern parts of the country and wet weather over Greece, resulting in low fire danger.

The third critical fire weather pattern (Fig. 1c) is characterised by the dominance of a high pressure system centered over Northern/Northwestern Europe, while lower pressure is found over Southeastern Europe. This weather pattern is associated with above average temperatures, dry conditions, potential atmospheric instability and enhanced winds over the southeastern insular parts, the western and northern continental parts, while weak winds are found over the eastern and southern continental parts of Greece. These fire weather conditions result in moderate to high fire danger over the western and northern parts and high to very high over the southern and eastern parts.

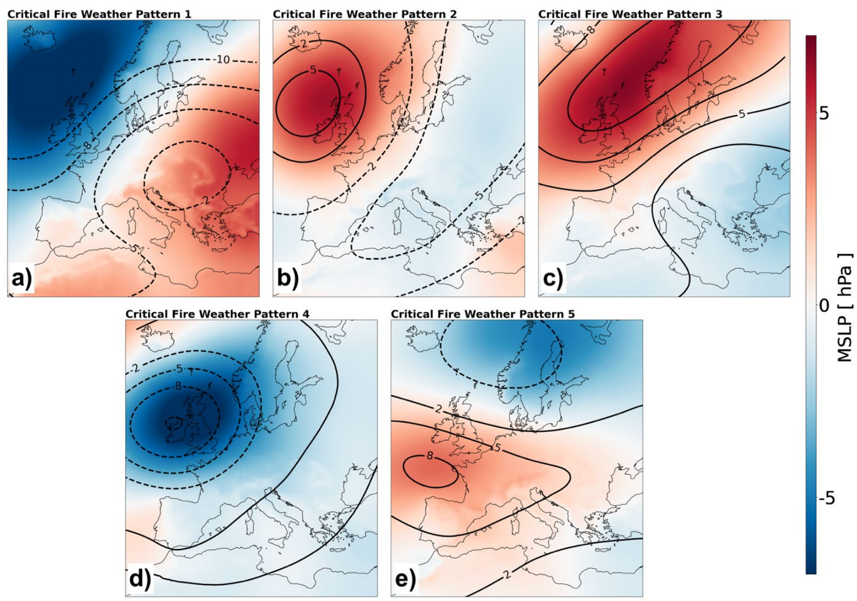

Figure 1. Critical fire weather patterns of Greece. Panels **(a)** – **(e)** show the geopotential height anomalies at 500 hPa (contours) and the mean-sea level pressure (MSLP) anomalies (shading) over Europe for each critical fire weather pattern of Greece. The analysis is based on ERA5 reanalysis data during June–October from 1979 to 2020.

The fourth critical fire weather pattern (Fig. 1d) is dominated by a low pressure system centered over the UK while an upper level ridge extends from Northern Africa to Eastern/Northeastern Europe. This weather pattern is associated with well above average temperatures, very dry conditions and generally weak winds over Greece, resulting in high to very high fire danger.

Finally, the fifth critical fire weather pattern is dominated by a high pressure system over Western Europe that extends from the North Atlantic to the Balkans, while lower pressure is found over Northern Europe and Eastern Mediterranean. This weather pattern is associated with above average temperatures, dry conditions and enhanced winds mainly over the eastern parts of Greece, resulting in very high to extreme fire danger.

The main changes in fire weather conditions and fire danger levels with respect to each critical fire weather pattern are summarised in Table 1.

Table 1. The table below summarises the 5 critical fire weather patterns of Greece. For each pattern, we present the associated fire weather conditions and the resulting, estimated level of fire danger.

CRITICAL FIRE WEATHER PATTERNS - GREECE

FLAME	Prevailing temperatures compared to climatology	Prevailing moisture compared to climatology	Prevailing wind compared to climatology	Atmospheric stability	FIRE DANGER
1	Much **cooler** weather	Much **moister** weather	**Weak** winds	Stability	Very **low**
2	**Cooler** weather	**Moister** weather	**Weak** winds over E Greece **Strong** winds over W Greece	Stability	**Low**
3	**Warmer** weather	**Drier** weather	**Strong** winds over SE Greece	**Instability**	**Moderate/High** over W & N Greece **High/Very high** over S & E Greece
4	Much **warmer** weather	Much **drier** weather	**Weak** winds	Stability	**High/Very high**
5	**Warmer** weather	**Drier** weather	Very **strong** winds over E Greece	Stability	**Very high/Extreme**

3. OPERATIONAL USE AND FUTURE DEVELOPMENT OF THE CRITICAL FIRE WEATHER PATTERNS

The operational use of the critical fire weather patterns at the METEO unit of the National Observatory of Athens started on May 1, 2022 illustrating good performance and delivering meaningful information up to 10-12 days in advance. Apart from monitoring and evaluating its performance we aim to further enrich the information of the critical fire weather patterns with respect to fire danger and expected fire behavior which is of great importance for practitioners, fire suppression strategies and management, as well as for increasing public's awareness and preparedness.

4. ACKNOWLEDGMENTS

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Oflood: A MODULE OF THE LocalPro PLATFORM FOR DYNAMIC FLASH FLOOD FORECASTING AT LOCAL SCALE

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ABSTRACT
LocalPro project aims in developing a unified technological platform to manage and facilitate the operational processes of the Municipalities and the Regions of Greece, as the national civil protection legislation defines them for natural disasters (flash floods, wildfires and earthquakes) and their consequent social responsibility. The specific module related to flash floods, namely Oflood, integrates precipitation forecast and hydrological modeling. Subsequently, the drainage capacity of the streambed to channel the peak discharge was evaluated and color code alerts arise. To that end, relevant in-house software was developed, for the necessary backend and frontend processes.

Keywords: flash flood, precipitation forecast, hydrological modeling, warning notification, civil protection

1. INTRODUCTION

Local authorities around the world are in charge of operational functions, obligations, and civil protection tasks that are of the utmost importance for the protection of life, property, and the local economy. According to the recent Greek legislation on Civil Protection (Law No 4662/2020), the first and second-degree local authorities of the country undertake important responsibilities regarding the reduction of the natural disaster risk and include necessary actions/ procedures in prevention, preparedness, response, rehabilitation, as well as feedback to reduce risk and enhance resilience at a local scale (http://www.et.gr/api/DownloadFeksApi/?fek_pdf=20200100027) [1]. Despite infrastructural improvements and considerable technological advances, natural disasters have claimed thousands of lives and caused major economic damage in recent decades [2]. However, new technologies and associated automated toolkits can help in the digital transformation of these processes so that the local authorities and local businesses are able to implement their preparedness and emergency plans more efficiently. To that end, under the LocalPro project, a unified online platform is being created to manage and facilitate the operational processes of the Municipalities and the Regions of Greece as the national legislation defines them for civil protection from natural disasters and the consequent social responsibility. The project is funded by the “Innovation Investment Plans” Programme of Central Macedonia Region (NSRF 2014-2020) in Greece and involves the conjoined efforts of two Greek SMEs; namely OMIKRON Environmental Consultants SA and Techniki Anaptixi ATEBE in close collaboration with CERTH/ ITI and REDi Engineering Solutions. The design of the platform allows easy configuration with functions that can respectively facilitate the specific operational processes of local businesses, such as touristic and others for the management of natural disaster. The LocalPro online platform includes features to facilitate processes and actions horizontally such as direct communication, two-way information, reporting, and awareness as well as an early warning for the readiness and guidance of staff, crews, and residents through an interconnected smart mobile application. In addition, the platform is developed with a modular architecture and can be expanded with specialized tools, based on the latest scientific methods and solutions, for managing local risk from specific natural disasters such as wildfires, flash floods, and earthquakes. The basic parts of the system are the web and the mobile application, which work supplementarily and the communication channel they create with each other is the main advantage of the product. Herein, the methodology and architecture of the Oflood module, regarding the daily dynamic flood hazard at a local scale, is presented.

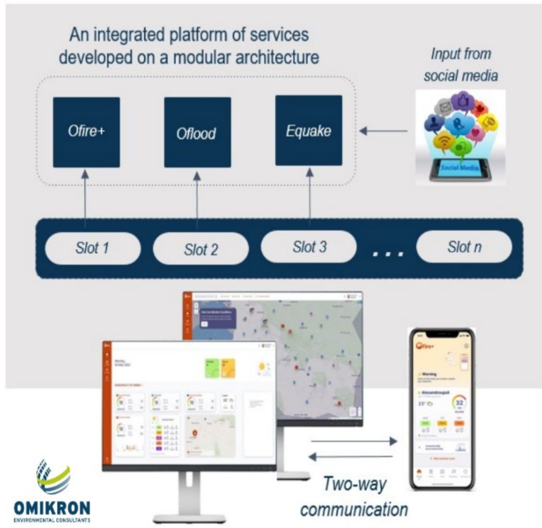

Figure 1. Modular architecture of LocalPro platform

2. MATERIAL AND METHODS

2.1. Data

Towards the development of Oflood, several open-access geospatial datasets were exploited. These datasets included precipitation forecasts, satellite imagery, soil and topographic data. All the datasets were organized into GIS thematic layers using the open source Quantum GIS (QGIS) software package (v3.22). Hourly precipitation forecasts are retrieved from the ICON (ICOsahedral Nonhydrostatic) global numerical weather prediction (NWP) model (https://openskiron.org/gribs_icon_eu/). Since January 2015, ICON runs operationally at Deutsche Wetterdienst (DWD) for weather forecasts on the global scale with a grid spacing of 13 km, while the local grid refinement over Europe has a horizontal resolution of 7 km, which is in operational use as well. The data is stored in a PostgreSQL database. Additionally, time series of Sentinel-2 Level 2A optical data are acquired from the European Space Agency (ESA) Copernicus Access Hub (https://scihub.copernicus.eu). The Sentinel-2 multispectral instrument (MSI) provide 13 spectral bands ranging from the Visible (VNIR) and Near Infra-Red (NIR) to the Short Wave Infra-Red (SWIR) with spatial resolution up to 10 m and a revisit time of 5 days. Level-2A data are bottom-of-atmosphere (BOA) reflectance ortho-image products. Soil data (parent material) are derived from the national Soil Map (scale 1:50.000) provided by the Greek Ministry of the Environment and Energy (http://mapsportal.ypen.gr/maps/289). The topography is represented by using the Tree Forest and Buildings removed Copernicus DEM (FABDEM). This is a global DEM at 30 m grid-spacing, with artifacts from forests and buildings removed (FABDEM). FABDEM has notable benefits compared to existing global DEMs, resulting from the use of the new Copernicus GLO-30 DEM and a machine learning correction of forests and buildings (https://data.bris.ac.uk/data/dataset/25wfy0f9ukoge2gs7a5mqpq2j7). This makes it preferable for many purposes where a bare-earth representation of terrain is needed [3].

2.1.1. Oflood architecture

The Oflood aspires to be an operational flash flood forecasting and preparedness system. The basic components of the system include: precipitation forecasts, hydrological modeling, and streambed drainage capacity. All structural components of Oflood are conjoined into a prototype operational chain of processes. The precipitation forecasts (ICON) are downloaded twice a day at 8:00 am and 20:00 pm in the winter time and at 9:00 am and 21:00 pm in the summer time period. The forecasting span is of order of three days and hourly time steps. Using hourly precipitation as input, hydrological modeling was performed according to the rainfall-runoff model of Soil Conservation Service-Curve Number (SCS-CN) [4]. Watershed boundaries, hydrographic networks, CN runoff coefficients, and other geospatial data required to run the model were created in a GIS environment using DEM, Sentinel-2 images for landcover mapping, and soil maps for soil permeability classification. The drainage capacity of the streambed to channel the maximum peak discharge was evaluated according to its geometric and hydraulic characteristics. Subsequently, based on these results, relative warnings notifications arise. The background processes are run by internally developed software (VisualStudio VB.net). Specifically, the precipitation forecast is downloaded and stored locally, the forecast precipitation and hydrological parameters are input into a database (PostgreSQL), peak discharge is computed, and the drainage capacity of the streambed to channel the computed discharge is checked. Moreover, in-house frontend software and a web platform were developed to automate visualize the dynamic flood hazard. This software developed using REACT, a free and open-source front-end JavaScript library for building user interfaces.

3. RESULTS

All structural components of Oflood, have been optimized to run on a sub-daily basis, in order to check the system's performance as well the quality of its outputs. Currently, the final operational output is a color code alert at watershed scale. Each color assigned with an adequate warning notification as presented in Table 1.

Table 1. Color code alerts and associated warning notification messages

Hazard Class	Warning Message
Low	Low likelihood of flooding according to the forecasted precipitation
Moderate	Flooding with minor impacts is likely. Monitoring of weather forecasts is recommended
High	Flooding with severe impacts is expected. Increased preparedness and continuous monitoring of weather forecasts is required
Extreme	Extreme flood events with devastating impacts are expected. Vigilance and implemet of prevention measures are mandatory

An example of the visualization of the results for selected watersheds in Thessaloniki's conurbation can be seen in the following figure (Figure 1).

4. CONCLUSION AND DISCUSSION

The Oflood module of LocalPro platform provides timely and reliable information related to flash floods daily hazard on a local scale, which is crucial for increasing risk awareness, promoting preparedness and, ultimately, reducing the potentially catastrophic impacts nof an upcoming flash flood.

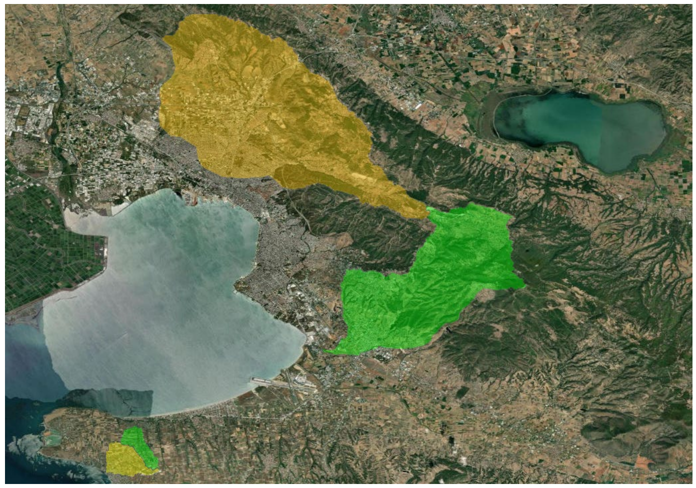

Figure 2. Examples of visualization of color code alerts in selected watersheds

The development methodology is based on well-known scientific approaches, which are combined in a novel way. The results will be presented in a user-friendly format in order to maximise the positive impact from using the module at a local scale. The module is hosted on a modular platform (LocalPro) which is targeted to facilitate the operational processes of the Municipalities and the Regions of Greece, as the national civil protection legislation defines them for natural disasters (flash floods, wildfires and earthquakes) and their consequent social responsibility. Apart from that, the platform allows for easy configuration with functions that can respectively facilitate the specific operational processes of local private businesses, such as touristic and others, regarding the management of natural disasters. Moreover, in future development the use of advanced 1D/2D hydraulic simulation models could be used. Additionally, data mining techniques could be used to extract informations for flood occurances from social media. Also, the team will explore the efficiency of sensors for early detection and event monitoring, as well as models calibration. Finally, use of UAV and SLAM applications for detailed mapping of the streambed and the extraction of cross-sections will be checked.

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CLIMATE CHANGE AND SEVERE WEATHER EVENTS IN THESSALONIKI

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ABSTRACT
Climate change is expected to particularly affect cities because severe and extreme weather events can be especially disruptive to complex urban environments. Severe weather phenomena are not uncommon in the city of Thessaloniki including intense thunderstorms, heavy rainfalls, floods, windstorms, lightning, hailstorms and seasonal events like snowstorms, frost and fog. They can cause significant damage to infrastructure, buildings and property, serious temporary problems and occasionally injuring and human losses. In this work an investigation is undertaken to detect climate change influence for Thessaloniki by examining temperature and rainfall profiles and their deviation from normal for the last four decades (1979-2021). Based on a severe weather event database a total of 110 events identified as the most severe and highest impact weather events occurred in Thessaloniki and the greater area in the 40 year period 1983-2022 and their yearly and monthly frequency is presented. Strong thunderstorms and heavy rainfalls associated with flash floods are the most frequent damaging events in Thessaloniki. The results in agreement with climatic model projections indicate future increasing in frequency and intensity of severe weather events in Thessaloniki with their damaging potential also expected to increase. This research is offering to increasing awareness about possible climatic change influence to Thessaloniki, about the level or risk and vulnerability from weather related hazards and also to contribute to further development of infrastructures, protection systems, management of plans and adaptation and mitigation actions.

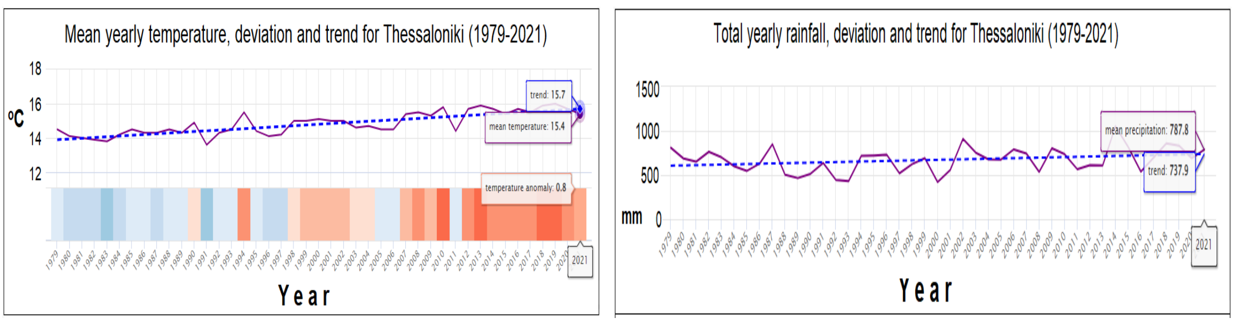
Keywords: Thessaloniki, weather, thunderstorms, floods, climate change

1. INTRODUCTION

Natural disasters including meteorological and hydrological events constitute the most damaging threats in the four decades with a permanent upward trend in property and financial losses but also losses of human life. The damaging impacts and the level of economic losses in an urban environment are influenced by interaction of many factors, such as the intensity and duration of weather events, the local geomorphology, the urban land surface as it is covered by buildings, roads and walk sides and the demographic conditions with densely populated and high human activity areas. Climate model projections indicate a future significant increase in both the frequency and intensity of severe and extreme weather events more pronounced for the area of the eastern Mediterranean [1]. The city and the greater area of Thessaloniki is experienced severe weather events that occasionally cause various damages to infrastructure, houses, business and serious temporary problems including disruption in transport and power, damage and loss of property and also injures and in some cases loss of human life. The objectives of this work include an investigation of ERA5 reanalysis data to detect climate change for Thessaloniki, central Macedonia based on temperature and rainfall profiles and their deviation from climatic normal values for the period 1980-2010. Based on database of the most severe or extreme weather events occurred in Thessaloniki and the greater area in the last 40 years (1983-2022) a total of 110 events are identified and their yearly and monthly frequency and distribution is analyzed.

2. CLIMATE CHANGE AND YEARLY TEMPERATURE AND RAINFALL

Climate change is indisputably real and accelerating based on the recent sixth report of the Intergovernmental Panel on Climate Change (IPCC) [2]. Climate change projections for urban areas indicate an increasing threat for heavy rainfalls and flash floods, with greater vulnerability with co-existing factors including limited economic resources, rapid population growth and poor planning, regulation and adaptation strategies. In this section an analysis is presented about yearly temperature and precipitation variation in Thessaloniki and the extended area based on the ERA5 reanalysis data of ECMWF (European Centre for Medium Weather Forecasting) for the 43-year period 1979-2021 (https://cds.climate.copernicus.eu/#!/search?text=ERA5&type=dataset) [3].
The mean yearly temperature fluctuation with the deviation (anomaly) from the climatic mean and the trend for Thessaloniki and the extended area (30x30 km) appears a positive trend more pronounced in the last 10 years that are consecutive warmer than average years (Figure 1a). The vast majority of the years after 1997 up to 2021 with the exception of 2011 constitute a consecutive total of 14 warm years, a strong evidence of increasing mean yearly temperature of Thessaloniki in the last decades. In the 43-year period 1979-2021 the warmest year was 2019 with a mean yearly temperature of 16^{o} C and 1991 was the coldest year with 13.6^{o} C.



(a) (b)

Figure 1. Yearly values, deviations and trends for Thessaloniki based on the ERA5 reanalysis data (1979-2021): a) Mean yearly temperature and b) Total yearly rainfall.

The total yearly rainfall for Thessaloniki range based on the reanalysis ERA5 data appears also a slight positive trend more pronounced in the last decade (Figure 1b). However, clear results cannot be stated given that the number of increased rain years are rather equal to number of dry years. The slight positive tendency can be primarily attributed to the increased total rainfalls of individual years. This result that can be further examined as it can be related to increasing rainfall rates with increasing probabilities of heavy rainfalls episodes responsible for flood and flash flood events.

3. SEVERE WEATHER EVENTS IN THESSALONIKI

3.1. Severe weather database

A severe weather event database was examined including the severest and most damaging weather events occurred mainly in the city of Thessaloniki for the 40-year period 1983-2022 (Table 1). Damaging weather reports and data included various sources of information such as, public authorities and services, weather station records of the Hellenic National Meteorological Service (HNMS), National

Observatory of Athens (NOA), the Hellenic National Agricultural Insurance Organization (ELGA) damage records, newspapers and web site reports, eyewitness and other verified severe weather reports [4, 5].

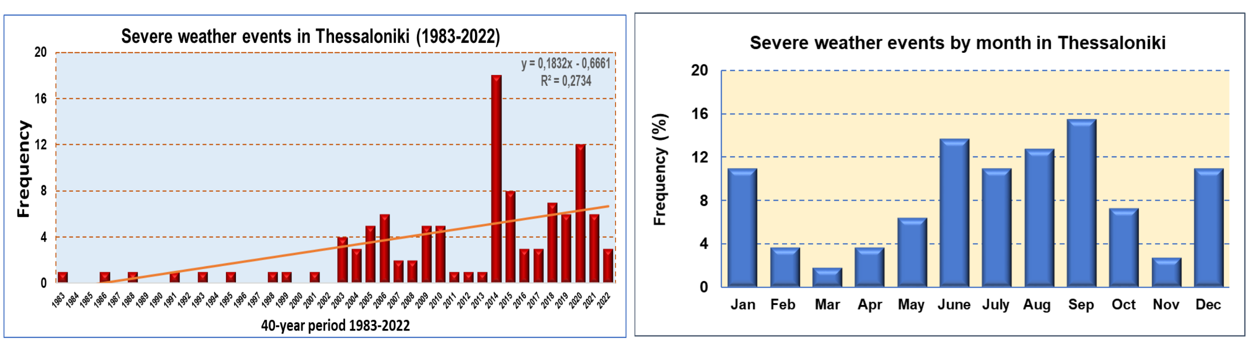
Table 1. Frequency of severe and damaging weather events in Thessaloniki in the 40-year period 1983-2022.

No	Severe and damaging phenomena	Frequency of events (%)	Number of deaths
1	Thunderstorms-Heavy Rainfalls - Flash floods	65.4 %	4
2	Windstorms	10.9 %	9
3	Snow-Frost	17.3 %	2
4	Lightning	6.4 %	7
	Adverse weather conditions and other local scale phenomena		
1	High temperatures – Heatwaves	--	--
2	Fog	--	--
3	Hailfalls	--	--
4	Tornadoes-Waterspouts	--	--

A total number of 110 damaging weather events recorded in Thessaloniki in the 40-year period 1983-2022, including severe thunderstorms, flash floods, windstorms, snow-frost and lightning (Table 1). Other adverse phenomena are heatwaves, fog, hailfalls and very rarely tornadoes or waterspouts. A total of 22 people lost their life in the 40-year period because of severe weather conditions, with hundreds injured and numerous helped by rescue services. Severe thunderstorms with heavy rainfalls and flash floods are the most frequent events with 65.4% of the total events, followed by snow and frost with 17.3%, then by windstorms with 10.9% and by lightning with 6.4% as the less frequent event.

3.2. Yearly and monthly distribution

The yearly distribution of the damaging weather events is presented in Figure 2a. A mean yearly number of about 3 severe weather events is extracted for Thessaloniki for the 40-year period 1983-2022. However, considering the last two decades the mean yearly number increased to 5 and in the last decade increased to 7 severe weather events. The greater number of damaging weather events occurred in the year 2014 with 18 events followed by 2020 with 12 events and then by 2016 with 8 events. The monthly distribution in Figure 2b indicates September as the most active month with 15.5% of the total severe weather events followed by June with 13.6% and January and December with 10.9%.



(a) (b)

Figure 2. a) Yearly and b) monthly distribution of severe weather events in Thessaloniki for the 40-years 1983-2022.

4. CONCLUSIONS AND PROPOSITIONS

Climate change and severe and extreme weather events are examined for Thessaloniki and the greater area. Investigation of ERA5 reanalysis data indicated an increasing trend in mean yearly temperature that has overcome 1^{o} C in the last decade. Total yearly precipitation is slightly increasing, an increase attributed to increasing rainfall rates and heavy rain episodes. Based on a severe weather database for Thessaloniki and the greater area in the last 40 years (1983-2022) a total of 110 severe and damaging weather events are identified. Intense thunderstorms and heavy rainfalls associated with flash floods is the most frequent damaging event for Thessaloniki with 65.4% of the total events. The greater number with 18 severe and damaging weather events in Thessaloniki occurred in 2014 a year with total yearly rainfall of 1052.4 mm, amount 398.5 mm higher than the normal. The mean yearly number of severe weather events in Thessaloniki in the last decade has been increased to 7 events from 3 events in the previous decades prior to 2000. September is the most active month in severe weather events with 15.5% of the total events followed by June with 13.6% and then January and December with 10.9%. Thunderstorms, heavy rainfalls associated with flash flood, lightning, windstorms and hailfalls occur at an average of 23 days in Thessaloniki based on weather radar data. Frequent flash floods hit the area of Thessaloniki during the last decade, especially in the years 2014, 2015, 2018, 2019 and 2020. Protection against flooding of Thessaloniki is a matter of high concern and in this frame appropriate studies and significant infrastructures are necessary. A good example is the study “Flood Protection Works Master Plan Update for areas in the Regional Unit of Thessaloniki” developed by Greek Ministry of Infrastructure and Transportation in 2019 and updated in 2022. Adapting a climate strategy in Greece is in a rather preliminary stages with some emphasis given on flood prevention. Strategic planning for metropolitan areas such as Thessaloniki, is necessary incorporating the risk dimension into strategic goals and priorities, with ecosystem-based solutions and green infrastructure development.

ACKNOWLEDGEMENTS

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URBAN-SCALE SEISMIC RISK ASSESSMENT: THE CASE OF THESSALONIKI

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ABSTRACT
This work presents a holistic framework for large-scale seismic risk assessment of structures, including soil-structure-interaction (SSI) and site amplification (SA) applied to the city of Thessaloniki. The proposed methodology is comprehensive and has strong modularity since it exploits the coupling among globally available input data and open-source analysis tools. To correctly consider local site-effects and determine the soil's main features in the SSI modeling, we took advantage of detailed microzonation studies and exposure data available for Thessaloniki. The main scope is to investigate whether a more sophisticated method for urban risk assessment can affect the final risk calculation. Finally, we test the reliability of our methodology by computing damage distribution inferred by the building stock of the city of Thessaloniki for a scenario corresponding to the destructive historical earthquake of MW 6.5 1978. The so-estimated physical damages in this study are compared with the ones obtained and with the literature approach and validated against the collected damage for the 1978 Mw 6.5 earthquake. Despite the numerous uncertainties and simplifications, a good comparison is found between the results of the proposed framework and observed damages.

Keywords: Urban scale seismic risk assessment, vulnerability, fragility, Thessaloniki

1. INTRODUCTION

In seismic-prone cities, earthquakes are among the most significant hazards affecting the urban environment producing considerable damage and causing human and economic losses. A comprehensive risk assessment is fundamental to identifying the impact of potential future earthquakes and provides central and local authorities with the most valid short- and long-term risk mitigation policies.

Much effort has been devoted lately towards a more refined urban risk assessment, proposing different methodologies and deeply assessing data and models for exposure, hazard, and vulnerability modules [1,2]. Despite this, the compliance of the foundation subsoil and its interaction with the foundation-structural system (SSI) is rarely considered in most current methods and applications [3,4,5]. The main issue is the lack of fragility functions accounting for different SSI scenarios and methodology to integrate these curves in large-scale applications. Additionally, site amplification (SA) is commonly considered by simplified approaches, selecting a broad set of soil-class compatible records for the derivation of fragility curves.

The main innovation of the current effort concerning previous works relates to the use of fragility functions considering SSI and SA computed following the holistic, modular methodology proposed in Amendola and Pitilakis (2022) [6]. These fragility curves are classified according to the averaged shear-wave velocity in the top 30 m ($V_{S,30}$) and a foundation feature such as the slenderness ratio and H/B as proxies for the SA and SSI effects.

This paper aims to apply and extend this modular framework linking these fragility curves with actual soil and foundation conditions for a retrospective appraisal of the past damaging Mw 6.5 Volvi earthquake in Thessaloniki, northern Greece. Some specific details of implementation and extension of the proposed methodology are presented, together with some preliminary results.

2. METHODOLOGY

This work applies and extends the methodological framework proposed in [6] specifically conceived for large-scale risk assessment applications. Figure 1 illustrates the extension of the methodological framework and specifications of all the steps involved in the implementation.

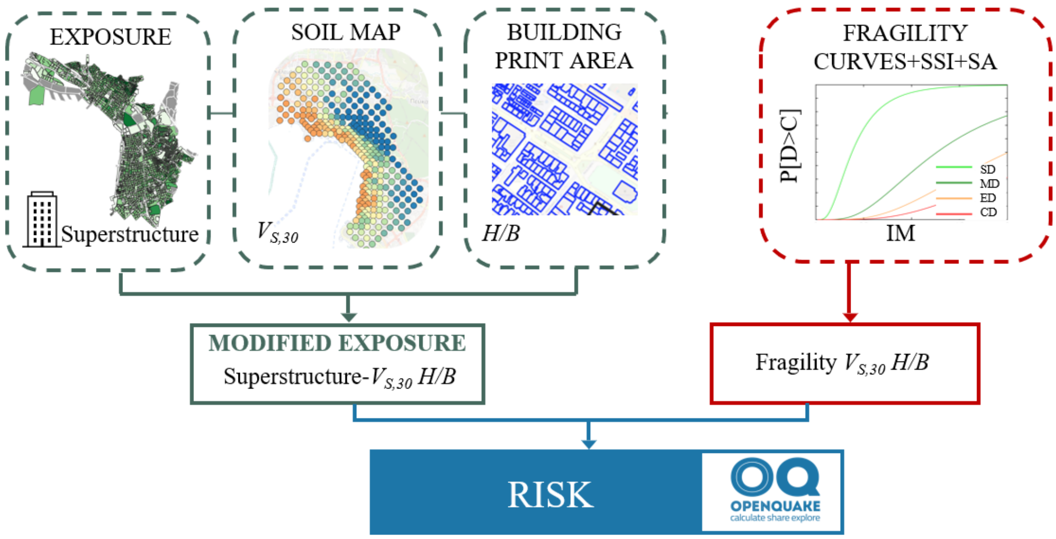

Figure 1 Methodological framework providing fragility functions including SSI and site amplification expressed in terms of an improved taxonomy. Proposed approach to modify the exposure model to account for SSI and SA through globally available data

As graphically illustrated in Figure 1, fragility functions classified according to the averaged shear-wave velocity in the top 30 m ($V_{S,30}$), and the foundation feature the slenderness ratio, H/B are integrated with a modified exposure model to consider SSI and local SA in the final risk calculation.

In detail, the input exposure model is modified considering, for each location in which building classes are located, actual site conditions defined on the base of H/B and $V_{S,30}$ maps. $V_{S,30}$ maps may be derived, to mention a few, from detailed in situ analyses, proxies such as the slope [7], or local geology [8]. At the same time, the foundation system, in lack of local information, can be retrieved from the building print area as available in the OpenStreetMap [9].

To give a practical example, according to the proposed approach, one building class (e.g., CR_DUAL_DUL_H3 classified according to the GEM taxonomy, [10]) resting on a soft soil characterized by $V_{S,30}$=300 m/s and with a foundation corresponding to H/B=2 will be renamed CR_DUAL_DUL_H3 _HB2_VS300. Despite its simplicity, the proposed extension makes the methodological framework implementable in the Openquake Engine [11].

3. APPLICATION AND RESULTS

The scope of this section is twofold: we apply the integrated methodological framework to address the distribution of damages for the real destructive scenario of the Mw 6.5. 1978 Volvi Earthquake [13, 14] considering the influence of SSI and local site amplification effects on the building stock of Thessaloniki.

As a second objective, we test the reliability of the proposed approach by comparing the estimated physical damages with the one obtained following the literature approach, which neglects SSI, and considers SA using simplified approaches and with the observed damages available for the same seismic event [15, 16].

In this application, fragility functions accounting for SSI and SA are integrated with an exposure model modified through $V_{S,30}$ maps from very detailed microzonation studies available for the city of Thessaloniki [12]. The foundation feature is estimated from the building print area as available in the OpenStreetMap [9]. Such parameter is evaluated for all the municipalities of Thessaloniki. For the case of Thessaloniki central municipality, a more refined model systematization is performed to consider the higher exposure concentration.
Figure 2 reports the distribution of physical damages for the most heavily damaged typology during Mw 6.5, 1978 Volvi EQ computed following the proposed approach (Figure 2a), the standard framework that considers fixed-base fragility functions and SA employing amplification factors (Figure 2b) and the collected damage data (Figure 2c).

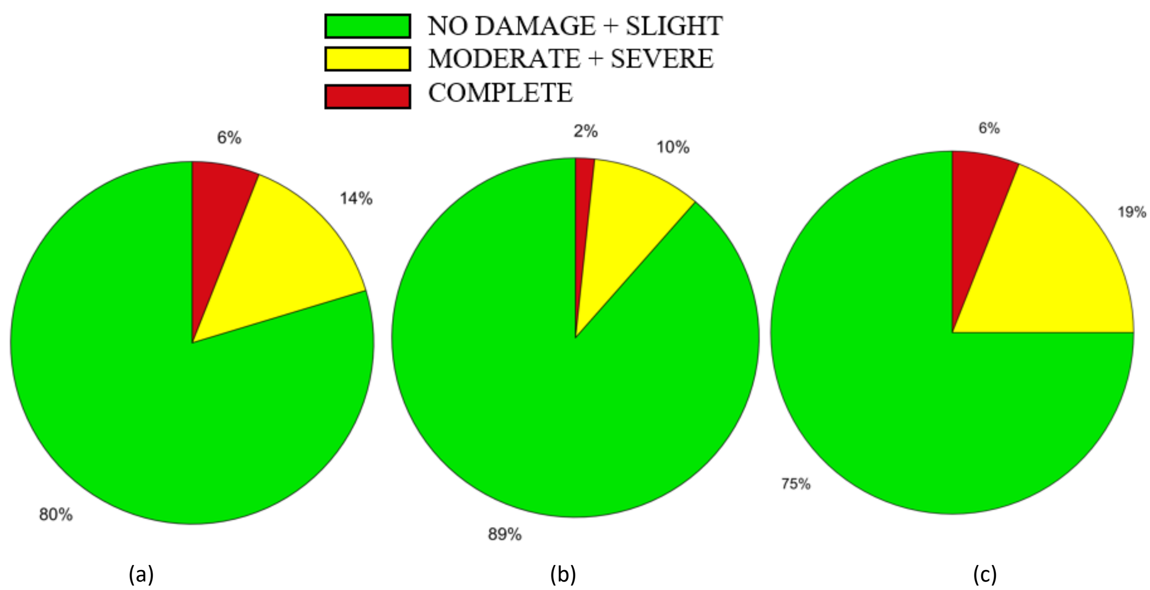

Figure 2 Aggregated physical damages for most heavily damaged typology during Mw 6.5, 1978 Volvi EQ computed following the approach proposed in this work (a), the literature approach (b), and the actual damage data (c).

The number of buildings in damage states increases when considering SSI and SA (Figure 2a) with respect to the FB reference case, where SA is considered through amplification factors (Figure 2b). It reasonably reproduces the total distribution of physical damages collated after the earthquake (Figure 2c).

4. CONCLUSIONS

A comprehensive methodological framework to develop site-consistent fragility curves, including SSI and SA, is presented and applied in this work to assess the distribution of damages in Thessaloniki, northern Greece, for the 1978 Mw 6.5 earthquake. The proposed approach explicitly introduction of the averaged shear-wave velocity in the top 30 m ($V_{S,30}$) and the foundation parameter H/B in the fragility functions as a proxy for the site and SSI effects. Following this improved taxonomy, we propose to link fragility curves for a spatially distributed portfolio of structures with actual site conditions, leading to a risk assessment framework in which SSI and SA are directly considered in the fragility analysis.
In the showcase application, we take advantage of available microzonation studies to consider the surface ground foundation's variability correctly. In contrast, the foundation geometrical features are retrieved from the building print area as available in the OpenStreetMap [4].

The numerical simulations confirmed that the conventional way of calculating risk analysis, i.e., fixed-base structures and SA using amplification factors, may lead to a potential underestimation of the physical damages.
Regardless of the numerous uncertainties, the results of the proposed framework have been successfully verified through the comparison with the post-1978 earthquake damage observations. Based on applying the proposed methodology in the city of Thessaloniki, this study encourages the adoption of SSI models in the fragility computation. Compared to more simplified approaches for large-scale application, this methodology quantifies the potential physical and economic losses more accurately.

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OPTIMAL ROUTE SELECTION FOR FOREST FIRE SUPPRESSION (CASE STUDY: PERI-URBAN FOREST OF THESSALONIKI, GREECE)

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ABSTRACT
Increase in forest fires in Greece is a worrying trend the last decades. Wild fires out of control is an experience that few people can coop with. The great losses of human tragedy such as Mati in Greece (2018) is a part of more than 33,000 deaths which caused globally each year. Civil Protection Service set each year as number one goal to minimize of forest fires at the summer period especially when that is expanded between the end of spring and the beginning of autumn. The city of Thessaloniki is crowned by the peri-urban forest which is a pole of attraction for residents and tourists, but also an area of potential fire spread in the event of a forest fire due to its direct proximity to residential areas of the city. The immediate intervention of fire engines upon the announcement of the start of a fire is a matter of course for a forester, but the difficult terrain of the forest roads and the lack of suitable 4X4 vehicles often prolongs this intervention of the fire service. The aim of this research is to show that the accurate digital mapping of the forest road network and infrastructures (water tanks, hydrants for fire hoses, water sources, etc.) and the selection of an appropriate algorithm for highlighting the optimal route, in order to immediate intervention of firefighting vehicles, is a main tool of strategic intervention in a forest fire. We used Dijkstra algorithm for digital map measurements of optimal routes and we ran scenarios of movement of different firefighting vehicles based on steep terrain and time of immediate intervention to the fire starting point.

Keywords: Optimal forest routes, Forest fires, immediate intervention, Civil Protection Service, peri-urban forest

1. INTRODUCTION

On Earth always something is burning. Wildfires are started by human actions who used to manage farmland and pastureand clear natural vegitation for farmland by burning them. A large amounts of smoke pollution cased by fires whice release greenhouse gases and unintentionally degrade ecosystems [1]. Fire also can clear away dying underbruch and by that way can help resore an ecosystem to good health. İt is also known that some forests and plants have co-evolved with fire requiring periodic buringn in order to be productive. The importance of forests for the planet is indisputable. The existence of life is due to them as carbon dioxide binding CO_2 feeds the atmosphere with O_2 oxygen [2]. One more of peri-urban forest multiple functions is to protect urban areas from floodplains, acting as natural barriers to water retention and aside produce pure water [3-4]. Peri-urban land shaped by urban expansion and, more in general, rural areas surrounding big cities are characterized by a variety of land cover types, which is reflected in a highly fragmented morphology [5]. The peri-urban forests in Greece are very vulnerable to fire occurrence and spread. Covering 105,353 hectares in Greece, the peri-urban forests are mainly a result of afforestation activities by the Forest Service during the 1950's [6]. Fires in the peri-urban zone are a complex phenomenon which may lead to uncontrollable aspects of fire behavior [7].

1.1. Research Area

Peri-urban forest of Thessaloniki is an artificial forest and was created after the liberation of the city at 1912 by planting 1000 trees of *Pinus halepensis* at an area well known as "Thusand trees" [8]. The total area of the peri-urban forest of Thessaloniki is 30.018 hectares covered by: *Pinus brutia, Cupressus emprevirend, Quercus coccifer, Pinus pinea,* and at small areas near by streams the areas are coverd by: *Platanus orientalis, Salix sp., Populus sp*.[9]. Forest fires are one of the major environmental risks, since they are the main reason of the three global environmental problems: a) global warming, b) climate change, and c) land desertification [10 - 13]. A forest fire risk map usually prepared as an early warning system [14]. A fire risk map, updated on a daily basis, is of great importance in terms of forest and civil protection [15]. The purpose of this research is to highlight the necessity of digital applications using data and offline, where the optimal route for the immediate intervention of a fire engine in a forest fire will be displayed.

2. EXPERAMENTAL METHOD

An optimal forest road selection is based on varius of parameters and facts such as: (1) the influence of terrain parameters as slope and geology, (2) the assess the effect of cost estimating strategies on optimal road network layout, (3) the vehicle type which is moving on that road. [16]. Designing an optimal forest road network across a varying landscape is a challenging task [17]. Several engineering problems, such as an overwhelming amount of terrain and environmental data, the uncertainty of cost figures, a lack of explicit constraints, and fuzzy and contradictory goals, make this task even more complicated. Computer-aided engineering approaches for solving road network layout problems have now emerged [18].The development of such approaches has been accelerated by the widespread availability of digital elevation models [19]. The open source algorithm Dijkstra (Figure1) [20] was used to measure on digital map the distance between the fire trucks's nearest stopping point for potential fire observation and the forest fire start point and combined with the information of Firefighting Department about the vechicle types are usually used for forest fires. We calculate the mathematical formulas for average route slope and vehicle speed per hour. Dijkstra's algorithm is the basic methodology used by routing applications like Google's to calculate the above [21-23].

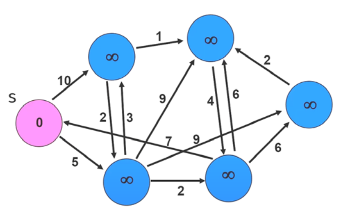

Figure 1. This is a figure of Dijkstra's Algorithms based on shortest paths from s point to all nodes (source: GeometryLab, https://www.youtube.com/watch?v=_Zhx4b3ygNg).

$$\textbf{Average route slope (\%)} = \frac{\text{Final Altitude - Initial Altitude}}{\text{Total Travel Distance}}$$

$$\textbf{Vehicle speed/hour (km/h)} = \frac{\text{Route Length X 60' (min)}}{\text{The time it takes to travel the route}}$$

3. RESULTS

We dicided to ran a number of scenario's based on an hypothesis that we are going to draw a 1,5km radius centered on the posision that a firefighting vehicle takes in order to observe the beging of a pottential forest fire at summer period. Based on that point we have to find the optimal route to the potential forest fire which is on early beginnings, using google maps who are calculating various optimal routes based on Dijstra algorithem (Figure 2).

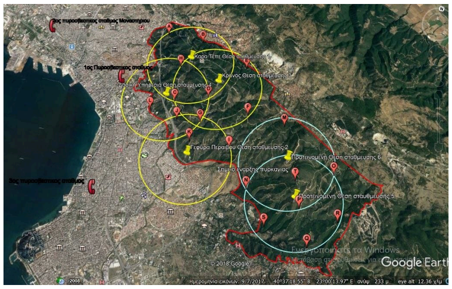

Figure 2. This is a figure of all the scenario's based on six (6) observation points and over twenty four (24) early starting fire points.

Figure 3. Google map distance and slope calculator between the 1st Firefighting Station of Thessaloniki and a hypothetical pointed area at a recreation point at peri-urban forest of the city.

The scenarios were based on: a) the average speed of the vehicle, b) the average slope of the terrain of the proposed route and c) the distance. A typical case is the scenario with the movement of the fire engine from the 1st fire station of Thessaloniki to the hypothetical starting point of a forest fire near the entrance from the "Exochi" area to the recreation area of the peri-urban forest of Thessaloniki. The observation fire point is the parking area "Kara Tepe", the average longitudinal slope of the road is 4,8%, a 4X4 Firefighting vehicle is moving with speed of 12,5km/h and the immediate Fire Department Service reaction for forest fire suppression is nearly 13 min (Figure 3). After processing the data from the fire brigade, the fire scenarios we set and the fire safety planning of the peri-urban forest we came to the following results: 1) The Eastern area of peri-urban forest is not properly protected from the Fire Departments (blue cycle areas at figure 2), 2) At the eastern area there are some of properties in the forest 3) The Civil Protection Bureau designates volunteer firefighters as responsible for the surveillance and fire safety of the eastern suburban forest sector who sometimes seams to be careless and not puntually accurate on their observation points, 4) neither volunteers nor their vehicles are deployed on a 24-hour basis in forest fire alert areas.

4. CONCLUTIONS - DISCUSSION

The scenario's we ran on peri-urban forest of Thessaloniki and the information that we had from Civil Protection Office, Firefighting Service and Forest Service about the personel that activates on summer periods at this forest lead us to conclude that deficiencies occure in the issue of immediate and timely notification of a forest fire and the movement of fire trucks to the point of first ignition, is usualy calculated over the 30' of the first announcment of the fire. Based on the above we propose that: a) the improvement of the road surface of the forest roads, in order to achieve better accessibility, b) the production of digital maps of the naming of forest roads which will work and offline, and they can be used by the fire services, the forest office and civil protection service, c) Research into the creation of new water reservoirs to fully meet the needs of the suburban forest water, d) Civil Protection with Fire Fighting Department and Forest Protection Department Office must use a common web application which will be used from all workers cellphones and visualize the development of a forest fire and the optimal pathway to drive nearby in order to extinguished. We believe that a well-developed Master Observation Plan and a constant monitoring of the forest for protection and prevention of a wild fire in peri-urban forest of Thessaloniki will be a step forward to have an everlasting development of the forest and a new era of environmental sustainability.

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FIRESCOPE: A FIRE WEATHER INFORMATION AND EARLY WARNING SYSTEM SUPPORTING THE SHIFT FROM SUPPRESSION TO PREVENTION IN EUROPE AND GREECE

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ABSTRACT

This work presents the development and operation of Firescope. Firescope is a fire weather information and early warning system designed to support the shift from suppression to prevention, and to increase awareness and preparedness of stakeholders, practitioners, and the public concerning wildfire danger. The system takes advantage of WebGIS technology and state-of-the-art atmospheric numerical modeling to interactively present key fire weather information, both for the present (observations) and the short-term future (forecast). Firescope began its operation in the summer of 2022 and its capabilities are continually expanded.

Keywords: fire weather, early warning, information system, WebGIS, fire danger

1. INTRODUCTION

In Europe, wildfires are a major hazard that threatens human lives and properties, amid producing large environmental and economic losses. Over the 2000 – 2017 period, wildfires across European countries ravaged more than 8.5 billion ha of land, led to the death of more than 600 people (firefighters and civilians), and induced economic losses of more than 54 billion Euros [1]. Recent large and destructive events (e.g., 2017 in Portugal, 2018 and 2021 in Greece) are challenging the suppression capacities of most fire protection programmes across Europe. This is because traditional policies and management practices can be successful in suppressing wildfires under normal weather conditions but are insufficient to cope with extreme wildfires. Addressing this new wildfire reality requires investing more in effective science-based wildfire management and risk-informed decision-making. In turn, this implies shifting the focus from suppression to prevention and increasing awareness and preparedness of stakeholders, practitioners, and civilians.

Understanding how meteorological conditions influence the ease of fire ignition, and the spread and behavior of fire is of paramount importance. Within an operational context, gaining this knowledge would allow for more effective use of suppression resources and planning of emergency operations, especially on the occasion of simultaneous events. In addition, knowing and understanding fire weather is fundamental for providing early warning of the potential for large wildfires and thus, raising awareness and increasing the preparedness of operational agencies and the public.

This work presents Firescope, a fire weather information and early warning system for Europe and Greece, developed and implemented operationally by the METEO Unit of the National Observatory of Athens (NOA). The system disseminates data through an interactive, online WebGIS interface that provides access to forecasts and real-time observations of key weather variables that affect fire ignition, spread and behavior, including air temperature and humidity, wind, and fire weather indices. In that regard, Firescope aims at contributing to the build-up of the capacity required for more effective fire management, allowing users to identify when and where weather conditions escalate fire danger. The current version of Firescope can be freely accessed directly through https://fireweather.eu/firescope/.

2. OVERVIEW OF FIRESCOPE

Figure 1 provides an overview of the present architecture of Firescope. The fire weather information and early warning system is built around a WebGIS application that assimilates multiple input datasets and serves them to the end-users in the form of interactive maps.

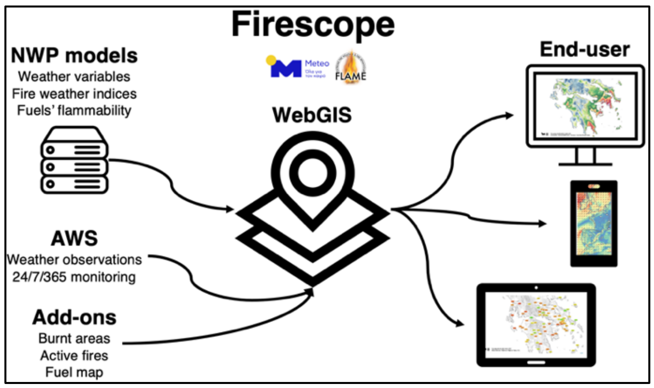

Figure 1. Overview of the architecture of Firescope.

2.1. Forecasting data

Accurate prediction of fire weather can support effective use of suppression resources and planning of emergency operations. For this, we exploit numerical weather prediction (NWP) models operationally implemented by the METEO Unit of NOA to provide high-resolution forecasts of the key weather elements affecting the ease of fire ignition and fire spread and behavior. Forecasts are provided for both Europe (at 10 x 10 km^2 spatial resolution) and Greece (at 2 x 2 km^2 spatial resolution), at hourly intervals for the next 3 days, and are updated twice daily. The meteorological variables currently available on Firescope include air temperature, relative humidity, precipitation, wind speed and direction, and vapor pressure deficit.

In addition to the weather forecast data, NWP model output is exploited for deriving forecasts of key fire weather indices. Firescope currently provides access to three-day forecasts for three components of the Canadian Forest Fire Weather Index System (CFFWIS, [2]). These include the Fine Fuel Moisture Code (FFMC), which is a numeric rating of the fuel moisture content of fine dead fuels, the Initial Spread Index (ISI), which is a numeric rating of the expected rate of spread of fire, and the Fire Weather Index (FWI), which is a numeric rating of the expected fire intensity. It is important to note that for Greece, the thresholds applied to the CFFWIS for communicating the level of fire danger have been properly adapted to the fire environment of the country [3]. Besides FFMC, ISI and FWI, hourly forecasts for the next 3 days are also provided for the Hot-Dry-Windy (HDW) index, which combines the dryness of the lower atmosphere (via the vapor pressure deficit) with wind speed to identify when and where weather conditions will make a wildfire difficult to control [4]. Last, we exploit NWP output for estimating landscape flammability through the computation of the dead fine fuel moisture content (DFMC), following the methods detailed in Dragozi et al. [5].

2.2. Observational data

Observational data are currently retrieved from the dense network of automatic weather stations (AWS) that the METEO Unit of NOA operates in Greece since 2007 [6]. In particular, Firescope provides access to real-time measurements of air temperature, relative humidity, precipitation, wind speed and direction, wind gusts, daily minimum and maximum air temperature, daily maximum wind gusts, and daily accumulated precipitation.

2.3. WebGIS interface

Both the forecasting and the observational data are served to the users of Firescope through a WebGIS application, accessible publicly through https://fireweather.eu/firescope/ (Figure 2). Entering Firescope introduces the user to an interactive map and a navigation menu that allows to select between the source of data to show (Forecasts or Observations), the model source (applicable only to Forecast data), the area of interest (Europe or Greece), and the variable to illustrate. Through the menu bar, the user can also move back and forth in time to examine fire weather conditions valid at any of the 72 available timesteps (i.e., three-day forecast, available at hourly intervals). An information box, providing short information about the importance of the displayed variables for fire spread and behavior, is available, while the user can also opt for a full-screen display of the maps.

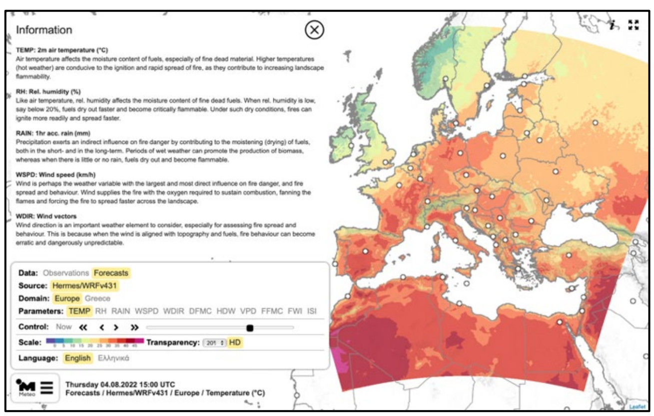

Figure 2. Welcome screen of the Firescope fire weather information and early warning system, with the main navigation and selection menu (bottom left), and an information box (upper left).

All data presented through the WebGIS application of Firescope are interactive. This means that the user can pan the map to navigate over areas of interest, zoom in and out, and, more importantly, click on any area of the map to derive point-based fire weather information. In particular, by clicking on any area of the map, the user is introduced to (a) the value of the selected variable for specific point he/she clicked on, and (b) a set of timeseries diagrams for air temperature, relative humidity, wind speed and direction, DFMC, and HDW (Figure 3).

3. FUTURE DEVELOPMENT OF FIRESCOPE

The METEO Unit of NOA plans to continue developing the Firescope fire weather information and early warning system by expanding its capabilities and providing access to more information concerning wildfires. For the forecasting data, additional models will be included to allow for a multi-model assessment of expected fire weather conditions. Observational data will be also exploited for providing access to a spatially interpolated interactive map of landscape flammability. As lightning strikes may be occasionally responsible for the ignition of wildfires, lightning data from the ZEUS lightning detection network [7] will be also added to Firescope. Furthermore, Firescope will be enriched with auxiliary geospatial content, including an ultra-high-resolution (10 x 10 m^2) fuel map of Greece, satellite-detected active fires and past fire perimeters. Overall, we anticipate Firescope to serve as a one-stop-shop for fire weather information, supporting both authorities and the public.

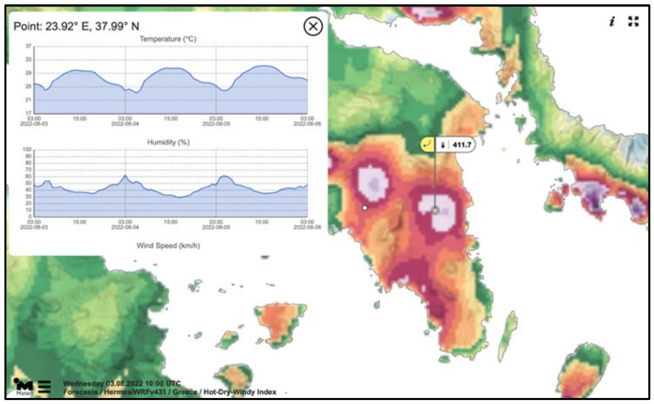

Figure 3. Example forecasting map of the HDW index zoomed over Attica and Northern Peloponnese for 3 August 2022, 10:00 UTC. By clicking on the map, the user gets access to the corresponding point-based time series of the data (shown on the upper left of the screenshot).

ACKNOWLEDGMENTS

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FUELS MANAGEMENT AT THE LANDSCAPE SCALE FOR WILDFIRE MITIGATION

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ABSTRACT

Extreme wind events, climate warming and forest fuel build-up are combined to allow anthropogenic ignitions evolving into mega-fires and burn the wildland-urban interface. Recent catastrophic forest fires in Greece have prompted stakeholders to plan for fuel treatment programs, in an effort to adopt the best compromise between fire control and fuel management approaches. We applied a framework that utilized stochastic wildfire simulations, geographic and trade-off analyses to evaluate different landscape fire management objectives and a more representative geography of risk in terms of setting goals and priorities. We used spatial analysis to investigate the existence of trade-offs among alternative fuel management scenarios to meet socioecological, economic and wildfire suppression objectives. We examined how focusing on one management objective results in trade-offs in others, and where spatial allocation achieves multiple forest and fire management objectives at the landscape level. The proposed scenario planning scheme helped to understand trade-offs and assess progress towards nationally identified priorities and targets in forest protection and fire risk management; and to discover the best investment projects at the appropriate scale. Related projects may include actions such as mitigation of surface and canopy forest fuels with thinning, mechanical treatments and pile or understory burning, reducing flammable vegetation surrounding homes, and optimizing preventive planning and disaster management based on local initiatives.

Keywords: *wildfires, fuel treatments, wildland-urban interface, forest resilience, stochastic fire simulations*

1. INTRODUCTION

Climate change has the potential to significantly alter wildfire regimes, while higher fire risks, longer fire seasons and more severe fire effects are prominent in the Mediterranean-type of ecosystems [1]. Forest fire behavior is complicated by the erratic and, often, weather-driven nature of these life-threatening events. The geographical extent of extreme and wind-driven fires can be further intensified by climate change-induced drying and forest mortality. These conditions may combine with extreme wind events, climate warming, fuel build-up and/or wildland-urban interface (WUI) to allow lightning and human-caused ignitions to evolve into major conflagrations not only in Greece but also in other fire prone regions of the globe [2].

Fuel management planning is narrowly focused on specific parcels of land, compared to landscape-scale approaches. For example, fuel breaks and other fuel treatments are concentrated between roads, WUI and developed areas, while ignoring the larger wildfire threats on the surrounding lands that are capable of producing large and destructive forest fires. In this paper, we used thousands of stochastic wildfire simulations to build a network of transboundary fire spread between forests and developed areas; and identify fire source and fire sink relationships. We then utilized spatial analysis methods to locate forest fuel treatments at the landscape level, in specific land types to reduce large fire growth that considers the connectivity of wildfire between different landcover types and the wildfire risk to individual human settlements; thus, contributing to a larger framework for building fire resilient landscapes and fire adapted communities [3].

2. FOREST FUEL MANAGEMENT FRAMEWORK

Management of forest fuels has proven to be an effective approach to stop fuel horizontal and vertical continuity and mitigate fuel quantity, rate of spread and intensity of wildfires [4]. Within this scheme, we applied a framework that combined stochastic fire simulations, geographic and trade-off analyses to evaluate different landscape fuel management scenarios and improve forest resilience to wildfires (ecological objective), effectiveness of firefighting (suppression objective), protection of communities (social objective), and timber harvests with optimal production and allocation of resources (economic objective). We used spatial analysis to examine the existence of trade-offs among alternative fuel management scenarios. We also examined how focusing on one fuel management objective results in trade-offs in others, and where this spatial co-allocation achieves multiple fire management objectives [5].

We created a framework for processing and creating spatial layers and descriptive data from open-access databases in stochastic fire simulations with the Minimum Travel Time (MTT) fire spread algorithm [6], to assess cross-boundary wildfire propagation and community exposure for a large-scale case study area (i.e. the Macedonia region of Greece; a total area of 34,000 km^2). We ran over 300,000 simulated wildfires, each independently modelled with constant weather conditions from a randomly chosen simulation scenario derived from present weather data. Simulations generated fire perimeters and raster estimates of annual burn probabilities and conditional flame lengths (Figure 1).

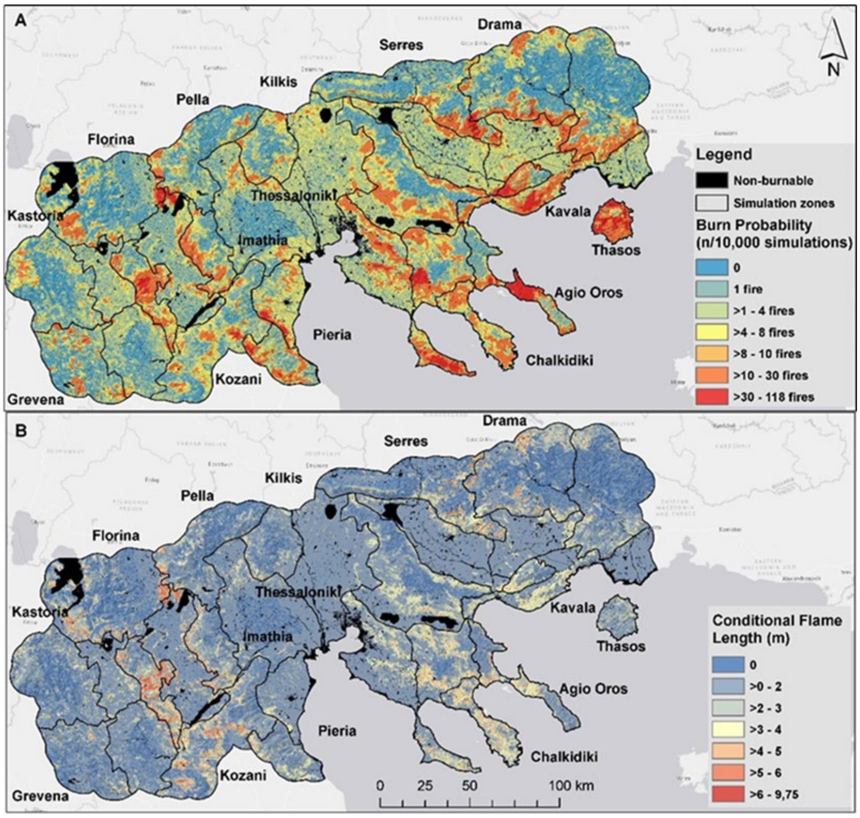

Figure 1. (A) Simulated burn probability and (B) conditional flame length in Macedonia, Greece.

Burn probability (the number of times a pixel burned per 10,000 simulated ignitions) estimates revealed that 25% of the study area did not burn by any simulated fire, while 17% burned from only one fire (Figure 1A). Most lands (42%) burned at a moderate frequency and encountered between 2 and 10 simulated fire events. Locations with very high (>30 times) and high (between 11 and 30 times) burning frequency represented 2% and 14% of the landscape, respectively. The estimated conditional flame length was very high (>3 m) on 14% of the study area (Figure 1B) that may increase the complexity of fire suppression efforts, probably requiring indirect tactics to confront the fire on those portions of the landscape due to high fire intensities and growth. Most of the area (77%) had the potential to experience low flame lengths (0-2 m) meaning that hand crews and machinery can confront the fire. Finally, 9% of the study area had the potential to experience fires with moderate flame lengths (2-3 m), requiring aerial means in collaboration with ground forces for fire suppression [7].

We ranked and mapped the best 100 projects (approximately 500-ha each) in Macedonia, Greece, and assessed cumulative attainment and area treated. For example, the cumulative attainment of the 100 projects for the protection of developed areas priority was 47% if we treated 43,000 ha. This level of attainment was much higher compared to any attainment achieved by other runs, suggesting that small parts of the landscape account for most of developed areas fire exposure, making it easier to manage less land to achieve high attainment [5]. We found that for the protection of developed areas, almost 15% of the total attainment could be achieved in four years with 34 projects treating 2,195 ha (Figure 2). The number of projects implemented increased over time to achieve the same level of attainment compared to year one. When the abovementioned projects were combined to remove duplicate stands (i.e. stands that were selected by the prioritization process for more than one priority), the total area treated during the four-year treatment plan was 77,350 ha with 855 projects on lands with sufficient growing stock volume.

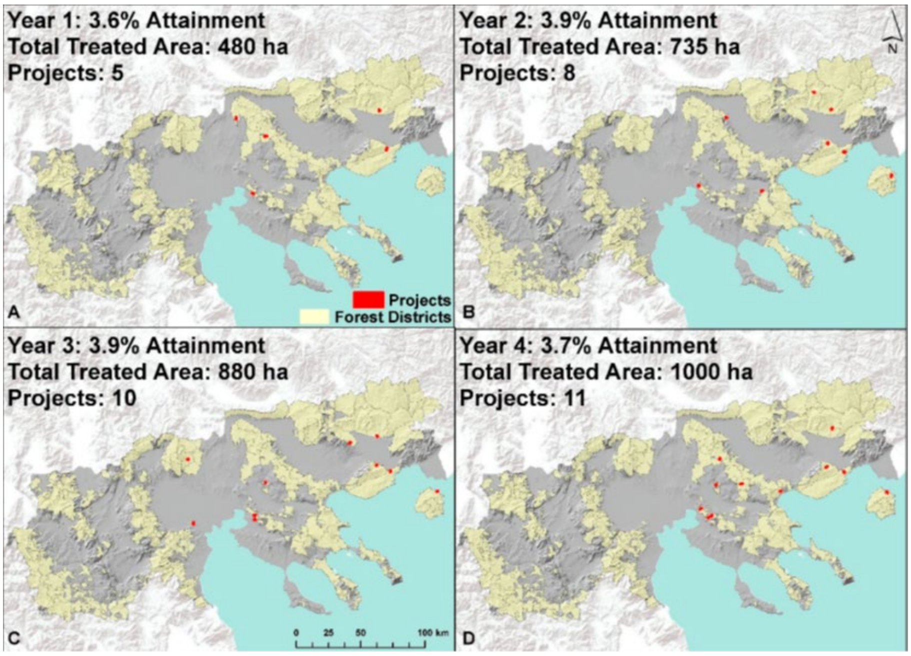

Figure 2. Annual fuel treatment areas of the best 100-hectare projects in a 4-year management plan at Macedonia, Greece, as estimated for human community protection.

3. CONCLUDING REMARKS

This work was a first application of large-scale fire simulation modelling to evaluate fuel management planning for wildfire exposure mitigation through scenario planning in Greece. Specifically, it provided measurable outcomes on how focusing on one forest fuel management priority results in trade-offs in others and identified fuel treatment projects to achieve multiple forest and fire management outcomes. However, despite the widespread implementation of fuel treatments in the United States [8], their benefits are diminished over time on large landscapes due to the low probability that treated areas will be burned by a subsequent fire within a treatment's lifespan (temporal mismatch) and the influence of climate change [9].

Fuel treatment projects should employ a combination of surface fuel loading, depth and continuity reduction treatments (e.g. prescribed burning and mechanical means), silvicultural practices to change tree crown structure (e.g. thinning and low pruning), and infrastructure and safety zones to facilitate fire suppression activities (e.g. road networks and defensible spaces) [10]. Since increasing fuel loads and continuity represent the main factors responsible for the recent catastrophic fire events in Greece, we anticipate that our results can inform fire risk management stakeholders on the optimization of forest fuel management to improve fire suppression efficiency and reduce spread to the WUI and protected areas. We advise the Greek State to promote sound legislation that requires new prevention plans to include analyses examining the operational, economic and logistic aspects of implementing different forest management scenarios that target meeting different priorities, with measurable outcomes for important priorities such as community and wildland protection from fires in a changing climate [2]. Fuel treatments provide the potential to contribute to improving the efficiency of wildfire management investments aimed at creating fire resilient ecosystems, facilitating safe and efficient fire suppression tactics, and safeguarding rural and other human communities from catastrophic mega-fires.

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SAFESCHOOLS: EARTHQUAKE EARLY WARNING AND REAL-TIME SEISMIC RISK ASSESSMENT SYSTEM FOR SCHOOL BUILDINGS

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ABSTRACT
The protection of schools and critical infrastructure against earthquake and other natural hazards is a subject of first priority, especially for Greece. We briefly describe herein SafeSchools system for earthquake early warning and real-time risk assessment of school buildings against earthquakes implemented in the framework of SafeSchools project, (https: www.safeschools.gr/), funded by the General Secretary of Research in Greece.The system combines data from the national broadband strong and weak motion network and on-site classical and new-designed accelerometric sensors installed at selected school buildings, supported by appropriate software, to provide: (a) early detection of the incoming earthquake in terms of magnitude and location (early warning), (b) automatic estimation of the seismic motion characteristics in target sites, (c) real time assessment of expected damage in school buildings, and (d) warning send immediately to selected end-users for the incoming event and the intensity of the expected damage. These estimations provide a timeline of few seconds in order to take critical safety measures for the humans (pupils, employees) and the infrastructure affected. At the same time, the system allows health monitoring of the school building structures to check their safety margin and improve their vulnerability model. This innovative system is already installed and operable, at selected school units, in the city of Thessaloniki.

Keywords: early warning, risk assessment, school builidngs, seismic vulnerability, structural monitoring.

1. INTRODUCTION

A modern tool for earthquake protection, developing rapidly in recent years, is earthquake early warning systems (EEWS). Early warning is an important element in the disaster reduction chain. The need to use early warning methods to reduce natural hazards in modern societies is related to their unprecedented dependence on technology. The increasing interconnection of societies and economies places modern populations at increasing risk of large-scale natural disasters, such as earthquakes. This dependency sparks efforts to develop systems that can reduce the negative impacts of such disasters in particular for critical facilities and infrastructures. Reducing this risk is a complex process that requires the cooperation of various specialists, including seismologists, engineers, IT scientists, and decision-makers. Several EEWS capable of rapidly performing seismological analysis of ground motion during a strong earthquake are currently operative or are under development and testing (e.g., in Japan, Taiwan, Mexico, Italy, Turkey, California, Romania, China, Italy, etc. [1-4]. A key parameter of EEWS is the lead time, which is the time available for protective measures to be taken at target sites once an earthquake has been promptly detected and, based on the expected ground motion at the site, an alarm is issued. Lead times depend on the distance between the earthquake source and the targets to be protected, as well as the time necessary for the implementation of protective measures, hence may vary from no warning at all (i.e., in the blind zone) to tens of seconds if the source is at a greater distance (e.g., further than 100 km). In EEWS two different approaches are typically implemented [5]: regional (or network-based), and on-site warning. However, EEWS provide only an estimation of the upcoming magnitude and epicenetre, while it is equally important, if not crucial, to know in real-time if this upcoming event in a target building may produce damages, light, moderate or severe. To this regards the REAKT project (http://www.reaktproject.eu/) was one of the pioneer efforts to bridge this gap using an onsite EEW system to estimate the real-time seismic vulnerability of targeted buildings like schools, hospitals, etc [6,7]. In the framework of the SafeSchools project (www.safeschools.gr), a regional network-based early warning and risk assessment system for school buildings is further developed and is under validation in the broader area of Thessaloniki in Greece.

2. THE SYSTEM

The proposed SafeSchools tool for early warning system and real-time seismic risk assessment, developed for specific critical structures, as for example school buildings, consists of four interconnected subsystems, shown in Figure 1, that communicate with each other: (a) integration of seismic records from monitoring regional and on-site networks, and development of a powerful database, archiving exposure and continuous seismological history; (b) a continuously (24/7) operating early-warning system using the regional and on-site network data; (c) appropriate building-specific vulnerability and risk assessment software and (d) visualization, alert and communication software.

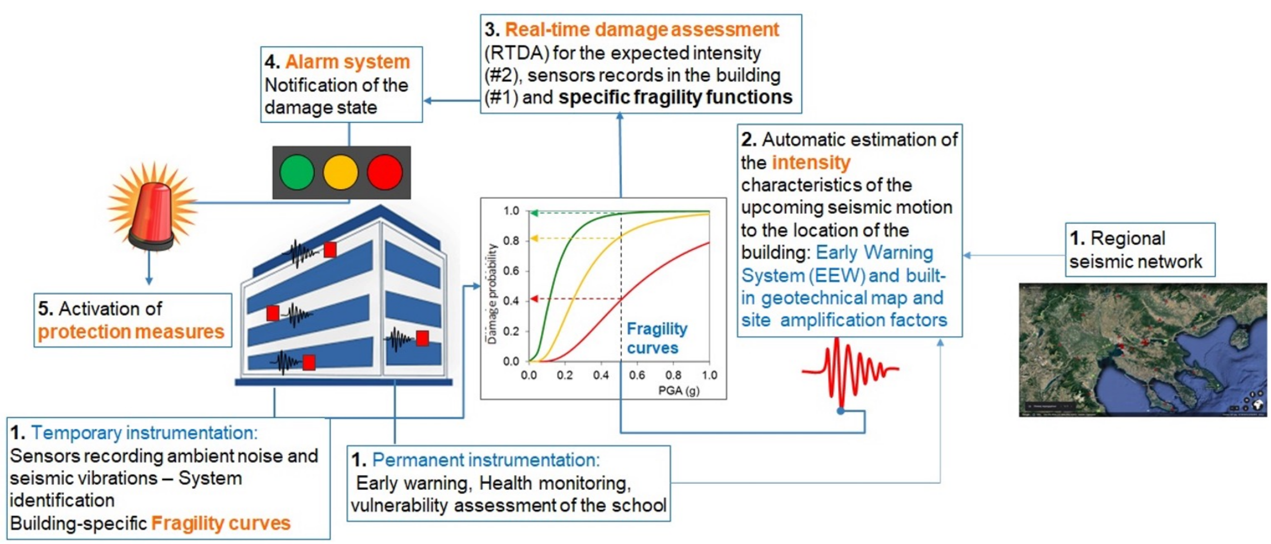

Figure 1. Overview of the SafeSchools early warning and risk assessment system

The vulnerability of the critical buildings is defined in terms of predefined fragility and vulnerability curves evaluated combining through a comprehensive methodology, combining numerical analysis and field monitoring data, enhancing thus the reliability in the risk assessment procedure. The instrumentation of schools consists of digital high-precision accelerometers and low-cost seismic instruments allowing also continuous monitoring of the real structural 'health' and safety of the buildings. The system is installed and operates in selected schools of Thessaloniki, Greece. The proposed system with few adjustments could be used for other natural disasters and/or for other critical facilities like hospitals, industrial complexes, lifelines, among others.

3. DISCUSSION- CONCLUSIONS

SafeSchools project aims at developing and pioneering an innovative system for earthquake early warning, real-time damage assessment, and protection of critical buildings. While various early warning systems exist, SafeSchools innovates (i) by estimating the impeding damage in real time, (ii) by updating the fragility curves considering the actual seismic response of the building after a real event, (iii) by utilizing low-cost instrumentation accompanied by high-precision instruments, facilitating a wide applicability of the system proposed, and (iv) by incorporating a stakeholder-specific visualization scheme.

ACKNOWLEDGEMENTS

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ACCU-WAVES: AN OPERATIONAL SYSTEM FOR WAVE FORECASTS SUPPORTING SHIP NAVIGATION AROUND AND INSIDE SEAPORTS

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ABSTRACT
This paper presents a new Operational Forecast Platform (OFP) for prevailing sea conditions at very important ports worldwide (project Accu-Waves; http://accuwaves.eu/). The OFP produces reliable, high-resolution, predictions of wave characteristics in and around harboured coastal areas. Its goals are to support safer navigation, assist vessel approaching, enhance management of towing services, and bolster secure ship manoeuvring in busy ports around the globe. Hence, port managers and authorities can be assisted in timely predicting possible port downtime. Accu-Waves OFP is based on integrated, high-resolution, spectral wave modelling over the continental shelf and in coastal areas that incorporates data from global- and regional-scale, open-sea, wave forecasts as boundary conditions. The models' setup, coupling, validation, and application are presented and discussed, concerning 50 selected areas near and inside significant port basins. The platform provides three-day forecasts at three-hourly intervals. Exceptional cases of very high waves and rough sea conditions in representative ports are discussed reflecting the performance of the prediction system.

Keywords: operational forecasts, wave modelling, ports, harbours, navigation safety

1. INTRODUCTION

Seaport infrastructures provide access and marine services to global short sea shipping and the maritime industry in general, by feeding and supporting the supply-chains worldwide; 80% of the world trade volume is carried by port-to-port marine pathways. However, they are considered as endangered areas as they contain low-lying inland terrains (berths, wharf sheds, piers, bulkheads, and container terminals) and structures (breakwaters, piers, docks, jetties, dykes, and quays) exposed to sea level variation and wave attack, caused by extreme weather conditions. These can severely impact harbours' infrastructure and cause port service downtime. To address these issues, a new web-GIS OFP (https://accuwaves.eu/forecast/index.html#), called Accu-Waves [1], has been created. It relies on a modern automated setup [2] and delivery of three-day marine weather predictions (for wave characteristics, sea levels, currents, and winds) in very high resolution, based on a set of robust, integrated, numerical models [3], concerning areas near and inside 50 very important ports worldwide.

2. METHODOLOGY

Accu-Waves OFP incorporates met-ocean data from global- and regional-scale, meteorological and open-sea wave forecasts as input and boundary conditions in order to automatically feed the integrated, high-resolution, spectral wave modelling suite.

2.1. Available Data (Atmospheric Input, Boundary Conditions, Field Observations)

The sequence of implementation components in Accu-Waves OFP comprises the retrieval of patrimonial, open-access, forecast input data from: a) NOAA (https://www.ncdc.noaa.gov/; meteorological forcing), b) Copernicus Marine Service (http://marine.copernicus.eu; hydrographic boundary conditions), c) national mapping agencies and Navionics (https://webapp.navionics.com/; bathymetric data), and d) Aviso+ (https://www.aviso.altimetry.fr/; tidal components of sea level). In situ observations of wave characteristics from sea-surface buoys in several ports (e.g., Algeciras - Spain, Antwerp - Belgium, Los Angeles - USA, presented herein) are gathered from available sources, namely Puertos del Estado (https://www.puertos.es/en-us), Copernicus, etc. These are used for wave model calibration and validation. A great effort was made to create a continuously updated inventory of solid boundaries inside ports to represent the fully or partially reflective boundary conditions in wave models.

2.2. Numerical Models (TOMAWAC and WAVE-L)

The sea level and current conditions in coastal areas are also provided as input to the wave simulations by a 2-D hydrodynamic model for barotropic circulation (High Resolution Storm Surge, HiReSS) that considers the synoptic scale meteorology and astronomical tides [4], operating in forecast mode [2, 3]. TOMAWAC (Model A; http://www.opentelemac.org/) is a 3rd generation, phase-averaged, directional, spectral wave action model that simulates the generation and propagation of wind-induced irregular wave fields on high resolution, triangular, finite element meshes. It is applied on coastal areas in the vicinity of ports, reproducing the irregular wave shoaling and depth-limited breaking, energy dissipation due to white-capping and bottom friction, non-linear wave-wave interactions, etc. The model can also capture the wave-current interaction processes around port and coastal protection structures [5]. WAVE-L (Model B) is based on the hyperbolic mild-slope equation, and simulates the transformation of wave fields with very high resolution (dx=2m) inside ports with rapidly varying bathymetries. It includes shoaling, refraction, diffraction, reflection from structures, energy dissipation due to wave breaking and bottom friction in a combined way [6]. The proposed evolved version of the model can cope with quasi-irregular wave generation in a peripheral mode with lateral incident wave propagation by any direction with the help of surrounding sponge layers; an advanced approach to incorporate partial and full reflection from structures is also followed [4]. The numerical scheme is based on a fast, explicit, staggered-grid solver to account for demanding computational times of simulations with $5 \cdot 10^6$ cells.

3. RESULTS

3.1. Models' Validation

Figure 1 and Table 1 present features for the validation of Model A in operational forecast mode against field data of significant wave height, H_{mo} or H_s, in the ports of Algeciras, Antwerp and Los Angeles. The very good performance of the wave model, shown in the scatter diagrams of H_{mo}, is corroborated by the very high values of Pearson Correlations, Willmott Skill Scores, and Hit-Rate-of-Percentiles Index [4], and small errors (<8%) of model results against field data derived from wave buoys in the three port basins.

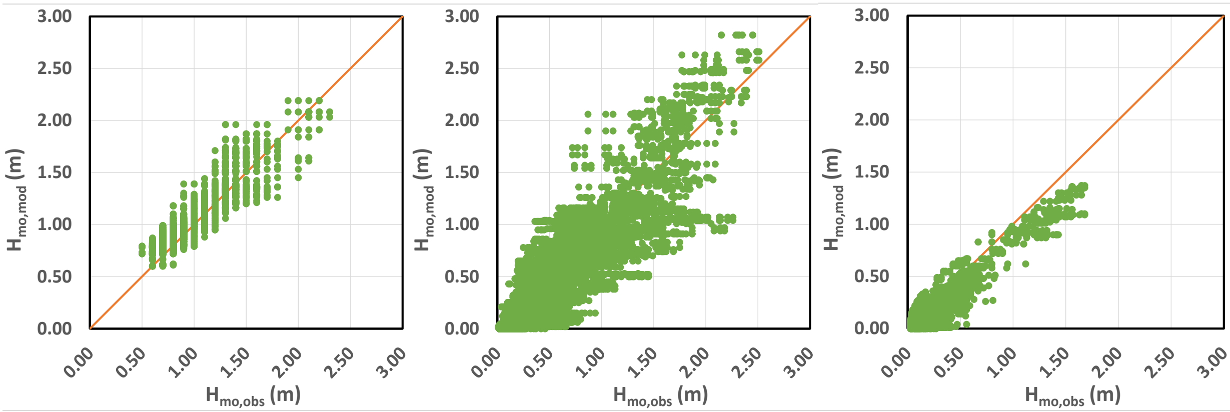

Figure 1. Scatter diagrams of comparisons between values of H_{mo} (m) from Model A simulation outputs (mod) and wave-buoy field data (obs) for the ports of Los Angeles (left), Antwerp (middle), Algeciras (right).

Table 1. Quantitative features of validation for Model A performance metrics in the three regions of Figure 1: Pearson Correlation, Willmott Skill Score, Hit-Rate-of-Percentiles Index, Root-Mean-Square-Error to $H_{mo,obs}$ Maxima.

Port	Pearson Correlation	Willmott Skill Score	HRP-Index	RMSE/$H_{mo,obs,max}$
Los Angeles	0.91	0.95	1.00	5.9%
Antwerp	0.90	0.94	1.00	7.8%
Algeciras	0.88	0.91	0.99	7.4%

3.2. Wave Propagation in Coastal Areas and Wave Agitation at Ports

Figure 2 presents the evolution of H_s fields in the coastal areas around the harbours of Jebel Ali (United Arab Emirates) and Port Headland (Australia) based on Model A simulations of extreme wave conditions' scenarios with H_s=6m and 4m, for north-westerly and northerly winds, respectively. Respective wave height maps of Model B simulation results are shown in Figure 3 for Algeciras and Buenos Aires ports under high wave conditions, H≈2m, for easterly to south-easterly winds, respectively.

4. CONCLUSIONS

A modern OFP, built on an integrated wave modelling suite of very fine resolution, is presented herein to account for reliable, detailed predictions of wave conditions in and around 50 globally significant ports. Accu-Waves is a prototype tool that can assist in safer shipping operations and port navigation management. The system incorporates external data from global-scale met-ocean forecasts and offers a downscaled processing of complex numerical data within automated parallel execution frameworks. Proper validation of the integrated models' performance was achieved. Therefore, Model A implementations offer useful information about port approaches and certified navigation pathways for ships calling to ports, while Model B offers very high resolution representation of wave fields (e.g. standing waves, refraction or shadow regions, etc.) redefining the OFP paradigm for port areas. It is built in MarineTraffic's web-GIS app and provides an intuitive interface for coastal- and port-scale data query.

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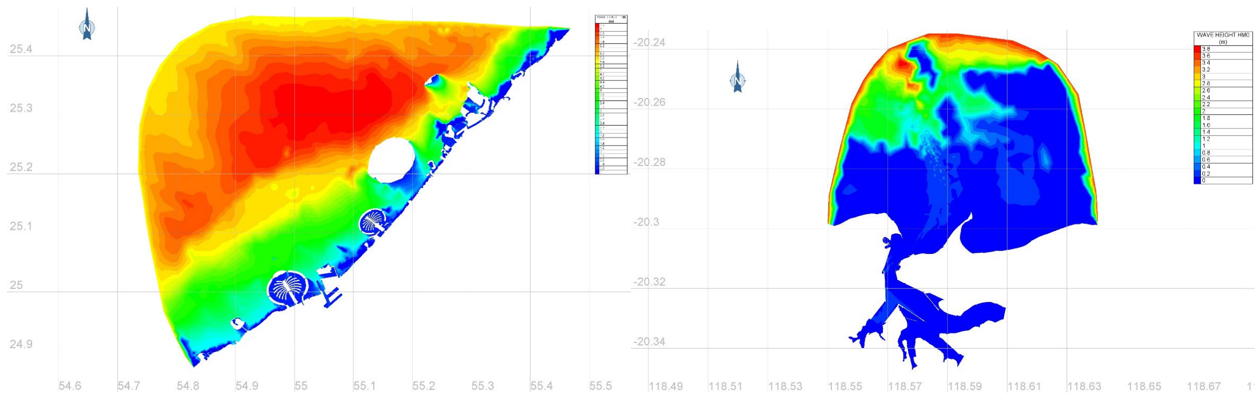

Figure 2. Maps of Model A results for significant wave height H_s (m) in Jebel Ali (left) and Port Headland (right) coastal areas with port approaches during extreme wave conditions, H_s = 6m and 4m, for north-westerlies and northerlies, respectively.

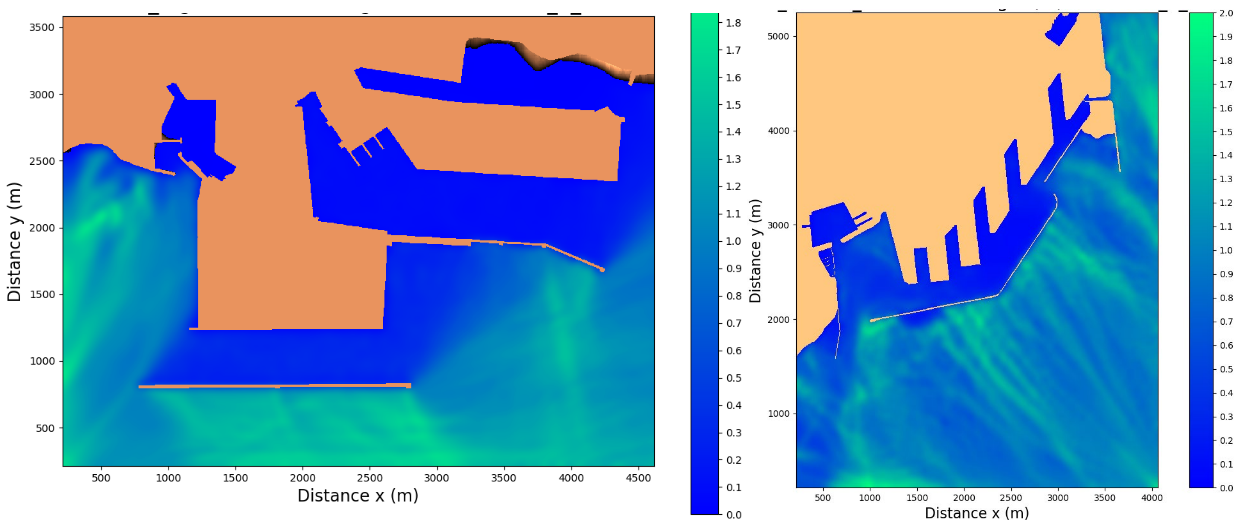

Figure 3. Maps of Model B, very fine resolution results, for pseudo-spectral wave height H (m) in Algeciras (left) and Buenos Aires (right) ports during high wave conditions, H≈2m, for easterly to south-easterly winds, respectively.

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EPIPELAGIC: AN INTEGRATED DECISION SUPPORT SYSTEM USING SATELLITE AND IN-SITU DATA FOR COASTAL AREA HAZARD MITIGATION AND RESILIENCE TO NATURAL DISASTERS

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ABSTRACT

Today's Remote sensing data and technologies offer the capability to effectively monitor diverse and challenging environments around the world such as coastal river and riparian zones. Coastal areas are exposed to multiple hazards of increasing severity, such as coastal floods, erosion, subsidence due to a combination of physical, social and economic factors, including climate change and urbanization. EPIPELAGIC project focuses on coastal and riverine areas monitoring using EU space assets, while addressing RIS3 priority for "Centers of excellence for environmental studies-Environment & Sustainable Growth because of the Climate Change" between Greece and China. The main objective is to contribute to "mitigation and adaptation to climate change and natural disasters" by providing methodologies and tools by utilizing Earth Observation and in-situ real time auxiliary data. EPIPELAGIC project, introduces an innovative Decision Support System (DSS) that is based on state of the art technologies for knowledge extraction and change detection approaches. It deployes tools for collecting and analysing data from various heterogeneous sources (satellite, in situ and other auxiliary data) for monitoring land cover and use changes; erosion; coastline changes as well as land deformations. Experimental results will be provided to assess the performance of the proposed system, which is implemented within the EPIPELAGIC bilateral Greece-China project and will be applied to EPIPELAGIC greek case study that concerns the coastal area of Thermaikos Gulf and includes part of the city of Thessaloniki and the Axios Delta National Park (Axios National Park - Loudia - Aliakmonas).

Keywords: Remote Sensing, Machine Learning, Soil erosion, coastal monitoring, climate change

1. INTRODUCTION

Coastal and riparian zones are the link between land and sea and are unique areas, with excellent biodiversity and ecosystems [1]. They are valuable both from an environmental, social and economic point of view. The European Commission [2], so as many other political and environmental organizations, have issued a series of guidelines and practices on the protection of these areas Under this perspective, EPIPELAGIC (project code: T7ΔKI-00160) is a project with the main object and goal of monitoring coastal and riparian zones and ecosystems for their resilience and adaptation to climate change and its effects, by exploiting a variety of data from different sources, for the development of an online Decision Support System platform. The project uses a variety of data from different sources, including satellite, in-situ and auxiliary data, and develops an online platform, which will be used by end-users to measure the adaptation and resilience of these areas in climate change, to provide multi-hazard early warnings and to assist them in timely decision-making for risk mitigation.

Coastal floods, erosion, degradation, subsidence and coastal change due to climate change are some of the risks to be addressed at EPIPELAGIC. Modern approaches in Earth Observation and Remote Sensing fuse multi-temporal data from different sensors to better extract information that is useful in decision support [3]. A key concept in EPIPELAGIC project is to fuse diverse data from different data sources, such as optical multispectral imagery, radar (e.g. Synthetic Aperture Radar, SAR), in-situ data and / or other ancillary measurements, in order to periodically extract new knowledge on different coastal zone hazards, assess associated risks, produce early warnings, develop accurate prediction models based on past data, generate simulations and assist users in decision-making for mitigating these risks.

The case study is shown in Figure 1 and is an area of approx. 762 km2. It concerns the coastal area of Thermaikos Gulf and includes part of the city of Thessaloniki and the Axios Delta National Park (Axios National Park - Loudia - Aliakmonas). This park is of high ecological importance and its protection has been included in the Ramsar Convention as a Wetland of International Importance and in the network of Natura 2000 sites. Additionally it has been included in the Important Bird Areas (IBA). This area was chosen to be studied under EPIPELAGIC because it is a coastal area close to a river delta and combines a variety of land uses (urban, industrial, commercial zone) and a variety of economic activities, which in many cases are in conflict with environmental protection and have significant environmental impacts. It is therefore an optimal choice for the case study under EPIPELAGIC

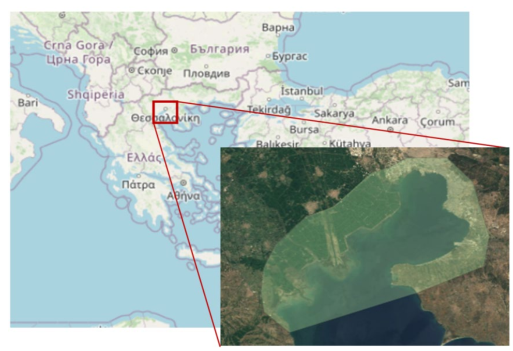

Figure 1. EPIPELAGIC case study

2. METHOD AND DATA

2.1 Platform Architecture

The basic architecture of the EPIPELAGIC platform is illustrated in Figure 2 and consists of four main subsystems: a) a data collection and processing module, b) four knowledge extraction modules, c) the Decision Support System (DSS) and the d) the User Interface (web app).

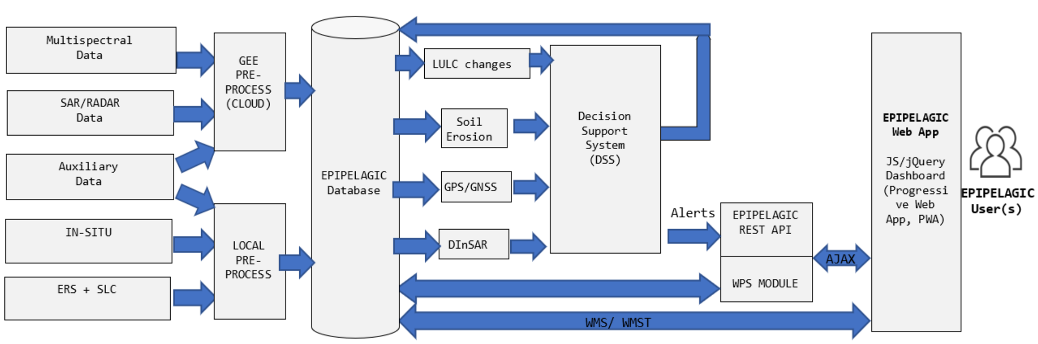

Figure 2. EPIPELAGIC architecture

2.2 Data Selection, Pre-Processing & Storage

In EPIPELAGIC, various satellites and auxilliary data is collected and preprocessed. The Google Earth Engine [4] is heavily used throughout the project, as downloading and preprocessing remote sensing imagery is completed, uncomplicated and swiftly. Imagery deriving from Sentinel-2, Landsat-8, Landsat-5 and Sentinel-1 [5][6] as well as various spectral indices are used for the Land Cover map generation, RUSLE algorithm, Coastline Extraction and Flood Probability Maps, whereas SAR data in combination with in-site surveys are used for the Land Displacement module. This data, is either pre-processed through the Google Earthn Engine as mentioned above, or locally with various Remote Sensing Software. After the preprocess, all available data, is stored in the EPIPELAGIC database.

2.3 Modules

To provide, end users, with monitoring insight, various modules are developed throughout the project. These modules focus on a) Land Cover Land Use map generation with Deep Learning Neural Networks, b) Soil Erosion Maps with the RUSLE algorithm [7], c) Coastline Extraction and Flood Probability Maps based on remote sensing imagery and d) Subsidence Change Heat maps based on in-site measurements and SAR data.

2.4 EPIPELAGIC Web APP & DSS

An EPIPELAGIC Web APP has been developed as the frontend (viewer and GUI) of the system. It was developed as a Progressive Web App (PWA), combining merits of modern internet browsers and mobile apps, i.e., progressive display in different systems, cross platform support, use of standard web development technologies, ability to run offline. The EPIPELAGIC web APP provides a WebGIS interface, allowing the user to query and visualize raster or vector data from the server, as well as data from external sources (e.g. WMS/WMTS services) or user-uploaded data (e.g., in situ measurements).

The full functional capabilities and services of the Decision Support System (DSS) is still under development, but is expected to offer operational capabilities for all the aforementioned modules in chapter 2.3, such as to evaluate risk factors and produce alerts or notifications to the end users. The current version of the Web GIS app, is able to host multiple end users, where each one has the ability to retrieve remote sensing imagery from various sources and time periods instantly from the EPIPELAGIC database. Another feature of the Web GIS app is to compute from land cover maps, change maps on the fly. Features to be included in the EPIPELAGIC Web GIS app is, the implementation of the RUSLE algorithm and the Coastline Extraction Module.

3 RESULTS AND DISCUSSION

So far, preliminary results have been made available for all different EPIPELAGIC modules. These modules provide some most-needed insights to policy makers and end-users. The Land Cover and Land Use Classification module, is a Machine Learning application, more precisely two Deep Neural Networks, one Convolutional Neural Network and one Transformer based network, which provide Land Cover Maps for multiple time periods. The Coastline Extraction module, relies on multispectral imagery from the Landsat missions from the year 2000 till 2020. By averaging available imagery into one-year composites and performing unsupervised classification the end product is a Sea-Land-Cloud map The next module, focuses on calculating Soil Erosion with the RUSLE algorithm on both Axios and Aliakmonas catchments, which belong to the EPIPELAGIC region of interest. Finally, in-situ measurements are interpreted and processed, to provide heat maps, showing subsidence to the end-users. Finally, the

EPIPELAGIC platform will be implemented as a WEB GIS application. This WEB application, is capable to perform, change maps calculations on the fly, while also featuring an alering system to policy makers and end-users in order to mitigate risks.

4 CONCLUSION

EPIPELAGIC is a project that introduces solutions and tangible measures for mitigating the effects of climate change in coastal areas as well as adapting them using a wide range of data. Regarding the social dimension of the problem related to the safety of citizens, through EPIPELAGIC it will be possible to support a better and more sustainable planning of areas on a local scale (location of protection projects, development projects, etc.), leading to a safer living of citizens in coastal areas. From an environmental point of view, the project will implement a risk analysis, identifying the vulnerability of areas related to hazards such as coastal erosion, soil erosion, floods, etc. with a view to their sustainable management and rapid response. EPIPELAGIC will support efficient and faster risk analysis and management using high-resolution models and large-scale data processing, to provide a fast and reliable Solution as a Service (SolaaS). This will increase the time available for the coordination and organization of emergency measures. All alarm warnings will be addressed to end users (decision makers, municipal authorities and relevant ministries, industrial and insurance companies, etc.) for better cooperation and coordination.
Finally, EPIPELAGIC supports the development of new research activities and innovative tools while at the same time strengthens the cooperation between the academic and industrial sector, as well as the transnational cooperation between Greece and China.

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THE RISK AND RESILIENCE ASSESSMENT CENTER OF THE EAST MACEDONIA AND THRACE REGION: A NEW MULTIHAZARD RESEARCH CENTER FOR RISK AND RESILIENCE ASSESSMENT STUDIES

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ABSTRACT
The Risk & Resilience Assessment Center (RiskAC) is a research project that aims at supporting the decision-making on the repression and prevention of disasters in the Region of East Macedonia and Thrace (REMTH) in Greece. The objective of the project is to establish a new, properly equipped, and organized research center up to the technological readiness level 5 (TRL5) by the mid of 2023, dedicated to risk assessment and resilience studies of possible hazardous scenarios within REMTH. This paper will present specific aspects and characteristics of this new research infrastructure, emphasizing its novel approach of bringing together, under one system, ten research teams, each specializing in different natural and technological hazards.

Keywords: Research Infrastructure, Multihazard Assessment, Risk Assesmment, Resilience, REMTH.

1. RiskAC: AIM AND OBJECTIVES

The RiskAC research project aims at strengthening the decision-making process of public and private organisations during the prevention and suppression phases of the dissaster management cycle related to natural and technological hazards within REMTH in Greece, and to contribute, through its reliable operation, to enhancing citizens' trust into the disaster prevention and management mechanisms of our country.

Funded by National Strategic Reference Framework (NSRF – ΕΣΠΑ) with 2Million Euros, RiskAC's objective is to establish an innovative scientific infrastructure with the appropriate,
• organizational structure,
• logistical, hardware, software infrastructures,

• and human resources
dedicated to data collection and risk and resilience analyses studies, up to a TRL level 5, till the April of 2023.

2. HOLISTIC APPROACH AND MODULAR STRUCTURE

RiskAC adopts a holistic approach to the risk and resilience studies [1]. It adopts the view that some natural and technological hazards in a specific geographical location are associated via contributing relations over time. For instance, a forest fire during summer time may be a causal factor for landslides during spring time in a specific geographic area. Therefore, RiskAC should be viewed as an umprela under which different research teams, each specialized in specific natural or techological hazard, are brought together to form one system dedicated to multi-hazard risk and resilience assessment studies for a specific geographical location over time. It was the first time that such a system is about to be formed in Greece.

Logo	Group Name
	Project Coordination and Critical Infrastructure Interdependencies
	Fire Hazard
	Air Pollution and Meteorology
	Hydrological Hazard
	Engineering Infrastructure
	ICT
	Cultural Capital
	Human Health and Land Microbiology
	Geotechnical - Geological Hazard and GIS
	Seismic Hazard

Figure 1. The ten teams of RiscAC Project

Based on this view, RiscAC has a modular structure with 80 research positions. Currently, 10 research teams (i.e. see Image 1) from Democritus University of Thrace, Aristotle University of Thessaloniki, and the Institute of Engineering Seismology and Earthquake Engineering are forming the core components of the RiskAC system. Out of the 80 research positions, 53 are dedicated to young researchers. Due to its modular structure, RiskAC in the future can increase the number of expert groups under its umbrella, with teams whose expertise is in different methods of analysis compared to the existing groups that form RiskAC and in different types of hazards (e.g. radiological hazards) based on the societal needs over time.

3. THE RiskAC INFRASTRUCTURE

Two are the main physical deliverables of the RiskAC project. Both are currently under construction. The first is the Data Fusion and Scientific Analysis Room. This is a room of approximately 100 m^2, located into the building of the Civil Engineering Department of Democritus University of Thrace in Xanthi Greece that will look similar to a control room. It will be equipped with large monitors on the walls, workstations with double monitors, and with the appropriate data and communications networks. The RiskAC teams will be able among other things to produce risk maps for various hazards, filter the data collected by sensors available by dedicated sensors as well as other data services, and update their models. Most importantly, though, the teams will be able to work simultaneously at analyzing together possible hazardous scenarios and investigate how the output of the analysis from one team can be used as input for the analysis of another team and how the output of the analysis from one group can affect the results of the analysis of other groups, over time and over specific geographic areas.

The second major physical deliverable is the Integrated Mobile Data Collection Unit. This is a unit in the form of a trailer, properly equipped to support the operation of specific sensors for a number of days. The Mobile Data Collection Unit of RiskAC has been designed and will be created to be deployed to specific locations of interest, where environmental parameters (air quality, meteorological and hydraulic data, image recording, etc.) need to be monitored in near real-time. The data from the Mobile Unite will be sent to the databases of RiskAC to be stored and further processed by the teams of the project.

4. EPILOGUE

This submission presents specific aspects of a new research infrastructure dedicated to multi-hazard risk and resilience studies. The RiskAC infrastructure is currently under development with the funding of the RiskAC project and the support of the National Strategic Reference Framework (NSRF – ΕΣΠΑ). By the mid of 2023, the objective of the RiscAC project is to develop the Risk and Resilience Assessment Center of REMTH to the technological readiness level 5. In short, the objective of the project is to set the foundations of a novel type of research infrastructure, where a new type of research model on multihazard risk and resilience studies can be established, under an environment that can bring together leading teams specialized in the research and analysis of different types of hazards.

Acknowledgments

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Co-financed by Greece and the European Union

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A NEW LOW-COST GNSS AND STRONG MOTION INSTRUMENT FOR MONITORING OF SLOPES AND CRITICAL INFRASTRUCTURES WITHIN THE GREEK “SUPERSITE”

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ABSTRACT

There is a continuous need for integrating multi-parameter instrumental observations with Satellite Earth observation data towards continuous monitoring of the environment and infrastructures. This task attains more importance within the tectonic and seismically active area of the Greek "Supersite" (Corinth Gulf, Ionian Islands, etc.) which is the study area of the PROION project https://proion-hellas.eu/. The “Supersite“ area presents the highest seismicity in Europe and a very high frequency of landslides. The significant level of geohazards have made necessary the implementation of new technological approaches that could offer reliable augmentation to permanent networks (both geodetic and seismological). In this contribution, we demonstrate the design, construction and installation of a new technological infrastructure that is based on the collaboration of a multidisciplinary team and on low-cost equipment.

Keywords: GNSS, Supersite, Achaia, monitoring, geohazards

1. INTRODUCTION AND OBJECTIVES

The “Supersite“ area (Figure 1) presents the highest seismicity in Europe and a very high frequency of landslides. The large amounts of ground deformation, [1] the occurrence of strong earthquakes [2] and the high frequency of earthquake swarms [3] have made necessary the implementation of new technological approaches that could offer reliable augmentation to permanent networks (both geodetic and seismological). In this contribution we demonstrate the design, construction and installation of a new technological infrastructure that is based on the collaboration of a multidisciplinary team and on low-cost equipment.

The main objective of the PROION Project is to attain business originality and to develop new products towards mitigating geohazards and natural disasters in general. We designed the low-cost system (GNSS and accelerometer) having as a priority the coverage of the user needs and the smooth operation of the system parts, but at the lowest possible cost. Another goal is to create a competitive product for the commercial exploitation of a possible warning-service on the world market.

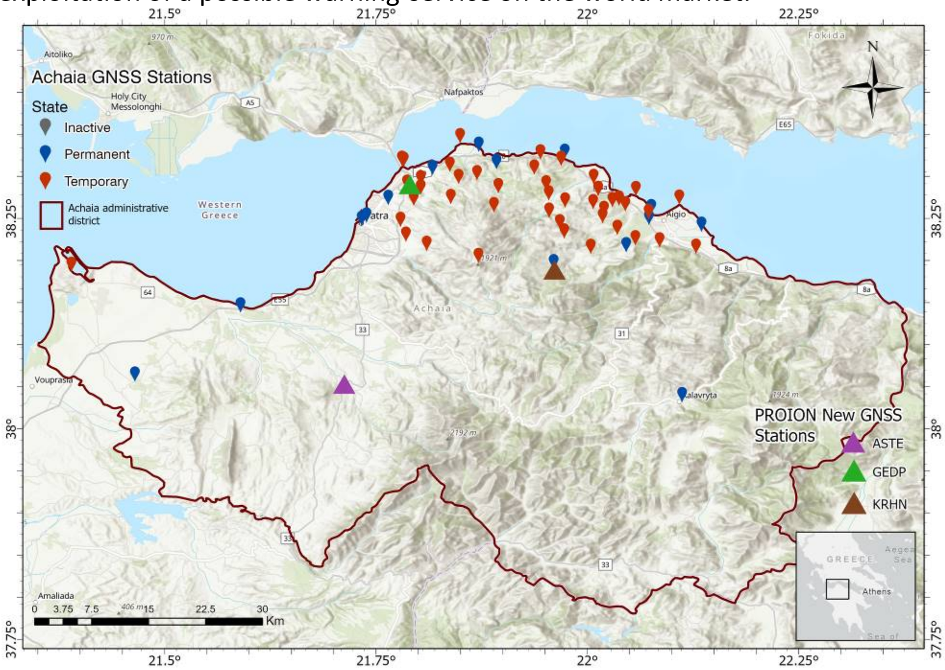

Figure 1. Relief map of Achaia Prefecture (western Greece) showing PROION sites (solid triangles) and other geodetic installations mostly belonging to the CRL Near Fault Observatory (https://nfo.crlab.eu/).

2. DATA AND METHODS

Methods based on Global Navigation Satellite Systems (GNSS) have been widely applied for monitoring displacements and deformations of ground surfaces [1] and building structures [4, 5]. Dual-frequency receivers, which receive signals of all available satellite systems, offer great possibilities for accurate measurements, regardless of cost [6]. Our low-cost instrumentation includes a multi-GNSS dual-frequency chip (Ublox ZED F9P module) mounted on a Raspberry-Pi 4 compute module IO board (Figure 2) together with an industry-standard MEMS accelerometer. It provides signal tracking for most of GNSS systems (*GPS, GLONASS, Galileo* and BeiDou). The GNSS data are collected, quality-checked and processed by use of open-source software. The 24/7/365 observations are coupled with SAR reflectors positioned at three test sites (thermal control monitored; Fig. 3). The reflectors have trihedral geometry and metre-size dimensions so that are visible above the background clutter (red circle in Figure 3). The corner reflector in Patras is clearly visible in the SAR intensity images showing surface reflections after (left) and before (right) installation. Also, we also used InSAR ground motion data (displacement time-series since 2016; [7]) to monitor slopes on the same test sites. At one PROION site (Krini, south of Aigion) we have installed an automatic meteorological station for 24/7 monitoring https://penteli.meteo.gr/stations/krini/.The combined-synergistic use of these new sensors is compatible with ground motion data provided by GNSS reference stations and accelerometers used by seismic agencies. Current work (May 2022 onwards) includes the collection, homogenization, processing and archiving of daily data from two test sites using 4G telemetry. The daily rinex version 3.x files are available from the NOA web server with a latency of a few hours. For example, the GNSS station data at the University of Patras (Department of Geology) are available from: http://194.177.194.200/GPS/GEDP/

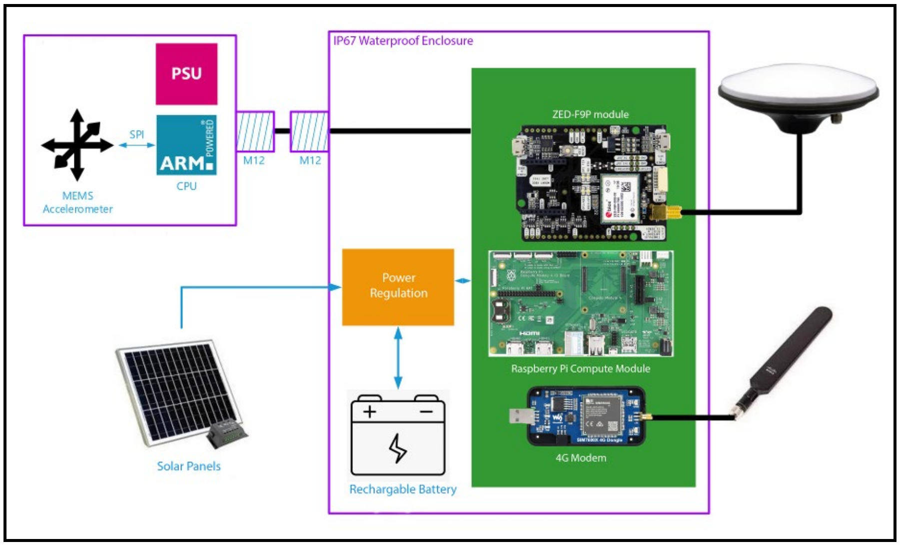

Figure 2. The basic elements of the PROION low-cost GNSS system architecture including a component for solar panels for fully autonomous operation.

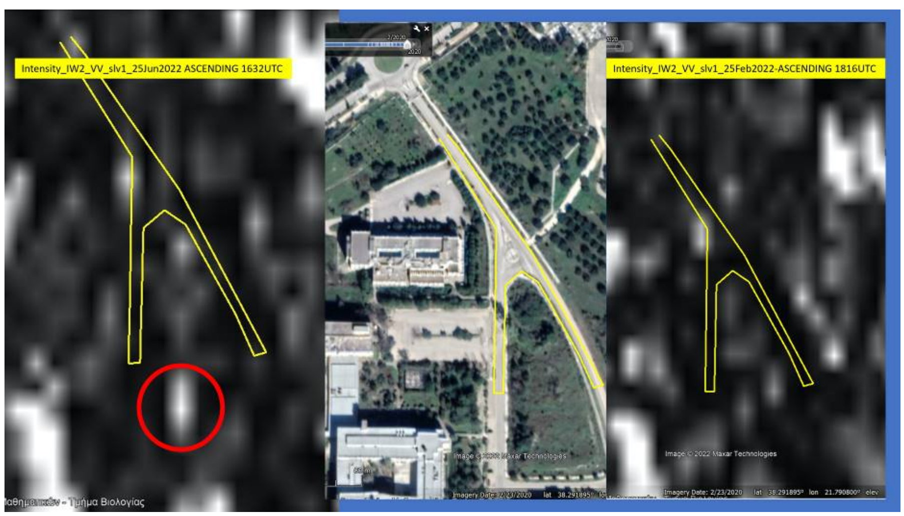

Figure 3. SAR amplitude images of the University of Patras Campus showing the location of the corner reflector (red circle). The reflector is oriented at N260°E towards the view direction of the Sentinel-1 ascending orbit.

We processed position time-series of two low-cost GNSS instruments in the village Krini and in the University campus of Rio, Patras (see Figure 1 for locations). The processed data comprise GPS and GALILEO observations at 30-s sampling interval in RINEX format (Receiver Independent Exchange, v3.x). The data were processed by the software PRIDE-AR v2.2 [8] using the Precise Point Positioning method. The accuracy of the solution is within a few millimetres, except for the vertical component (Figure 4). The reference height in the files and for calculations is the Antenna Reference Point (ARP) height of the antenna. We used the Vienna Mapping Function Model 3 (VMF3) to model the variation in the troposphere. We also used ionospheric corrections to account for signal delays through the ionosphere. We first obtained geocentric coordinates in the IGS14 reference frame which we converted to topocentric position time series (Figure 4).

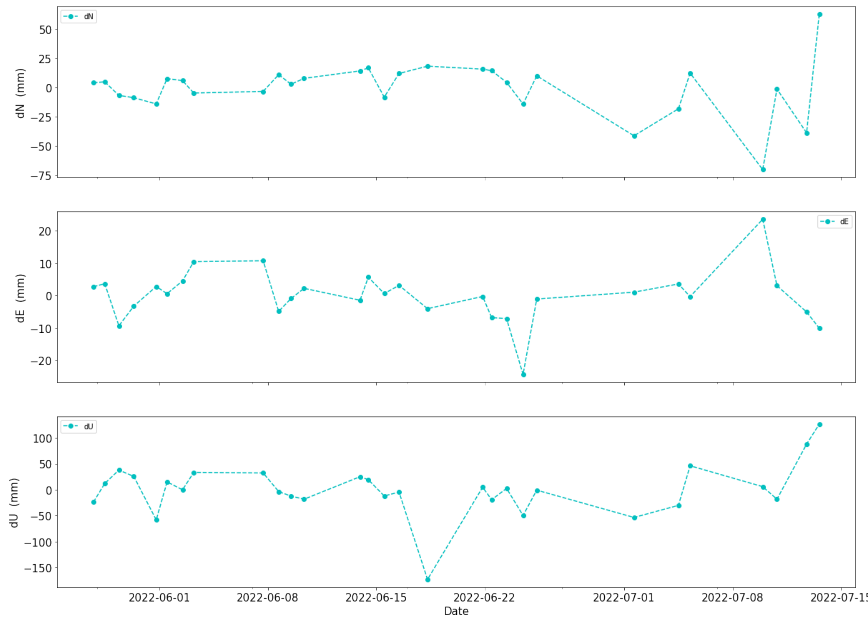

Figure 4. Graphs showing position time series for PROION station KRHN (Krini, Aigion). Top panel shows the N-S component, middle panel the E-W component and bottom panel the Up-Down component, respectively.

3. CONCLUSIONS AND FUTURE WORK

Our next step is to produce near-real time synergistic maps of surface changes, ground displacements and building oscillations, using algorithms that combine the results of accelerometers measurements, interferograms and GNSS observations. In addition to the low-cost monitoring network, it is envisaged to develop innovative analytical methodologies and ground shaking models for investigating seismic events and their impact on infrastructures.

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FAST-TRACK ASSESSMENT OF FLOOD-EROSION-LANDSLIDE RISKS IN FIRE-STRICKEN RIVER BASINS OF THE REGION OF ATTICA

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ABSTRACT
The Region of Attica, the most densely populated region of Greece, which contains critical infrastructures and social economic activities, was stricken by large forest fires in 2021 that caused incalculable damage. Thus, it was deemed necessary to conduct urgent assessment of flood-erosion-landslide risks in the fire-stricken river basins, with a view to prioritizing the required urgent interventions. For this purpose, the Operational Unit BEYOND Centre of EO Research & Satellite Remote Sensing of the Institute of Astronomy, Astrophysics, Space Applications & Remote Sensing (IAASARS) of the National Observatory of Athens (NOA), in cooperation with the Laboratory of Engineering Geology and Hydrogeology of the National Technical University of Athens (NTUA), studied the five river basins in the region of Attica that were affected the most by the aforementioned forest fires. Both research groups collected and studied all available geospatial data, and conducted field visits in the areas of interest for on-site observation and collection of additional data, emphasizing at residential areas, road network and other critical infrastructures. All the collected and produced data, the flood hazard and landslide susceptibility maps, as well as the identified critical points and the proposed mitigation measures (both short-term and long-term) were delivered to the decision makers of the Prefecture of Attica and the 11 affected Municipalities, and access was given to the dedicated online platform which was specially developed for the needs of the authorities. Overall, 224 critical points were identified, 136 for flood and 88 for landslide risks. Presentations were organised for all the relevant stakeholders and the public. Subsequently, mitigation measures were applied to the most critical points by the Prefecture's technical services.

Keywords: flood, landslide, erosion, risk assessment, mitigation measures.

1. INTRODUCTION
The Prefecture of Attica constitutes a region with special features, such as long coastline, large inland area, various geoenvironmental units, high population density (3.792.469 residents, 36,4% of the country's population according to the Hellenic Statistical Authority [1], critical infrastructures and social economic activities. In March 2021, a Programming Agreement was signed between the Prefecture of Attica and the NOA – Part A – to conduct the study entitled «Earthquake, fire and flood risk assessment in the region of Attica» funded by the Prefecture of Attica [2]. Moreover, due to the large forest fires of 2021, it was urgently deemed necessary to conduct a fast-track assessment of flood-erosion-landslide risks in the fire-stricken river basins of the region of Attica, with a view to prioritizing the required interventions.

2. METHOD AND DATA

2.1. Selection of the study areas

Aiming to select the study areas, the following spatial information were taken under consideration:

- the river basins of Attica affected the most by the forest fires of 2021, as they were mapped by the FireHub Service of the BEYOND Centre of IAASARS/NOA [3] using high resolution Sentinel-2 satellite images;
- the Areas of Potentially Significant Flood Risk in the Water Department of Attica according to the 1st Revision of the Preliminary Flood Risk Assessment [4];
- the Spatial Distribution of Flood Risk from fluvial flows in Attica for return period T=1000 years [5] according to the Approved Flood Risk Management Plan in the Water Department of Attica for the implementation of the EU Floods Directive [6].

Given the above, the BEYOND Operational Unit of IAASARS/NOA in cooperation with the Laboratory of Engineering Geology and Hydrogeology/NTUA studied five river basins in the Prefecture of Attica, which are included in 11 Municipalities (Image 1). Both research groups collected and studied all available geospatial data, and conducted field visits in the areas of interest for on-site observation and collection of additional data, emphasizing at residential areas, road network and other critical infrastructures.

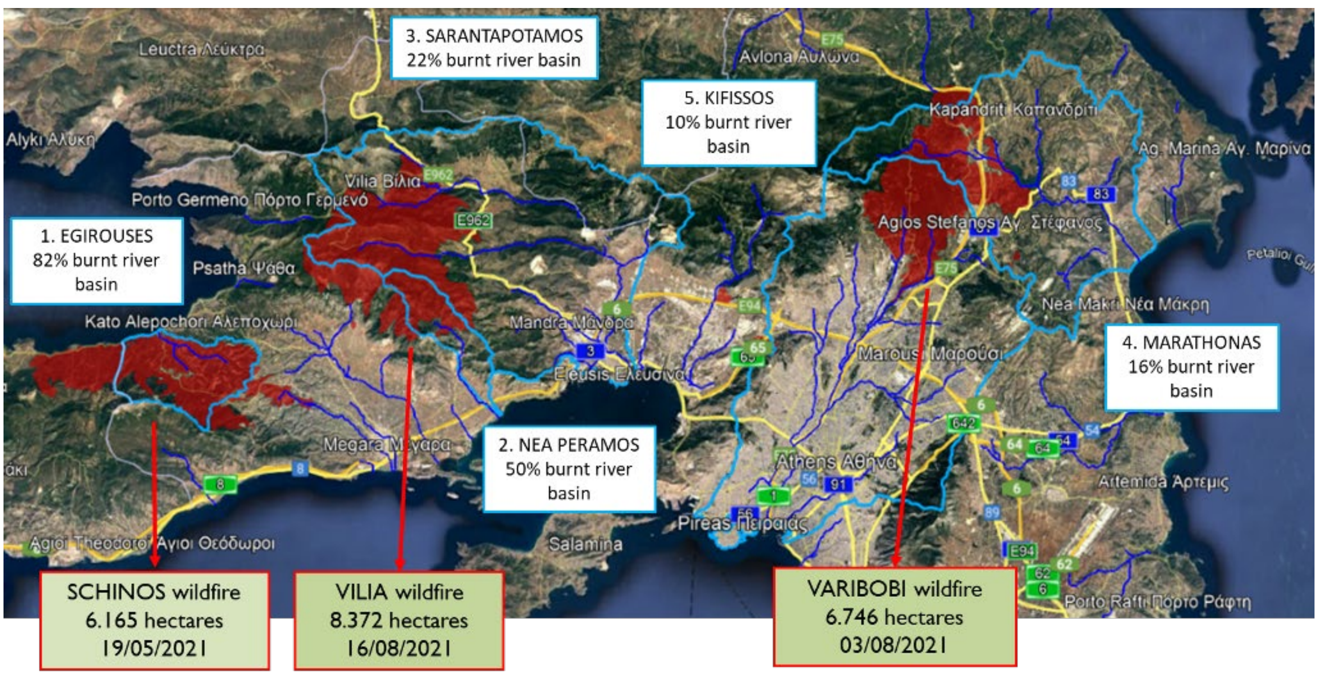

Figure 1. The five river basins (in light blue color) in the region of Attica, which were mostly affected by the forest fires during 2021 (in red color)

2.2. Urgent assessment of flood risk

A general ombrian curve for the Attica region was implemented [7]. The HEC-RAS model was used to perform two-dimensional unsteady flow calculations in 10 m resolution, using rain-on-grid method, a uniform spatially distributed rainfall method within the river basin and Digital Elevation Model provided by Hellenic Cadastre in 2 m resolution. The burnt scar mapping was used to update the Curve Numbers polygons and the Manning's roughness coefficient polygons. After having analysed model-simulated maximum water depth, flood extent and velocity maps, the field visits were planned.

2.3. Urgent assessment of erosion risk

Three cartographic products were developed, corresponding to: a) the assessment of the spatial distribution of soil loss in the period before the fire, b) the assessment of the spatial distribution of soil loss in the period immediately after the fire, as well as c) a map showing the difference in soil loss between the two periods. In both periods the Revised Universal Soil Loss Equation method, known as the RUSLE model [8], was applied. Cartographic data from RUSLE model solutions were correlated with the inundation extent and depth and flow velocity maps, and qualitative inferences were drawn about the risk of increased transportation of sediments loads as a result of the occurrence of fires.

2.4. Urgent assessment of landslide risk

A cartographic product was developed which captures the spatial distribution of landslide susceptibility, as defined according to Fell et al. [9]. The method followed is an empirical landslide susceptibility assessment model based on "expert knowledge". The control and validation of the produced map was carried out by comparing it with the locations of past landslides as well as by using statistical indices and the receiver operating characteristic curves, ROC - Receiver Operating Characteristic curves [10]. Based on the elements of the produced landslide susceptibility map, the field visits were planned.

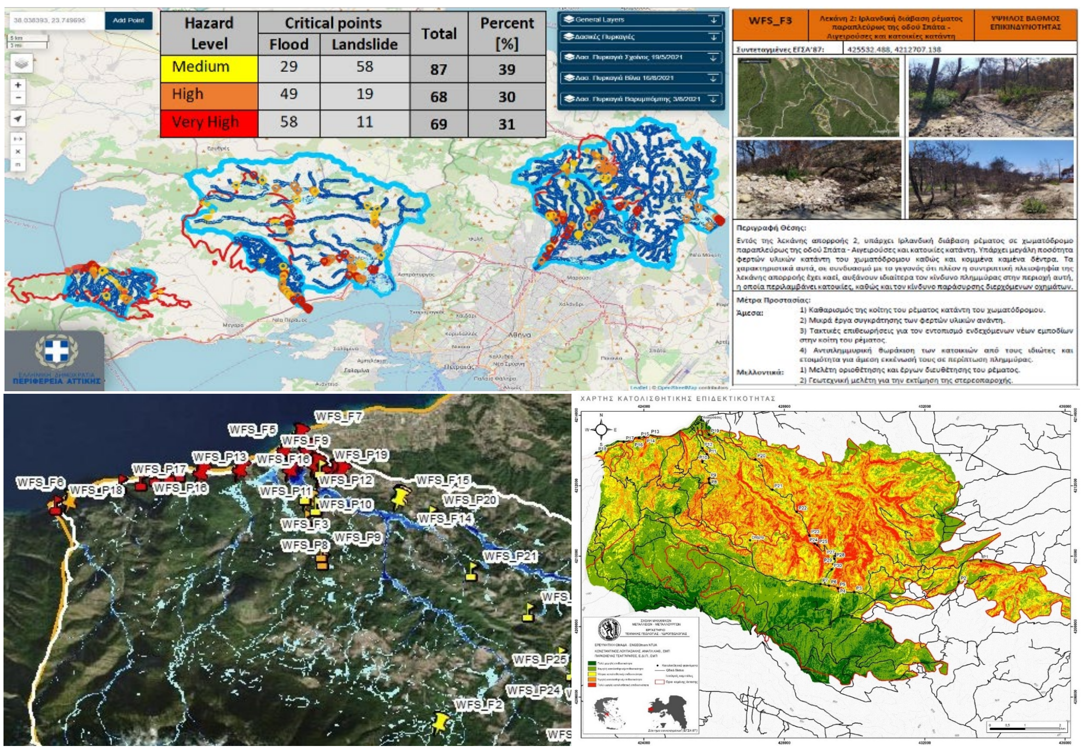

Figure 2. The 224 identified critical points and the geographical hazard level distribution of the critical points in the region of Attica. **Image 3**. Example of technical report for a medium hazard level critical point. **Image 4**. Example of flood hazard map for T=1000 years return period. **Image 5**. Example of landslide susceptibility map.

3. RESULTS

The geospatial data, modelling results, critical points from the field visits, and the proposed mitigation measures were delivered to the Prefecture of Attica and to the fire-stricken Municipalities both in hard copy and in digital format by developing an online platform specially designed for the needs of the specific project by the BEYOND Centre of IAASARS/NOA. Overall, 224 critical points were identified, 136 for flood and 88 for landslide risks (Image 2). For each critical point, the hazard level was estimated and a detailed technical report, containing coordinates, map preview, photos, documentation and proposed mitigation measures (both short-term and long-term), was delivered (Image 3). Also, flood hazard and landslide susceptibility maps were produced for each impacted river basin (Images 4 and 5).

4. DISCUSSION

Given that the impact of the fire due to the land cover change in the burnt areas is severe, as it increases the risks of flood, landslide and soil erosion, the research groups identified many high-risk points in residential areas, road network and other critical infrastructures. Some of these points became critical because of the fire. However, some others were already critical, but they became even more dangerous following the disaster. All these required immediate interventions in order to mitigate the risks and avoid further damage, including loss of lives and property.

5. CONCLUSION

First, it is very important that for the first time all the pre-existing, collected and produced data along with the scientific analysis, are properly organised and stored on a user-friendly web platform, becoming available to all Prefecture's and Municipalities' services. This supports the operational needs during the crisis, as well as the preparedness and the strategic decision making towards disaster resilience. Moreover, it is of crucial importance that these fast-track studies identified the critical points and proposed mitigation measures, both short-term and long-term. This allowed the authorities to respond quickly and prioritise the recommended short-term measures in the critical points of highest risk, with fast and low budget solutions for most of the cases (such as cleaning the riverbed and the culverts and stabilising the steep slopes along the road network). All the above-mentioned were confirmed and evaluated positively according to the stakeholders' feedback.

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NEW CHALLENGES OF MULTI-HAZARD EMERGENCY PREPAREDNESS

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ABSTRACT

The aim of this paper is to document the risk perception, awareness and preparedness for different types of emergencies in today's conditions and to highlight prevention and training priorities for workers and the public in Greece. The results of a recent survey in Greece conducted during the summer 2022 are presented. War, environmental pollution, epidemics and natural disasters are of most concern to the respondents. Respondents' subjective assessment of changes in their lives comparing the period before and after the COVID-19 pandemic report deterioration mostly in terms of social relationships, mental health and financial situation. There has been no improvement in the level of information and mainly training of the population comparing with previous studies in Greece. The vast majority of the respondents report that they feel unprepared/slightly prepared against the threat of a war. High percentages of respondents report that they do not feel prepared in relation to threats such as environmental pollution, major technological accidents and natural disasters. Lower but quite significant is the percentage of those who report that they do not feel prepared for epidemics. A positive effect of previous information and training on the level of preparedness of the population is obtained and in particular the importance of workplace health and safety procedures. The results of the study highlight the new challenges and priorities for the intensity of the efforts of all parties involved to strengthen the preparedness of the workers and the public against multi-hazards such as natural phenomena, technological accidents, military conflicts, environmental risks and epidemics.

Keywords: multi - hazards, emergency preparedness, training, natural disasters, major technological accidents, war, environmental pollution, epidemics, COVID-19

1. INTRODUCTION - OBJECTIVE

The increasing occurrence of catastrophic phenomena such as forest fires, earthquakes, floods and technological accidents that pose risks to the environment and the public, epidemics such as the COVID-19 pandemic, etc., highlight the need to strengthen the level of emergency preparedness of the population. New risks and threats such as those related to environmental pollution and warfare, further intensify psychosocial risks and risks to occupational and public health and safety.

Within the context of the Sendai Framework for Disaster Risk Reduction (2015-2030), the importance of an integrated multi-hazard approach at local level, and the importance of multi-stakeholder and all-of-society engagement are highlighted [1]. As it is mentioned in the APELL Handbook [2], "*Preparedness for emergencies is not only emergency response. The main objective of an emergency preparedness plan is to protect lives and the environment by reducing the occurrence and the potential impacts of both industrial accidents and natural disasters. This is achieved by first promoting awareness of hazards and risks and then addressing them at the local level with a focus well beyond simply responding after an accident or disaster occurs. In a preparedness plan, accident prevention, disaster risk reduction,* *mitigation of possible consequences, emergency response and community recovery are all important elements".*

Previous studies have highlighted the importance of information, training and developing a safety culture to the population for strengthening emergency preparedness. The special importance of occupational risk assessment and prevention procedures also emerges from previous studies [3, 4, 5, 6].

The aim of this paper is to document the risk perception, awareness and preparedness for different types of emergencies in today's conditions and to highlight prevention and training priorities for workers and the public in Greece. This objective is achieved through the following research questions: What is the risk perception and awareness of the workers and the public in Greece in today's conditions, in relation to threats such as natural and technological disasters, epidemics and war? What is the level of information, training and preparedness of the workers and the public in relation to these threats? By which factors are they affected? Is there an improvement over previous studies? In today's conditions, what is the effect of the COVID-19 pandemic on the population in relation to various parameters? What are the priorities for training and developing a safety culture for the population in relation to the above threats?

2. METHOD AND DATA

A special research tool (electronic questionnaire) was created to conduct a field study. After its validation, the questionnaire was distributed to the public through an online platform for the period from mid-July to mid-August 2022. The sample of the study consists of male and female adults of all ages and education levels living in Greece. For the use of the research tool, all the terms related to the protection of personal data complied with the legislation of the country. The sample under study is considered a sample of the general population during the period of conducting the study. Statistical tests were performed on the "sample". The confidence level was a=0.05.

3. RESULTS AND DISCUSSION

The existing level of information and training in relation to protection against natural disasters and technological accidents was investigated. A fairly large percentage of respondents state that they have read online guidelines for self-protection in case of natural and technological disasters. Such guidelines for example are those of the Hellenic Ministry for Climate Crisis and Civil Protection [7]. About 1 in 3 of the respondents state that they have been trained in the workplace. The percentage of respondents who state that they have been informed by their Municipal or Regional authorities is very small (about 1 in 10 respondents). Even smaller is the percentage of those who declare that they have taken part in a regional evacuation drill in the area where they live.

These results are in line with previous relevant studies that have been carried out in our country [5, 6]. There have been several reports from institutional bodies indicating that the efforts to inform and train the population are being strengthened, and given the disasters that have occurred in Greece in recent years with very serious consequences, such as forest fires, floods and earthquakes, it unfortunately seems that the level of information and mainly training of the population remains very low.

In relation to risk perception, the subjective degree to which respondents believe that a natural or a technological disaster or other emergency situations, as well as war and environmental pollution will affect them in the future was explored. The results show that war, environmental pollution, epidemics and natural disasters are of most concern to the respondents. The relative percentages of those who reported that they are concerned/extremely concerned exceed 80%. Fewer but still significant (about 50%) are concerned/extremely concerned about the risk of a major technological accident or the occurrence of a fire or accident at home.

The degree of subjective assessment of preparedness against the above threats was investigated through the question: "How protected or prepared do you think you are for the following situations - threats?" The vast majority, 4 out of 5 respondents, report that they feel unprepared/slightly prepared against the threat of a war. There are also high percentages of respondents who report that they do not feel prepared in relation to threats such as environmental pollution, major technological accidents and natural disasters. Lower but still significant is the percentage of those who report that they do not feel prepared for epidemics (about 2 in 5 reports that they feel unprepared/slightly prepared for this type of threat).

The effect of risk perception, previous training and information in relation to the degree of subjective preparedness was investigated. A positive effect of previous information and training on the level of preparedness of the population is obtained. Factors affecting respondents such as age, gender, place of residence were investigated. The stress factor was correlated with the risk perception and the subjective assessment of preparedness. The results are compared with other studies (e.g. [8, 9, 10]).

Respondents' subjective assessment of changes in their lives was also explored comparing the period before and after the COVID-19 pandemic. The investigation was carried out by examining various parameters. A significant number of respondents report deterioration in their lives in terms of social relationships and mental health (about 3 in 4) and deterioration in their financial situation (about 3 in 5). Nearly half of the respondents report deterioration in workload, and about 2 in 5 report deterioration in job satisfaction, relationships with colleagues and health. A smaller percentage report deterioration in the protection of health and safety at work, while almost half report an improvement in this parameter after the COVID-19 pandemic. These results are in line with previous studies in Greece and Europe (e.g. [6, 11]).

To the question: "How do you think the development of an emergency planning methodology will affect the improvement of health and safety conditions?" the vast majority of respondents (about 9 out of 10) answered that it would have a rather positive or positive effect. More than half of the respondents cite emergency planning, evacuation, fire protection, first aid, protection from natural and technological disasters, and home safety as priority issues for training. In contrast, the topic "protection from the COVID-19 pandemic" is not selected to the same extent as a positive priority module. Only 1 in 3 mentions it as a priority training course.

4. CONCLUSIONS

The paper presents the results of a recent study in Greece on the level of awareness and preparedness of workers and the general public against multi-hazards in today's conditions.

The results of the study show that war, environmental pollution, epidemics and natural disasters are of most concern to the respondents. Respondents' subjective assessment of changes in their lives comparing the period before and after the COVID-19 pandemic report deterioration mostly in terms of social relationships, mental health and financial situation.

It seems that there is no improvement of the level of information and mainly training of the population comparing with previous studies in Greece. The percentage of respondents who state that they have been informed by their Municipal or Regional authorities is very small. Even lower is the percentage of those who declare that they have taken part in an evacuation exercise in the area where they live.

The vast majority of the respondents report that they feel unprepared/slightly prepared against the threat of a war. There are also high percentages of respondents who report that they do not feel prepared in relation to threats such as environmental pollution, major technological accidents and natural disasters. Lower but quite significant is the percentage of those who report that they do not feel prepared for epidemics.

A positive effect of previous information and training on the level of preparedness of the population is obtained and in particular the importance of workplace health and safety procedures.

The results of the study highlight the priorities in the current conditions for the intensity of the efforts of all parties involved to strengthen the preparedness of the workers and the public against multi-hazards such as military conflicts, environmental risks, natural phenomena, technological accidents and epidemics.

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EVACUATION IN WUI FIRES: UNDERSTANDING PUBLIC ATTITUDES AND PERCEPTIONS IN PREPAREDNESS PLANNING

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ABSTRUCT

The occurrence of a WUI fire is now a phenomenon of increased frequency and people may be advised to evacuate their homes as a protective measure against the threat of fire. Effective implementation of the evacuation measure requires an understanding of the human behavior of the threatened population, a multi-faceted area with a diverse range of factors influencing different primary evacuation preferences. The purpose of this paper is to identify, document and tracing gaps in both research regarding the effective implementation of the evacuation measure, developing a future research plan that can support, improvements in training programs, decision making, planning requirements, and policies developed for WUI fire evacuation. Since the Greek literature on this topic is very limited, the review focused on the data provided by the international literature mainly on wildfires and supplemented by other catastrophic events where the field is more developed. The literature survey highlighted a wide variety of factors influencing the evacuation decision making. However, much of the research data may appear contradictory or inconclusive. Given that most disaster research follows a case study approach the generalisability of results should not be taken for granted and public policy, designed for many, under great pressure and in times of turmoil, should not assume a homogeneity where none exists.

Keywords: evacuation, wildfires, WUI, civil protection, emergency management

1. INTRODUCTION

Fires pose a serious threat to human health and safety. The development of residential areas in contact with or mixed with forest vegetation, internationally referred to as "wildland-urban interface areas" (WUI), is recognised as one of the main reasons for the worsening risk. Evacuation, i.e. the urgent, temporary removal of people from the risk area, is a common protective action to reduce impacts. Ensuring the safe evacuation of potentially large groups of people is a highly complex and difficult task that depends on the cooperation of numerous agencies involved in the evacuation management and execution process, available resources, adaptability to the nature of the fire (size, directionality, escape exits, etc.) and the environment (high temperatures, wind, vegetation type, etc.) and the characteristics of the people who have to evacuated [1]. The evacuation policies followed vary between countries. Mandatory evacuations may be favoured and enforced by the competent authorities (e.g. America) or a warning may be issued and evacuation (voluntary or advisory evacuation) may be recommended (e.g. Australia, Greece). After an evacuation warning/command, some residents will follow the instructions and evacuate and others will remain on their property to actively protect it. Evidence that ordinary people can actively protect homes has informed the development of the 'Prepare, stay and defend or leave early' (PSDLE) policy, while highlighting that late evacuation is an inherently dangerous response to fires. However, people assess the risk and make their own decisions about the protective actions they take, which may differ from official recommendations and advice. Many residents among them decide to 'stay and defend' (SD), consciously or unconsciously reserving delayed evacuation as a last minute option or they will remain in their home passively 'sheltering-in-place' (SIP) and some other residents who are not on their property when an evacuation warning is issued may seek to return [2,3,4]. While, there appears to be a high level of understanding in the "prepare, stay and defend", the "leave early" message is not well understood and requires clarification.

2. MOTIVATING FACTORS IN EVACUATION DECISIONS MAKING

Both voluntary and mandatory evacuation orders have been found to increase the probability of evacuation, with the latter having a greater effect on the probability of compliance. However, this may not always be the case [5,6] and more research is needed to determine whether the concept of voluntary evacuation is perceptually associated with a lower probability of risk.

Experience in WUI fire events may influence evacuation decisions [7]. Many studies show a positive correlation between experience and the evacuation decision. That is, those who evacuated in previous WUI fire events were more likely to evacuate again compared to those who did not have such experience [8]. Further, having an evacuation plan made people more likely to evacuate [9]. At the same time, it is argued that previous experience can reduce the probability of evacuation in cases where previous evacuations were considered unnecessary [10], and there are opposing views that argue that such experience does not have a negative impact on future evacuation intentions [11]. There is also variation in the relationship between fire experience and preparedness measures and risk perception, which is far from clear. It may encourage, discourage or have no effect on the adoption of mitigation measures. People who have lost their homes to fire may have the impression that mitigation measures are not effective and implement fewer mitigation measures [12].

Although a key factor in staying and defense is the belief of adequate preparedness against the perceived level of risk, a high level of risk awareness does not necessarily translate into high levels of preparedness and preparedness is not fully correlated with the likelihood of evacuation as it can give people a sense of control or a feeling of self-efficacy [13,14,15].

Various socio-demographic factors and social norms of the threatened population influence evacuation decisions. There are studies that support that the probability of evacuation is considered higher among older people [16], younger people, women and households with young children [17]; however, there are studies that argue the exact opposite, i.e., that age and gender show no significant differences in evacuees or non- evacuees [18].

The desire to keep one's family safe was identified as one of the strongest influences on evacuation intention and families tend to evacuate as a unit and sometimes with neighbours and extended family [7]. However, this influence varies. How a family functions in emergency management has to do with internal roles and dynamics established over time. Traditions and stereotypes can contribute to how a family and its members relate and make decisions in a crisis. The more experienced family member, usually the man, has more authority and traditionally the role of women is to follow their husband's instructions. [6]. The gendered dimensions of the WUI fire are an area of analysis that needs further investigation.

Location, ownership and income were also identified as important parameters for making evacuation decisions. The likelihood of evacuation is directly related to the vulnerability of the home and the belief that the home is a safe shelter [18]. Cases have been observed where residents made the decision to stay given the time and distance required to reach a safe area [14].

Those residing in rural or semi-rural areas were more likely to evacuate than those residing in urban areas [8]. The desire to protect private property increases the likelihood of staying and defending and accepting some degree of personal risk [11,7], with longer-term residents less likely to evacuate than short- term residents [19]. However, other studies found no effect of property location on the protective action decision [17]. It has also been found that pet liability can lead to delays in evacuation or even staying in the house for defense [5,17,15]. The impact on stay decisions is stronger in people whose livelihoods depend on animals (e.g. farmers), feeling they had no other choice both for financial reasons and for animal safety [5,18]. Full-time residents were less likely to move away than part-time residents [14]. Residents' concerns about their temporary residence once removed from their homes or traffic congestion or the potential inability to re-enter the evacuation zone also reduced the likelihood of evacuation [7]. Low resource use may in essence be an excuse that reduces the cognitive dissonance felt by individuals in such situations [18].

Social reinforcement of risk emerged as an important factor influencing decision making and self-delay of evacuation is likely if warnings are not accompanied by sufficient information, since residents will engage in information seeking rather than initiate evacuation actions [15,20]. Receiving information and recommendations from a trusted source in a face-to-face setting [17] or observing others leaving (e.g. friends, family, neighbours, peers) and strong social support [1,19] tends to lead to a higher possibility of evacuation.

The nature and number of environmental cues received regarding a WUI fire threat have been found to influence the protective action decision made. Sensory cues from the environment such as smoke, embers, flames indicate a real threat that "trigger" action [3]. On the other hand, we have cases where summer heat and fire smoke, prompted people to stay indoors, resulting in a reduction in the sense of perceived risk [13].

3. CONCLUSIONS

In order to support the development of appropriate strategies for protective measures, many researchers are working on evacuation modeling by simulating not only fire dynamics and traffic flow but also human behaviour in fire. The inherent complexity in civilian evacuation behavior, assumptions and subjectivity of estimates in quantifying the effect of different variables poses insurmountable challenges to these models. Several qualitative studies have provided insights into factors influencing evacuation decision making. However, far fewer studies have provided an empirical analysis of influencing factors in a multivariate context. At the same time, it is important to note that the findings were not consistent across studies, which is important to conduct additional research with particular attention to subjective risk and conflicting motivations of citizens that influence evacuation behavior. Evacuation research is hampered by a weakness often found in the social sciences: The “problem of recall” [20]; since after the catastrophic event people may experience difficulty in remembering exactly what happened and how their understanding of the situation changes throughout the decision-making process. Studies are conducted after the event and unfortunately people rationalize that they made the best decision, by changing in their memory the process.

Specific results from this study indicate that the content of risk communication can play a critical role in influencing residents' evacuation decisions. Ensure that the information they provide is consistent with the level of fire risk, as well as facilitating specific evacuation and resource allocation recommendations. The 'wait and see' tactic should be addressed and not simply dismissed as a risky option. Restrictive preparedness policies to protect property, relocate and temporarily house the displaced population, guarding their property, reliably predict the intensity and directionality of fire, etc., should be reviewed in conjunction with the factors influencing evacuation behaviour and a full cost-benefit analysis should be carried out on the policy pursued and any bias in estimates should be avoided.

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THE COMPLEX PROBLEM OF WILDFIRE MANAGEMENT IN THE MUNICIPALITY OF DIONYSOS, ATTICA, GREECE

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ABSTRACT

The Municipality of Dionysos is one of the most typical examples where all types and the entire continuum of the wildland urban interface (WUI) is present. As a result, thousands of homes are exposed to wildfire events, either incoming from neighboring municipalities, or ignited within Dionysos boundaries. In total, Dionysos has been affected by 28 fire incidents during the years 1984-2021 that totally burned 45,500 ha, of which, approximately 4,400 ha were burned within the limits of the Municipality; some more than once. From the above, questions arise as to how this extended WUI can be affected by potential future fires. The problem of wildfire spread within inhabited areas of Dionysos is complex and factors such as the type, continuity and density of vegetation, topography, buildings arrangement, existence of fuel management projects and local meteorological conditions play an important role in the exposure of each settlement. We attempted to answer these questions based on data concerning the propagation of historical fires, the current state of fuel and stochastic large wildfire simulations. We found that the fireshed area of Dionysos is 35,700 ha and wildfires can reach its boundaries from ignitions starting even 14 km away. The largest simulated fire started in the area of Varnavas and burned 7,500 ha, crossing the entire eastern part of Dionysos. Finally, we found the ignition locations of 21 potential wildfires that can affect up to 20% of all structures in Dıonysos. Our results can inform where the future fuel management planning should focus to more effectively protect the assets and livelihood of Dionysos inhabitants.

Keywords: Stochastic wildfire simulations, fuel management, wildfire history, fireshed, wildfire prevention, large-scale fires.

1. INTRODUCTION

The Municipality of Dionysos is fortunate to be located in a highly aesthetic area of Attica due to its dense forest cover, consisting mainly of Aleppo pines (*Pinus halepensis)* and evergreen - broadleaf shrubs; and due to its topography that includes the northern slopes of Mount Penteliko to the south, the forest estates of Tatoi to the west, the Marathon dam to the north and finally, the Public Forest of Rapentosa to the east. However, dense vegetation and steep topography make the area attractive for residential housing which in turn, is a source of concern due to the wildfires that have affected the mountains of the broader area of the northern Attica suburbs (Parnitha - Tatoi, Penteli, Dionysovouni, Agriliki, Scarpa). Most of Dionysos settlements meet the criteria to be characterized as Wildland-Urban Interface (WUI), which is a transition zone between the natural environment (undeveloped lands) and areas with anthropogenic development and activity. In this study, we attempted to understand the scale of risk for Dionysos settlements from potential wildfires due to their WUI nature, events that can either ignitied within the Municipality's boundaries or be incoming fires from neighboring areas. For that purpose, we used simulation modelling to: a) map the Dionysos fireshed; b) estimate structure exposure; and c) identify the location and potential spread of the most catastrophic potential fires.

2. METHODS AND DATA

2.1. Study Area

Most of Dionysos area is between 300-500 m altitude (64%), 18% between altitudes of 500-700 m and 11% at altitudes <300 m. The topography is characterized by steep terrain; one third of its area has slopes >20°, the other third is between 10° and 20°, and the last third is in relatively smooth relief (<5°). Only one-fifth of the area has tall coniferous forests, as estimated by crown cover (>45%) and average stand height (>15 m) (Data source: Copernicus. Reference year: 2018). It is characteristic that 76% of the area has canopy cover <15%, which essentially shows that there is no forest there. Almost 15% of the area was classified as "non-burnable", i.e., dense residential tissue, barren lands and water. Approximately 10% of the area is covered by medium-density shrubs up to 2 m high, while 26% is dominated by dense shrubs >2 m high. A large part of the area is occupied by grasslands (21%), while reforestation - areas of natural regeneration cover reach 17%. Finally, 5% of the areas are characterized by fuels of the "annual - herbaceous vegetation" type and 6% by canopy forest models.

2.2. Fire History

During the decade of the 2000s there were seven incidents that burned within the boundaries of the Municipality, three with a burned area < 10 ha each, two incidents in 2008 with a total burned area (within and outside the Municipality) of 42 and 166 ha, respectivel, one in 2007 in Penteli with burned areas of about 1,000 ha, but with little influence on the Municipality, and one in 2009 with a total of 17,900 burned ha. The fire of 2009 started in the area of Grammatiko and lasted for four days, with an extension to the south reaching Marathon and ending in Pikermi and Pallini, significantly affecting the intermediate part of Penteli within the boundaries of the Municipality of Dionysos. Finally, the decade of 2010s can be characterized as mild in terms of fire activity for Dionysos, with only five wildfire incidents that burned 225 ha within the boundaries of the Municipality. The largest incident was the fire of 2021 in Varybobi with a total burned area of 8,560 ha, of which 145 ha within Dionysos boundaries (Figure 1A). In conclusion, of the actual 4,400 ha that burned since 1984, 1,190 ha burned once, 2,140 ha burned twice, 990 ha three times, 78 ha four times, and 2 ha five times.

2.3. Stochastic Wildfire Simulations

To calculate how future fires may start and spread within the boundaries of Dionysos considering different meteorological scenarios, the Minimum Travel Time (MTT) algorithm was used, as incorporated in FConstMTT. Required model inputs include elevation, aspect, and slope to describe topography, surface fuel models, canopy cover and density, canopy base height, and stand height to simulate canopy fires. The required inputs were retrieved from the European Copernicus databases, data from the Forest Service, as well as other existing data sources and previous research actions, with a reference year of 2018 [1]. As a result, the simulations did not consider changes in vegetation of the area from the large-scale wildfire of 2021. From the 10,000 simulated incidents throughout Attica, 279 were incoming on Dionysos. This modeling exercise simulated each fire independently without changing the vegetation if a previous simulation has burned in the same area. In addition, constant and unchanging wind intensity and direction are defined throughout the simulation, with 300 minutes of active propagation) and fuel moisture content conditions are set to dry. Ignitions were randomly selected based on their proximity to the road network, residential areas and the density of historical wildfires. The contribution of firefighting was not considered.

3. RESULTS AND DISCUSSION

Of all the historical fires mentioned in the previous chapter, we estimated that the 2009 event affected 9% of the buildings that are located within the boundaries of Dionysos i.e., had proximity that could result in either burning, or entering courtyards, or covered with smoke, close or in the settlements of Agios Stefanos, Anixis, Stamata, Rodopolis and Dionysos. The Penteli fire of 1998 affected 3.5% of the Municipality's buildings, mostly in the settlements of Rapentosa, the Monastery of Agios Panteleimonos, Stamata, Rodopoli and Dionysos. Finally, the Varymombi fire of 2021 affected 1.5% of the Municipality's buildings, mainly in the settlements of Krioneri, Agios Stefanos, Pefkophytos, Kapitenia and Amygdaleza. Another three fires (1984, 2021 and 1990) affected from 0.7 to 1.1% of the Municipality's buildings, while 19 fires affected very few buildings (<0.1%), and four fires from 0.1 to 0.4%.

The fireshed of Dionysos was calculated using spatial interpolation methods at the ignition points of simulated fires, using as a weight the percentage of buildings predicted to be affected at each ignition pixel (Figure 1B). The fireshed is 35,700 ha large with ignitions that can enter Dionysos boundaries from 14 km away (e.g., Kalamos and Sesi). The greatest settlement exposure was caused by ignitions within Dionysos boundaries, while ignitions outside Dionysos pose a greater risk if they start from the areas of Kapandriti, Thrakomakedonew-Varymbopis and Marathonas-Afidnes pose (Figure 1B).

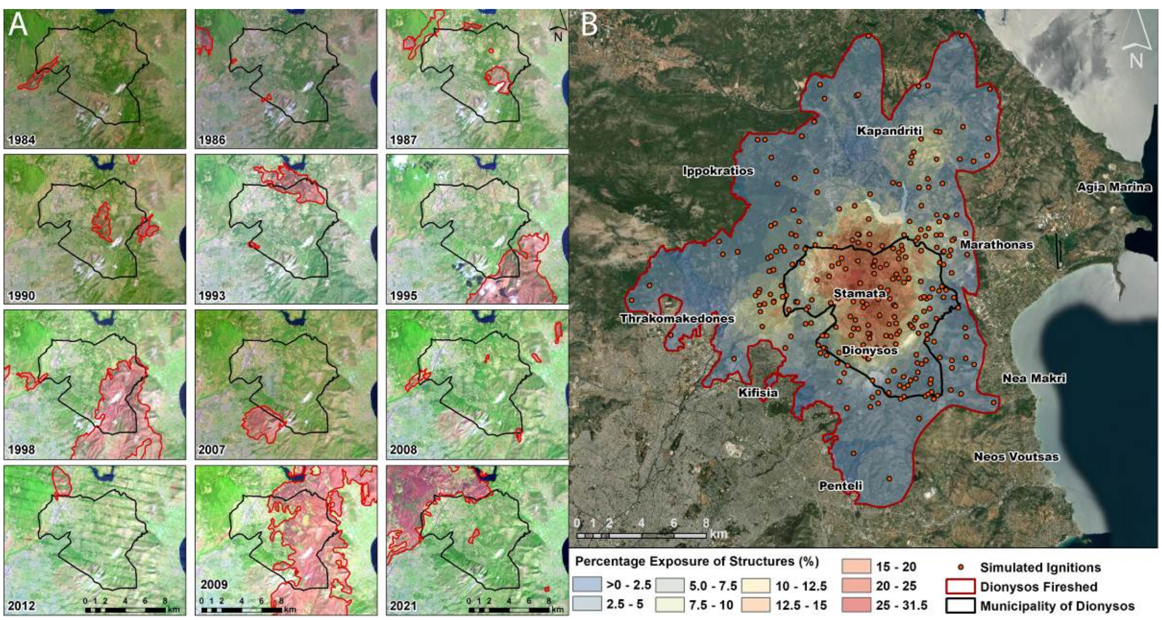

Figure 1. (**A**) Reconstructing the perimeters of the most important wildfires using Landsat satellite images for the period 1984-2021. (**B**) The fireshed of the Municipality of Dionysos. The color grading shows how many buildings can be potentially affected from future wildfires in each area.

Figure 2A shows the simulated ignitions of fires with their perimeters that started outside the boundaries of Dionysos. The average area burned per incident is 2,400 ha. The largest simulated fire started in the Varnavas area and reached 7,500 ha crossing the entire eastern part of the Municipality (Figure 2A, yellow perimeter). Some simulated fires closely matched the 2021 Varybobi fire boundaries, reaching 5,600 ha (Figure 2A, blue perimeter). Figure 1B shows the simulated ignitions of fires with their perimeters that started within the boundaries of Dionysos. A significant portion of the incidents are transmitted outside the Municipality boundaries to the northeast (Figure 2B, cyan perimeter), while the largest portion of the simulations were directed to the south and southeast (Figure 2A, purple perimeter). The average area burned per incident is 1,300 ha, significantly less than the incoming simulated incidents. Figure 2C shows the most destructive simulated fires (the 21 fires that affected more than 20% of the Municipality's buildings), while Figure 2D shows the largest simulated fires (the 21 fires that burned a total of more than 4,800 ha).

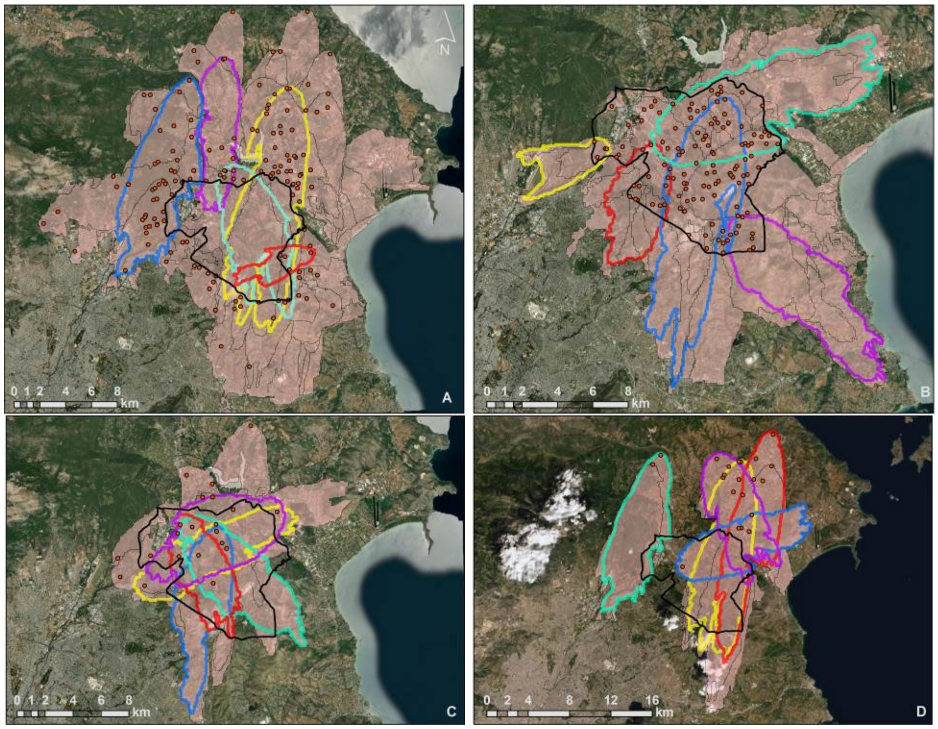

Figure 2. Ignition points and simulated fire perimeters: (**A**) from areas outside Dionysos boundary (**B**) from areas within Dionysos boundary (**C**) that may cause the greatest impact on the buildings of Dionysos. (**D**) The largest simulated fires that entered Dionysos boundary. For a better visual understanding of the results, the five most characteristic perimeters have been colored.

This analysis showed that with the use of modern forest fire simulation methods we can disentangle how possible fires under extreme weather conditions can develop and spread. The results were used to find areas that have the potential to cause large-scale fires that may threaten either residential areas, protected ecosystems or cultural heritage sites. As a priority, these areas need to be optimally sited for fuel management projects, but they must be of the right scale to effectively halt the spread of a fire.

ACKNOWLEDGEMENTS

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SILVANUS: AN INTEGRATED TECHNOLOGICAL AND INFORMATION PLATFORM FOR WILDFIRE MANAGEMENT – NORTH EVIA PILOT AREA

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ABSTRACT
SILVANUS is a Green Deal EU funded project on preventing wildfires, that envisages to deliver an environmentally sustainable and climate resilient forest management platform through innovative capabilities to prevent and combat against the ignition and spread of forest fires. The project will test and validate its outcomes in eleven pilots, among which is North Evia in Greece. The project follows a holistic approach engaging stakeholders relevant to wildfire management through a participatory process. Currently, the project is at the beginning phase. Various technologies will be developed based on well-established and internationally accepted scientific methods. A workshop has already been organized in North Evia to discuss the problems that led to the recent extreme fire of 2021. Some preliminary results are briefly discussed.

Keywords: Wildfire management, early detection, efficient response, training, restoration, sustainability.

1. INTRODUCTION

Wildfires are a complex phenomenon that depends mainly on vegetation, landscape, human activities and climate. Wildfires are becoming frequent and increasingly extreme, and according to [1], the recent extreme wildfires recorded globally between 2016 and 2020 are a consequence of climate processes due to climate change in relation to fuel mixture. According to [2], the summer season of 2021 was extreme in terms of wildfires in Greece, as the highest burned area since 2007 was recorded, mainly due to the wildfires in Evia island which burned over 51,000 ha, a large part of North Evia, resulting to a huge disaster, luckily without any death toll. In addition, large forest fires in Attica and Peloponnese in 2021 contributed to this extreme. Moreover, according to [3], the 2022 weekly cumulative number of forest fires in Greece is already above average.
SILVANUS (https://silvanus-project.eu/) is an EU Horizon 2020 Green Deal funded project that aims to create an innovative technological platform to support preparedness and response against wildfires. The project consists of 49 partners and was initiated in October 2021, with one of the main pilot areas being in Greece at Evia island. A significant number of SILVANUS consortium comes from Greece (EXUS, Agricultural University of Athens, Centre for Research and Technology Hellas, University of Thessaly, Center for Security Studies, Center for Security Studies, Hellenic Rescue Team, Aristotle University of Thessaloniki-AHEPA, Region of Sterea Ellada). SILVANUS main objective is to support civil protection and

first responders' agencies through innovative technologies, increase citizen awareness with relevant training programmes, and improve the restoration and sustainability of forests. The project is currently in the first stages of its implementation and has already enabled a participatory process that engages multiple stakeholders for the development of a platform capable to cover the needs of the various agencies involved in the management of wildfires (before, during and after an incident). Moreover, a workshop has recently been organized in North Evia in order to discuss the problems that led to the burning of a massive area and reach a consensus about future actions.

2. METHODOLOGY AND DATA

A holistic approach is followed to prevent and suppress wildfires, including a high level of stakeholder engagement through a participatory process. From first responders to the health sector, from forest owners to the construction and energy industry, the SILVANUS platform (Figure 1) will address the needs and requirements of stakeholders by addressing the challenges outlined in each of the phases of disaster (phase A – Prevention and preparedness, phase B – Detection and response, phase C – Restoration and adaptation). Novel methodologies in monitoring and analysing ecological growth of natural resources will be developed to complement the analysis of biodiversity models. Cutting-edge technologies for the early-stage detection and response coordination of wildfire will supplement the environmental monitoring framework developed within SILVANUS, the platform will offer support for rehabilitation, restoration, and adaptation of natural forest growth. The SILVANUS forest management platform, along with its technologies and methodologies will be validated in 11 pilot areas worldwide. Eight of them are located in Europe (Greece, Italy, France, Portugal, Croatia, Czech Republic, Slovakia and Romania), while three are international (Australia, Indonesia and Brazil) pilot sites.

In particular, the Greek pilot site is Evia island and more specifically the Northern part and the three municipalities of Mantoudi-Limni-Ayia Anna, Istiaias-Aidipsou and Dirfis-Messapion (Figure 2). Evia is the second largest island in Greece and its total area is 4,167 km^2. About 2,500 km^2 of Evia is covered by forests, while the rest of the island consists of agricultural land, residential areas and barren rocky areas of high mountains.

In terms of climate, Evia has a wide climate variety that is due to its geographical location and the diversity of its terrain. The climate of Evia is of Mediterranean type, the rainfall season is recorded during the winter months, while in the summer months there is drought with high temperatures. Winters are mild and the average minimum temperature of the coldest month is 7°C. The prevailing climate conditions, in the wider area, can be described as very favourable for the existing forest vegetation in the area with several rains falling mainly during most of the germination period [4, 5]. The most significant forest species that constitute the forests of Evia are Aleppo pine (*Pinus halepensis*), Firs (*Abies sp.*), Black pine (*Pinus nigra*), Chestnut (*Castanea sativa*), Oak (*Quercus sp.*) and, sporadically, in small areas, other species, i.e., *Platanus orientalis* and *Accer sp.* The oak and fir forests, due to their small extent, have a minimal effect on the fire behaviour of the area.

Evia island is one of the most fire damaged in Greece. Frequent fires are the most serious risk of degradation of the forests. According to statistics, Evia is among the regions of Greece with the higher rate of yearly burned area. The most recent fire occurred is the mega-fire of 2021 that lasted for 10 days and burned more than 51,000 ha.

The SILVANUS platform will be installed to monitor and support activities in North Evia. During the project implementation period, the following functionalities and capabilities will be developed, tested and validated in the pilot site: fire vulnerability and risk maps, fire ignition - fire behaviour and propagation models, drone surveillance, social media sensing for early detection and warning through twitter, Decision Support System (DSS) for assisting response, training both for firefighters and citizens, health metrics during a fire, soil protection measures and processes, forest restoration measures and activities, forest growth models, socio-cultural and local economy models, sustainability of actions, EU legislation and regulation for climate-related risks, policies for sustainable forests as well as ethical studies related to wildfire hazard.

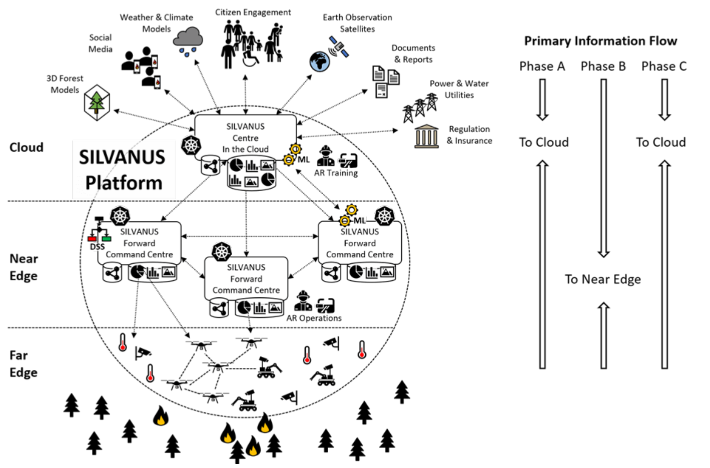

Figure 1. The SILVANUS platform.

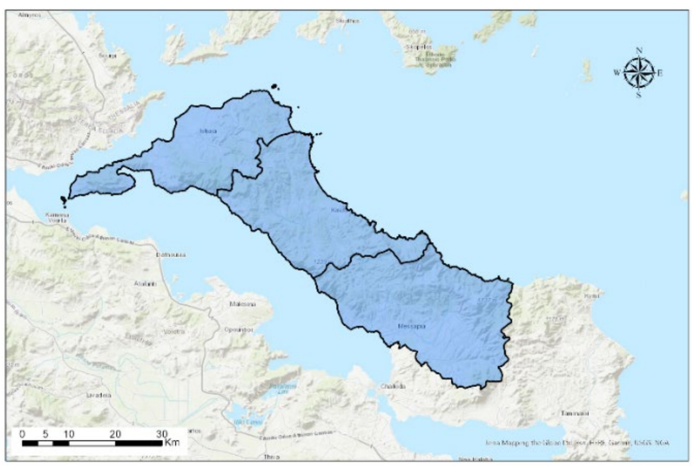

Figure 2. The SILVANUS Greek pilot study area.

Best practices related to both training of first responders and citizens will be applied. Innovative training that is related to the SILVANUS technologies and latest trends in training against natural disasters will be developed. SILVANUS will focus on enhancing citizen engagement and raising awareness activities in order to strengthen the interaction with local communities and their involvement in forest fire fighting. Info days will be carried out to educate them about safe forest behaviour and to train them on how to use the developed mobile application as well as on how they can support prevention efforts through its use. In addition, citizens will be educated on how they can help at all stages of a wildfire (before, during, and after an event). Such activities will be carried out in the areas of Evia and of Thessaloniki. Fire fighters will be trained on the use of the new technologies prior to pilot execution.

One of the core technological advancements that will be exploited and evaluated in the Greek pilot is social media sensing, i.e., the monitoring of public social media posts from citizens or news on Twitter in order to timely detect potential cases of forest fire. Analysing the textual and visual information of the

tweets with Artificial Intelligence (AI) and Machine Learning (ML) can also provide further insight on the detected incidents, such as the location of the fire, the severity of the situation, whether humans are in danger etc. Even though social media sensing mainly supports phase B, by communicating crowdsourcing-detected fires as soon as possible to civil protection and first responders, contribution to phases A and C will also be investigated in SILVANUS. In phase A, social media could be monitored for discovering citizen recklessness that could lead to fires (e.g., people having a barbeque near the forest on a hot day), while in phase C for detecting unofficial/unorganized reforestation activities.
The technologies and scientific background of SILVANUS will be used in such a way that the platform can provide to all eleven pilots the same quality of results in a harmonized and reproducible manner, based on well-established scientific methodologies (e.g., [6]). SILVANUS aims to harmonize the various data streams into a unified data model (schema) that could fit the needs of any organization, site, or country.

3. DISCUSSION AND FIRST RESULTS

Recently a workshop has been held in North Evia, through a synergy between SILVANUS and two other EU funded projects, RISKPACC (https://www.riskpacc.eu/) and FireEUrisk (https://fireurisk.eu/). The workshop was planned and designed to gather local stakeholders (local civil protection agencies and municipalities, first responders, volunteer teams, high school students and teachers, and residents). Some of the initial outcomes include the need for reliable tools for early warning and detection, the importance of preparedness in order to build resilient forests and societies, the constant update of equipment, the regular training, the importance of having trained citizens and the measures to support restoration in a way that will sustain the nature. By the end of the project, the platform of SILVANUS will be capable of encompassing preparedness and response tools and restoration measures that will be supported from a policy perspective.

ACKNOWLEDMENTS

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STRUCTURE VULNERABILITY TO WILDFIRES IN THE WILDLAND-URBAN INTERFACE OF IXIA, RHODES ISLAND, GREECE

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ABSTRACT

Rhodes Island, Greece, faces the risk of disastrous large-scale wildfires on a yearly basis. The island is characterized by landscapes where forest vegetation is mixed with urban areas; and wildfires usually cross through the wildland-urban interface (WUI), affecting forests, isolated structures and residential areas. These areas are considered most vulnerable to a catastrophic wildfire, so their protection and security is essentially considered of first priority. In this study, we examined the vulnerability of infrastructure located inside the Ixia WUI area from a potential large-scale wildfire, by combining wildfire simulations and *in-situ* inspections of the structures in the study area to find and analyze the causes that increase their vulnerability, such as excessive fuel in the home-ignition zone and structural construction flaws that increase their fire exposure and vulnerability. This methodology can be applied more widely in other settlements in the area or similar WUI areas of the island and elsewhere.

Keywords : *WUI, settlement resilience, fuel treatments, home-ignition zone, structure fire exposure.*

1. INTRODUCTION

Greece is among the countries with very high wildfire risk due to its geographical location in the Mediterranean basin, climate anomalies and crises, and rapid re-growth and accumulation of flammable vegetation around urban areas that cause fire suppression difficulties [1-4]. In Rhodes Island, Greece, several areas are characterized as wildland-urban interface (WUI) zones, i.e. the areas where houses and other developments meet or intermingle with forest and other vegetation sites, resulting to increased wildfire risk and high structure vulnerability that should be considered by both the State and the residents of these areas [5-7]. The purpose of this work was to conduct a structure vulnerability assessment in a WUI case study area (in Ixia, Rhodes), and once established, to indicate houses with high loss potential in areas susceptible to future wildfires.

2. MATERIAL AND METHODS

2.1. Study area

Rhodes Island is characterized by its semi-mountainous terrain covered by dense conifer forests, mostly in its central part. The island has all the characteristics of a typical Mediterranean ecosystem and during the last 45 years, more than 1,300 fires ignited that burned approximately 51,000 hectares. The study area is located at the north-eastern part of the island in an area called Ixia (an area of 134 ha), covered by conifers (*Pinus brutia*) mixed with Mediterranean-type shrublands (Figure 1) [8]. There are many different land uses, including critical infrastructures, such as the General Hospital of Rhodes, schools, hotels and homes. As a base mapping land use/ cover type layer, we used the 2018 version of the Corine Land Cover types (Figure 1)[9].

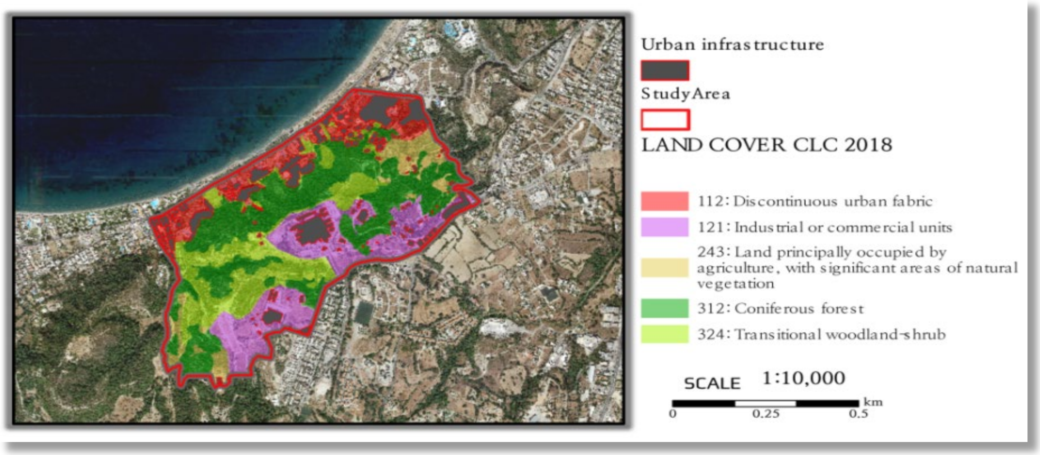


Figure 1. Wildland urban interface study area.

2.2. Simulations with the MTT algorithm – FLAMMAP

We used wildfire simulations at the "*pyro-limits*", i.e. the fireshed boundaries of each structure, to conduct a comprehensive examinationon whether there is a risk of fire initiation and spread based on the existing vegetation within these boundaries. The utilized Minimum Travel Time (MTT) fire simulation algorithm of FLAMMAP [3] can use an ignition probability grid ranging from 0 to 1 to place ignitions across the simulation landscape. We performed stochastic simulations of wildfires, in the specific mixing zone, with all possible meteorological scenarios and random ignition locations based on the values of the ignition probability grid.

2.3. Structure vulnerability due to wildfire

The next element that was studied and analyzed was the exposure probability to potential wildfires of each structure in the study area. Key factors for the increased exposure of a structure to high-risk conditions were the ground slope, tree height, tree distance from the structure and the fuel model of the surrounding area [10]. A 46-meter buffer zone was created around each structure, which defined its "*pyro-limit*", and then statistics like mean, min, max and standard deviation were run to find the average values of burn probability (BP), conditional flame length (CFL), altitude, slope and aspect.

2.4. Field verification

As an initial verification, we used a Satellite Google Earth photo for each of the top-10 most exposed structures, according to the vegetation types associated with fire spread inside the structure's "*pyro-limit*" boundaries. We also used a "*Building Risk Assessment Card*", which includes an evaluation of each building construction condition and its wider surrounding area regarding the type of forest fuel, divided into four zones from each building (0-1.5 m, 1.5-10 m, 10-30 m, 30-100 m) [10].

3. RESULTS AND DISCUSSION

While the fire intensity values are essentially the result of the interaction between spread direction, the slope of the terrain, fuel types and weather conditions, there are many regions of the study area that large portions with high BP values presented also large CFL values (Figure2, A-B). Regarding to each structure's exposure to wildfire by its mean BP (Figure 3), a percentage of 63.63%, for a total of 154 buildings presents low mean BP, 15.58% low-moderate, 7.15% moderate, 6.49% moderate-high and a percentage of 7.15% of the structures, i.e. 11 of them, presents high mean BP that was further studied due to constructions' high risk.

A B

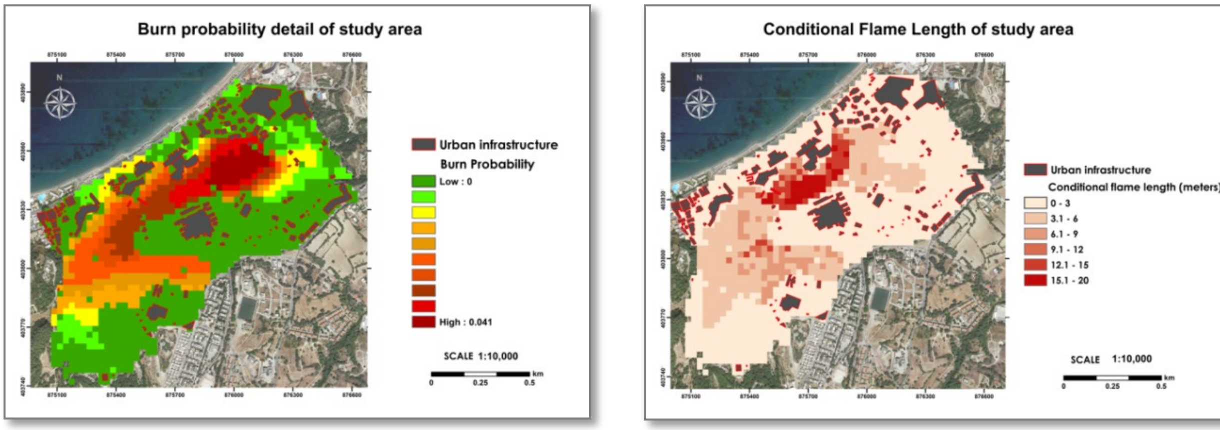


Figure 2. (A) Burn Probability, and (B) Conditional Flame Length mapped over the study area.

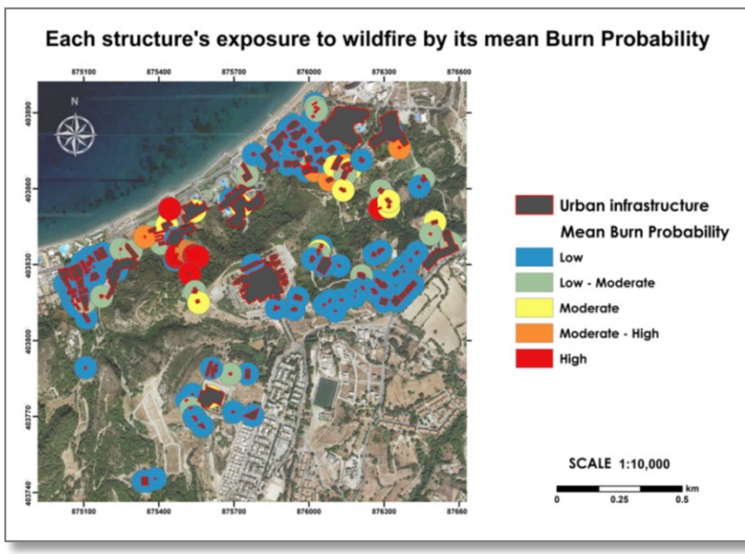
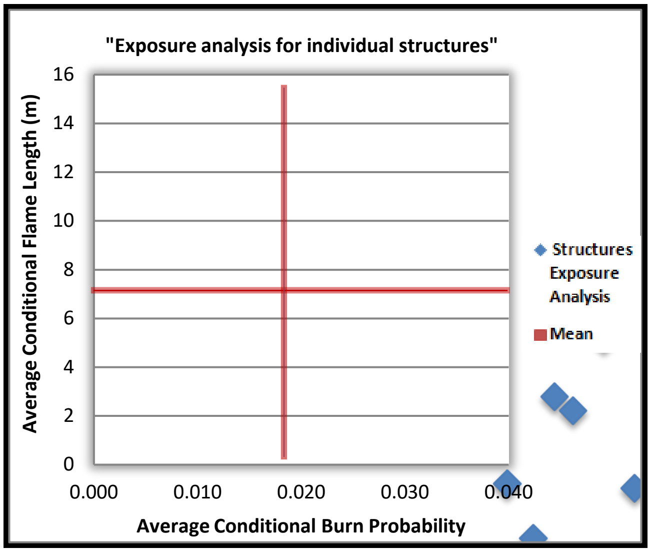


Figure3. Each structure's exposure to wildfire by its mean Burn Probability.

A scatter plot matrix indicated the exposure analysis for each structure (Figure 4) and located the 10 buildings with the highest vulnerability based on their "*pyro-limit*" values, after combining the probability that a wildfire will enter and burn inside (BP) with the intensity that would occur due to the conditional flame length (CFL) in the respective buffer. Lastly, the *in-situ* inspections of the 10 aforementioned structures proved that the causes that increase their vulnerability, were the excessive fuel in the home-ignition zone and the structural construction characterized by extensively exterior windows and doors in conjunction with combustible structure's materials.
The wildfire simulation methods used account for probabilistic ignition locations and subsequent fire spread under historical and forecasted weather conditions to generate multiple outputs useful for understanding the likelihood of extreme events and their impact to nearby urban areas. The study provided simultaneously insights regarding wildfire simulations and their interpretation in terms of community protection planning. The results can be used to prioritize government investments for integrated fuel mitigation projects in this WUI area of Rhodes Island, according to the levels of exposure

identified in the study and proposals for action by all stakeholders involved in the management and suppression of wildfires, such as the Fire Service, the Forest Service, the local and regional Civil Protection offices, the Hellenic Police etc.

A 

B 

Figure 4. (A) Exposure analysis for individual structures, and (B) *in-situ* verification inventories.

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AN APPROACH TO FOREST FIRES IN WILDLAND-URBAN INTERFACE AREAS: A CASE STUDY FROM ATTICA REGION (GREECE)

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ABSTRACT
The forest fires is one the three main Hazards including earthquakes and floods, which are threatening the Greek territory. Every summer the country has casualties in human life and huge economic losses. The wild fires in Greece in Wildland-Urban interface (WUI) areas according to European Forest Fire Information System Data are rising about 5%, the last five year around Athens. WUI interface according the definition of the U.S. Deparment of Agriculture (USDA) forest service is the area where built environment meets or mixed with the natural environment and the settlements are at a greater risk of catastrophic wildfires. A high percent of them are located around the capital of the country. The large cities in Greece are expended and the land use around them is changing especially in Athens in Attica prefecture.
This study makes a focus on the forest fires of the last decade in Wildland-Urban interface areas and trying to understand the reasons of their rise and to find a way to resude the consequences. There is an accent to the land cover changes using the Copernicus land monitoring data at the periods before the fire and also after the fire at the post event reconstruction and recovery. Is being investigate how the high rate of urbanization affect the forest fire related factors in a WUI area.The parameters pertain to the fires are the topography, the climate and the human factors. The study propose a model about the relationships between WUI and the largest fires. Furthermore, the study present a method to define the most vulnerable settlements.
This information can support the Greek governmental civil protection authorities in an more appropriate regional and local scale city planning in order to mitigate the risk of wildfires.

Keywords: Wildland-Urban interface, Earth observation, Fire management, Fire risk

1. INTRODUCTION

The year 2021 all the major fires in Attica burned WUI or Urban areas and this phenomenon is it seems that it continues at 2022. The WUI area fires have been studied in Greece and Europe [1,2] however they are at a preamble face. The Greek legislation is not determine what is a WUI area but there are several countries which follow their own metrology [3]. Additional there are several studies about the influence of the land use of the areas around the settlements for their safety from wild fires [4-5]. Moreover there is a number of studies about the determination of the wildfire risk and vulnerability [6-7] but no one of them detect the location with the higher risk in WUI areas.
This study create a new method to determine from a risk map the locations with the higher risk in WUI areas. The risk map to be more effective in this type of areas give emphasis on the land use as a factor.

2. METHOD AND DATA
The study area concerns the mainland part of the Attica region. The region of Attica has an area of 3808 square kilometers while the part of its land area which is the study area has an area of 2921 square

kilometers and constitutes 77% of them. According to the 2021 census, the total population of the region amounts to 1/3 of the total population of the country, which is 3,828,434 people with a population density of 987.9 people per square kilometer, which is the largest population density in Greece. This type of climate is hot and dry during summer and mild rainy winters. The average annual temperature ranges from 16.5 C^0 to 19.0 C^0.

For this study was used open access Copernicus satellite and geospatial data as well as the Digital Elevation Model (5.5m/pixel) of the LSO project from the Hellenic Cadastre Land Registry. It also included some open data from the Open Street Map. Specifically the data were used for two different thematic projects. The first one concerned the identification of Wildland Urban Interface areas as well as their statistical analysis, while the second concerned the creation of a fire risk model. All the data which used for the study are presented in the following table (Table 1).

Table 1. Satellite and geospatial data of the study area.

Data	Source	Use
CORINE Land Cover 2006 - 2012	Copernicus Land Monitoring Service	WUI statistics
Imperviousness Density 2012 - 2015 - 2018	Copernicus Land Monitoring Service	WUI statistics
Tree Cover Density 2012 - 2015 - 2018	Copernicus Land Monitoring Service	WUI statistics
Digital Elevation Model EU-DEM v1.1	Copernicus Land Monitoring Service	WUI statistics
EFFIS Burnt Areas database	European Forest Fire Information System EFFIS	WUI statistics
World Settlement Footprint 2015	EOC Geoservice DLR	WUI statistics
World Settlement Footprint (WSF) Evolution	EOC Geoservice DLR	WUI statistics
CORINE Land Cover 2018	Copernicus Land Monitoring Service	WUI statistics - Fire Risk Model
Digital Elevation Model from LSO project	Hellenic Cadastre (Land Registry)	Fire Risk Model
Sentinel 2 image (S2A_MSIL2A_20220420T090601_N0400_R050_T34SFH_20220420T145836)	Copernicus Open Access Hub	Fire Risk Model
Sentinel 2 image (S2B_MSIL2A_20220415T090549_N0400_R050_T34SGH_20220415T125557)	Copernicus Open Access Hub	Fire Risk Model
Sentinel 2 image (S2B_MSIL2A_20220415T090549_N0400_R050_T34SGG_20220415T125557)	Copernicus Open Access Hub	Fire Risk Model
OpenStreetMap roads shapefile	OpenStreetMap	Fire Risk Model
Shoreline	GEODATA homepage - Hellenic Republic Ministry of Interior	Map prodacts
Regions of Greece	GEODATA homepage - Hellenic Republic Ministry of Interior	Map prodacts
Europian Settlement Map 2015	Copernicus Land Monitoring Service	Map prodacts

The initial purpose of this work is to determine the Wildland-Urban interface areas of the Greek territory as well as their evolution over time. Greek legislation does not specify the process to determine the WUI areas as well as their spatial boundaries. For the above reason, their determination was chosen to be done in accordance with the French legislation. According this legislation the intersect area within a buffer zone of 200 meters from an urban area, which at the same time includes the distance of at least 400 meters from fuel, is defined as WUI area. From a first statistical analysis of the data of the mixing zones, there is a tendency of increase of the fires in mixing zones especially around Athens. Thus there is a need to create a fire risk model for the land part of Attica in order to somehow determine the risk of mixing zones (Table 2).

Table 2. The weights for the factors of the risk model

Criteria	Land Use	Human Factor	Aspect	Slope	Elevation	Weight
Land Use	1	3	4	5	5	0,465
Human Factor	1/3	1	3	4	4	0,263
Aspect	1/4	1/3	1	2	2	0,122
Slope	1/5	1/4	1/2	1	2	0,086
Elevation	1/5	1/4	1/2	1/2	1	0,064
					CI =	0,04507
					RI =	1,12
					CR =	0,04024

The map was created with all available spatial and satellite data. It was developed with an aid of 3 factors and 7 criteria. The factors include DEM-derived spatial models contributing to the clime (Aspect, Slope, Elevation) Land Use (Copernicus CORINE Land Cover 2018, NDVI from three Sentinel 2 images at

15 and 20 Apr 21), and Socioeconomic factors (Distance from major Roads and Settlements). The weights are determined using Analytic Hierarchy Process (AHP) and the result is classified on a scale from 1 to 5.

Table 3. This intensity of importance for the risk model

	Intensity of importance				
Criteria	1	2	3	4	5
Land Use (CLC 2018)	411,421,512	111,112,121, 122,123,124, 131,132,332, 333	141,142,211, 212,242,243,	221,222,223, 231,321,323, 324,334	311,312,313
Land Use (NDVI)	0,1	0,2	0,3	0,4	0,5
Human Factor (Distance from Roads)	1200+ m	900-1200 m	600-900 m	300-600 m	0-300 m
Human Factor (Distance from Settlements)	2000+ m	1500-2000 m	1000-1500 m	500-1000 m	0-500 m
Aspect	N	NE, NW	E, W	SE, Flat	S, SW
Slope	0-5°	5-15°	15-25°	25-35°	>35°
Elevation	>800 m	600-800 m	400-600 m	200-400 m	0-200 m

In the final map calculation is used Weighted Linear Combination (WLC) that is integrated into Spatial Analyst tools, according to the equitation (equitation 1):

$$S = \Sigma\, wi\, xi \qquad (1)$$

where S is the fire hazard rating, wi is normalized weight of factor i, and xi is the criterion score of factor i. This equitation (equitation 2) become according to the weight of criteria in this form:

$$Fire\ Risk = (0{,}465*0{,}750*NDVI) + (0{,}465*0{,}250*CLC\ 2018) + (0{,}263*0{,}750*Distance\ from\ Roads) + (0{,}263*0{,}250*Distance\ from\ Settlements) + (0{,}122*Aspect) + (0.086*Slope) + (0{,}064*Elevation) \qquad (2)$$

The location map was created by the combination of the first map and the WUI areas calculation, with clipping the data and reclassifying them at the pixel size of the WUI dimensions.

3. RESULTS AND DISCUSSION

The aim of this study was to identify the areas with the highest risk of fire around Athens. The results included 2 main products. The fire risk map in the mainland part of Attica and the second a risk map of the WUI area of Athens as well as the identification of the most dangerous locations in them. A model was used to construct the risk map, which included land use as a criterion. Land use as a criterion offered the model reliability because the WUI areas were determined with the use of the same data.

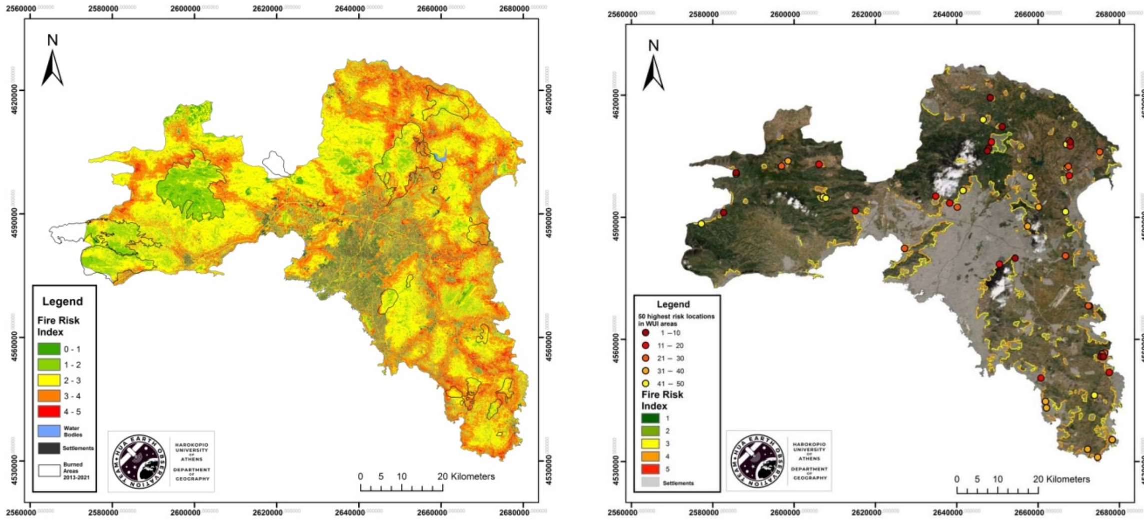
The following conclusions arise from the risk map:

1. The areas with the highest values appeared near the urban areas where simultaneously there is a forests or areas lush vegetation.

2. There is a high risk of fire in areas with lush vegetation in coastal areas of Attica such as the East and South and West coastal zone.

3. There is a large risk of fire in hills or the foothills of the mountains in contact with the urban areas.

4. In recently burned areas the risk of fire is low but increases significantly over time. There is usually a high risk of fire around the burned areas where the fire was fire extinguished



(**a**) (**b**)

Figure 1. Product maps of mainland part of Attica (**a**) Fire Risk Map (**b**) WUI Area Risk Map and the 50 location with the higher risk at the mainland part of Attica

4. CONCLUSION

The model has very good results about the starting points of fires which is confirmed for the summer period of 2022. Moreover the case of arson will be taken into account in the future risk model. In addition to the distance from the streets and the settlements, the value of the real estate properties may have to be included as a variable too. Local authorities should seriously consider the installation of monitoring, early warning systems and equipment of emergency firefighting around the high-risk settlements. In a future study after the validation of the data, the weight and the type of the factors will be optimized and a new proposal about the definition of the Greek WUI areas will recommended.

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EVALUATION OF A FOREST FUEL MANAGEMENT PLAN USING SIMULATION MODELING IN A MEDITERRANEAN WILDLAND-URBAN INTERFACE

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ABSTRACT

This work aimed to evaluate a 10-year forest fuel management plan targeting to protect structures and reduce fire suppression difficulty in a typical Mediterranean wildland-urban interface (WUI) in the Stavronikita forest of Kassandra, Chalkidiki, Greece. Three fine resolution landscape files (LCP) were created for this project after combining ground surveys, high-resolution Large Scale Orthophotography (LSO 25/2015), and literature data such as forestry management and fire protection plans. Fire behavior simulations were conducted with the Minimum Travel Time algorithm to estimate the change in forest fire behavior before and after treatment implementation. Fire parameters used to compare fire behavior were the Rate of Spread, Active Crown Fires, Fireline Intensity and Heat/Unit Area, while a spatial analysis of fire risk was attempted through the evaluation of Burn Probability, Fire Size and Conditional Flame Length for three different forest conditions. Results confirmed the hypothesis of fuel treatment plan efficiency on changing wildfire behavior, as significant reductions were observed for all fire parameters. We also identified high-risk forest areas where fuel treatment priority should be given in the management plan till 2030.

Keywords: *fuel treatments, WUI, Chalkidiki, wildfire simulations, MTT*

1. INTRODUCTION

Forest fires are one of the most important natural disasters for most Mediterranean regions and their behavior depends on a combination of factors such as vegetation, topography and meteorological conditions, with fuel being the only factor that can be managed to reduce the fire risk [1]. Forest fuel discontinuity for fire protection can be achieved by the method of 'Clearing'. This method combines a reduction of ground and surface vegetation, thinning and pruning of trees that decreases canopy cover and increases canopy base height, while the treated biomass is either collected and burned or chipped and scattered in the forest [2]. This research was based on the simulation outputs of the Minimum Travel Time (MTT) algorithm, as implemented in the FlamMap fire modeling system [3]. Thus, the main goals of this study were to evaluate the proposed fuel management plan effectiveness in reducing forest fire behavior and identify and prioritize the high-risk forested areas for treatment application in the management plan for the next decade.

2. METHODS AND DATA

2.1. Study area

The study area of Stavronikita forest is located in the Kassandra peninsula of Chalkidiki, 60 km south of the large metropolitan center of Thessaloniki, Greece, and is privately owned. Its area amounts up to 400 ha and is mostly covered with Aleppo pine (*Pinus halepensis* Mill.), i.e., a fire-prone conifer species typical over the coastal Mediterranean areas, with an understory of evergreen – sclerophyllous shrubs (maquis). The site is also covered in parts by agricultural areas (crops, olive trees), while its high residential density resulted from tourism activities (vacation homes, hotels and camping) transformed the forest into a high-risk, high-value and high-use Wildland-Urban Interface (WUI). This type of mixed and fragmented wildfire-prone ecosystems seriously increases the need for achieving fire resilience, a central concern of this private forest owners since the year 1969. Nevertheless, systematic management was applied in the forest only during 2011-2020, with an implementation of a decadal fuel treatment plan having an annual budget of 75,000 euros.

2.2. Methodology

By applying forest science principles and methods [4], field data were collected from 21 circular sampling plots (0.1 ha area each), allocated inside treated and non-treated stands of Stavronikita forest, to measure a series of variables that determine forest structure and composition. The above datasets were combined with the official digital vector layer from the Chalkidiki Forestry Cadastre [5] and literature data, such as forest management plans and fire protection plans for forests. Data were verified by photo-interpretation of high-resolution (0.25 x 0.25 m) Large Scale Orthophotography (LSO 25/2015) in natural color. With the above dataset, and by considering the predicted fire behavior each general vegetation type can potentially produce, we assigned for each sampling plot (land type) one or more fuel models [6–8], which represent sets of parameters which define fuel characteristics to various fire behavior modeling schemes. The methodology was applied for three different forest conditions: a) without tourism development and with no fuel management (St-1969); b) after the application of the 10-year fuel management plan (St-2020); and c) for the hypothetical scenario that no fuel treatments were applied in the forest in the year 2020 (St-rules). Finally, three fine resolution landscape files (called LCPs) with spatial raster data were created to deliver the required spatial inputs in the wildfire simulation model. A total of 10,000 ignitions were simulated with the minimum travel time (MTT) algorithm of Flam Map 6.1 for each one of the three forest conditions (St-1969, St-2020 and St-rules). Meteorological data of the last 50 years were also collected to determine the weather conditions that may occur during large forest fires, while a severe conditions weather scenario was used with a wind speed of 62 km h^{-1} and dominant wind direction from northwest (330 degrees, with 20% chance for selection from any given simulation). Dead fuel moisture was set as 1-hr=3%, 10-hr=4%, 100-hr=5% and live moisture as LH=30% and LW=60%, foliar moisture content to 70% corresponding to very dry canopy fuel conditions, while simulation duration was set at 60 min. The effectiveness of the applied fuel management plan was assessed through the interpretation of MTT outputs such as Burn Probability (BP), Fire Size (FS), Conditional Flame Length (CFL), Rate of Spread (ROS), Fireline Intensity (FI), Heat/Unit Area (HPUA) and the percentage of the Active Crown Fires (ACF).

3. RESULTS AND DISCUSSION

Table 1 provides information about the mean values of basic fire behavior parameters for each forest condition. Thus, it was recorded a decrease of approximately 15% in the mean values of BP and FS for the post-treatment forest (St-2020), compared to the non-treatment forest (St-rules), and a decrease of 30% in the mean value of CFL. Most mean values of fire behavior parameters displayed their lowest value for the forest condition of 1969 (St-1969), since the forest had low biomass due to the repeated wildfires that burned during 1945-1960. The percentage of the forest areas where dangerous active crown fires were simulated to occur represent approximately 31% of the total area in St-1969 and St-2020, increased to 45% in St-rules. The mean ROS within the study area varied from a low 27 m/min in the St-1969 to a high of 43 m/min in the St-2020 and a higher of 56 m/min in the St-rules, recording an increase of 30% between post- and non-treatment forest. Overall, most of mean values of fire behavior parameters showed a notable increase between St-1969 and St-2020 with an exception in FI and HPUA, while the comparison between St-2020 and St-rules showed universal increase in the ensemble of mean values of fire behavior parameters.

Table 1. Fire behavior parameters for the three forest conditions (St-1969, St-2020, and St-rules) and the differences (%) among them.

	Burn Probability	Fire Size (ha)	Conditional Flame Length (m)	Active Crown Fires (% of total area)	ROS (m/min)	Fireline Intensity (kw/m)	Heat/Unit Area (kJ/m²)
1 St-1969	0.0248	8.47	1.25	30.56	27.56	18,572	18,660
2 St-2020	0.0999	36.92	1.40	31.73	42.80	12,843	11,782
3 St-rules	0.1155	42.41	1.82	45.41	55.67	21,472	17,635
Differences 1 vs. 2 (%)	302.82	335.89	12.00	3.83	55.55	-30.85	-36.86
Differences 2 vs. 3 (%)	15.62	14.87	30.00	43.11	29.86	67.18	49.68

The spatial distribution of BP values (Figure 1a, b, c) showed that the areas covered by dense conifer forest and the areas where the residential development for tourism are located were more likely to be burned. An increase of 50% is noted in the percentage of smaller size fires (FS < 30 ha) in the St-2020 compared to the St-rules. The spatial depiction of CFL values gave information on suppression interpretation for each land cover type of the forest. Thus, wildfires could generally be attacked by crews using hand tools in the yellow areas in Figure 1g, h, i (CFL < 1.2 m) and areas of concern that had already been treated such as sparse conifer forests, forests with pine litter and the residential developed areas mixed with conifers trees. The purple areas in CFL maps (1.2 m < CFL < 3.4 m) represent wildfire conditions that can be confronted effectively with machinery such as dozers, pumpers and aircrafts throwing fire retardant, occupying 26% of the total study area in the St-1969, 49% in the St-2020 and, 38% in the St-rules. Finally, the percentage of black areas with CFL > 3.4 m represent wildfires that suppression will require the use of aerial means (aircraft, helicopters) and it is reduced from 17% of the total area in the St-rules to 5% in the St-2020. On the center part of the forest where the largest and most continuous treatments were applied, we found the largest differences in BP, FS and CFL.

4. CONCLUSIONS

This work is the first application of local-scale fire simulation modeling to evaluate a fuel treatment management plan for community protection from wildfires in Greece. The results revealed that the fire-prone Mediterranean forest ecosystems may attain a significant decrease in the values of basic fire behavior parameters when they have been properly managed. The spatial distribution of fire simulation outputs is essential to create maps that can help managers to: a) decide the best suppression strategy, and b) give priority for treatment to stands that are most likely to burn. A comprehensive fuel management plan may provide a significant reduction in the national suppression budget since it can improve fire suppression efficiency using ground-based means and human resources, and also limit the use of costly aerial firefighting. There are also important benefits highlighted by fuel mitigation in privately owned forest resorts and settlements of high-risk, high-value and high-use WUI in typical forested fire-prone ecosystems along the Mediterranean coast, especially during adverse socioecological conditions encountered in the era of climatic changes.

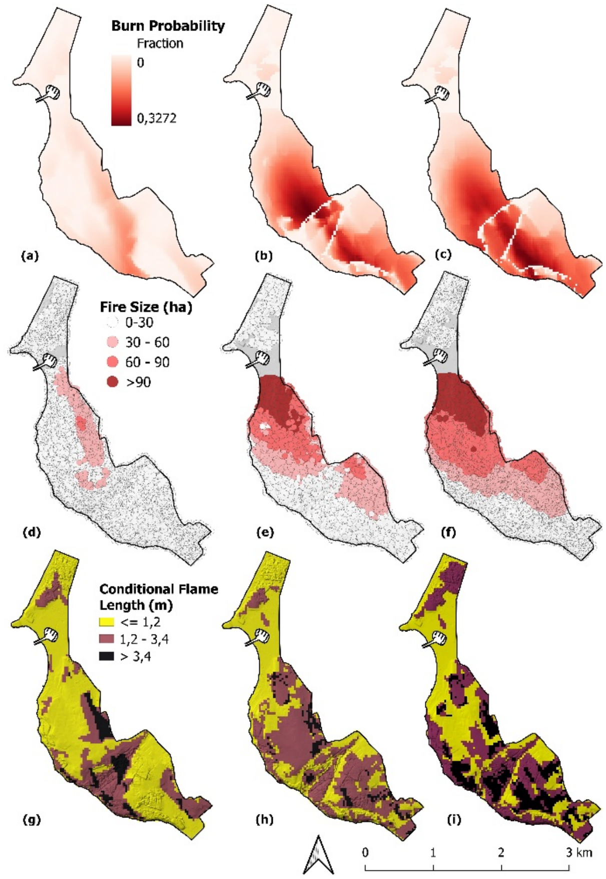

Figure 1: Spatial differences in burn probability, fire size and conditional flame length between the three forest conditions, i.e., St-1969 (a, d, g), St-2020 (b, e, h) and St-rules (c, f, i).

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GIS-BASED MORPHOMETRIC ANALYSIS FOR THE PRIORITIZATION OF EROSION-PRONE WATERSHEDS IN EVIA ISLAND, GREECE

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ABSTRACT

The aim of this study is the prioritization of one hundred eighty-nine (189) drainage basins in the north part of the Evia Island, in terms of their susceptibility to erosion, through the calculation of a compound parameter that takes into account linear, aerial and relief morphometric aspects of the catchments. Eleven (11) morphometric parameters including bifurcation ratio, average length of overland flow, drainage density, stream frequency, drainage texture, form factor, elongation ratio, circularity ratio, compactness coefficient, relief ratio, and ruggedness number were considered for the analysis. After the calculation of the parameters' values and the watersheds relative ranking, the compound parameter values were estimated. The final priority rating of the watersheds was based on the values of the compound parameter and the most prone to erosion catchments were identified. Thirty seven (37) watersheds were classified as of very high susceptibility to soil erosion, while each of the other four soil erosion susceptibility classes (high, medium, low and very low) includes thirty eight (38) drainage basins. The lowest values of the compound parameter correspond to highly susceptible to erosion catchments (watersheds No 39-41) and suggest that measures regarding soil conservation should ideally start from them. However, the final decisions should take also into consideration other useful information such as the land use, the presence of soils, and the soil characteristics of the catchments. The results of this study reveal that twenty three (23) drainage basins of very high to medium susceptibility are located in the recently burned (after the August 2021 wildfire) area and are expected to be under maximum soil erosion condition, which means that conservation measures are necessary as a matter of priority.

Keywords: soil erosion, morphometric parameters, geomorphometry, GIS; watershed prioritization.

1. INTRODUCTION

Over the years natural resources (i.e. land and water) becomes increasingly scarce because of the intense population pressure. Hence, natural resource planning and management that usually require the use of extremely large amount of data to be properly implemented is essential and necessary [1].
The prioritization of susceptible to soil erosion watersheds can become a useful tool for decision makers, scientists and planners to coordinate mitigation measures and effective strategies especially in areas affected by severe forest fires [2-3]. Of great importance is also the assessment of the potential future soil erosion risk, as well as the design of reconstruction plans [4]. Although geomorphometry is more commonly used in hydrological modelling [7-8], several studies discuss its contribution in the prioritization of watersheds in terms of their susceptibility to both flooding and soil erosion [5-6].
This study deals with the identification of the most prone to erosion drainage basins in the northern part of the Evia Island taking into account their morphometric characteristics. The study also focuses on the catchments that drain the burned after the recent wildfire area, which should come first when conservation practices will take place.

2. STUDY AREA

The study area is located in the northern part of the Evia Island, in Central Greece, and covers 1,842.3 km^2. It consists of one hundred eighty-nine (189) drainage basins, whereas the total channel length of the drainage networks is approximately 3,745.6 km (Figure 1). The two largest drainage basins (No132 and 78) constitute the Neogene basins of the area. They are of sixth-order and are mainly made up of marls and sandstones. Part of the north Evia Island (about 517 km^2) has been totally burned during the 2021 wildfire.

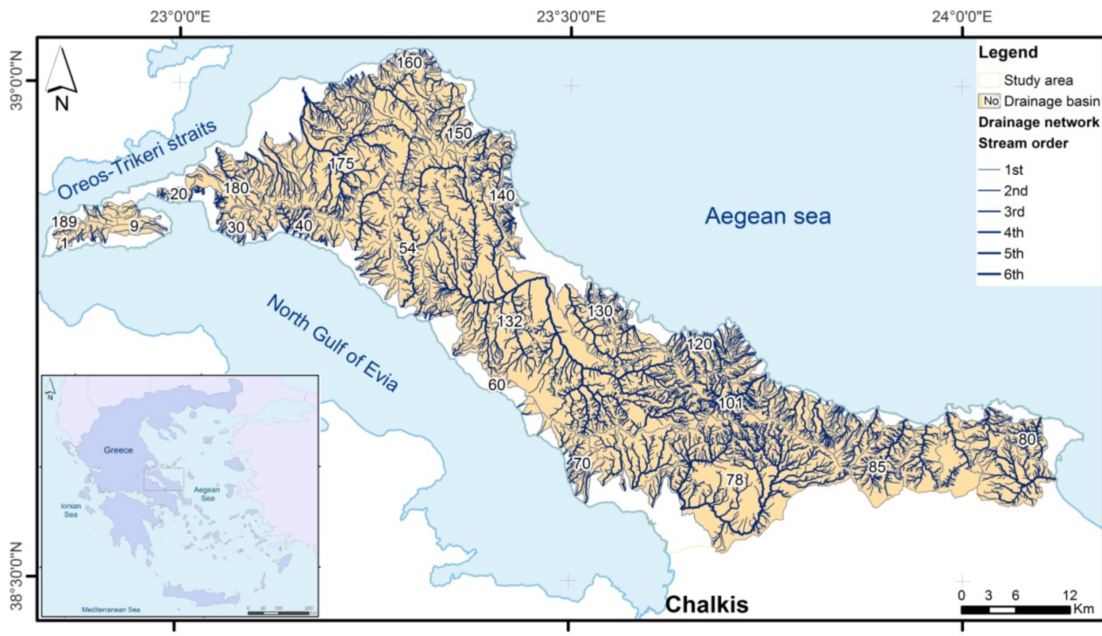

Figure 1. The drainage networks of the study area and their corresponding catchments.

3. METHOD AND DATA

To prioritize the watersheds of the study area with respect to soil erosion, selected linear, areal and relief morphometric parameters were estimated according to the methodological approach proposed by Singh et al. [9]. The linear parameters that were used include mean bifurcation ratio and average length of overland flow, the areal parameters include drainage density, drainage texture, stream frequency, form factor, elongation ratio, circularity ratio and compactness coefficient, while the parameters related to the relief include relief ratio and ruggedness number. Based on the values of these morphometric parameters the drainage basins were classified into soil erosion susceptibility categories. The higher value of bifurcation ratio, drainage texture, drainage density, stream frequency, length of overland flow, relief ratio and ruggedness number were ranked with 1 since there is a direct relationship among these parameters and the soil erosion susceptibility (high erosion - high priority - small rank number). On the other hand, the higher value of form factor, compactness coefficient, circulatory ratio and elongation ratio were ranked with 189 because there is an inverse relationship between these morphometric parameters and the soil erosion susceptibility. After the priority ranking, a compound parameter which corresponds to the average of the ranked values, was calculated. The compound parameter was finally ranked based on the parameters' priorities (small numbers corresponds to higher priority). The natural breaks classification method was then used to categorize the watersheds into five classes of soil erosion susceptibility: very high, high, medium, low and very low.

4. RESULTS AND DISCUSSION

The prioritization of the drainage basins according to the values of both the estimated morphometric parameters and the compound parameter, as well as the final priority rating are shown in Table 1, while the spatial distribution map of the prioritized drainage basins is depicted in Figure 2.
Thirty seven (37) drainage basins, located mainly at the south-eastern and the north-western parts of the study area, belong to the very high susceptibility to erosion class. The most prone to erosion drainage basins are No 39-41. Their compound parameter values range from 36.7 to 40.8 and they are located at the north-western part of the study area, near the town of Aedipsos. The higher priority of these watersheds indicates the greater degree of soil erosion and the necessity for erosion control measures.

Table 1. Watershed prioritization analysis results based on the morphometric parameters (the blue colour indicates the morphometric parameters which are directly related to soil erodibility, while the pink colour corresponds to the morphometric parameters that are inversely related to soil erodibility)

Watershed No	Bifurcation ratio Rb	Length of overland flow Lb	Drainage density Dd	Stream frequency Df	Circularity ratio Rc	Form factor Rf	Elongation ratio Re	Drainage texture T	Compactness coefficient Cc	Ruggedness number Rg	Relief ratio Rr	Compound parameter	Priority rank
	Linear parameters		Aerial parameters							Relief parameters			
1	14	156	156	151	138	116	116	121	52	175	171	124,18	164
2	148	157	157	143	76	62	62	144	114	115	48	111,45	143
3	144	173	174	139	142	96	96	138	48	145	56	122,82	163
4	125	170	170	123	53	155	155	112	138	126	57	125,82	168
5	133	77	77	28	128	100	100	99	62	106	30	85,45	72
6		47	47	84	106	76	76	152	87	98	20	79,30	50
7	46	137	137	134	119	58	58	122	71	84	75	94,64	98
8		152	152	189	23	14	14	189	167	130	144	117,40	155
9	54	175	175	183	12	11	11	170	178	124	156	113,55	149
10		186	186	101	97	127	127	155	94	189	93	135,50	183
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
179	105	105	104	120	75	77	77	46	115	50	154	93,45	95
180	66	115	115	122	32	43	43	47	158	51	166	87,09	77
181	102	171	171	179	22	36	36	168	168	184	188	129,55	175
182	53	187	187	182	78	117	117	162	112	185	178	141,64	187
183	47	172	172	161	171	157	157	129	18	149	87	129,09	173
184	153	180	180	177	64	85	84	167	126	129	82	129,73	176
185		45	44	98	79	64	64	158	111	92	29	78,40	49
186		81	81	74	143	126	126	148	47	117	10	95,30	100
187	50	135	135	136	34	88	88	135	155	85	70	101,00	118
188	45	128	128	108	56	40	40	118	134	78	62	85,18	71
189	4	136	136	156	102	74	75	123	88	90	108	99,27	112

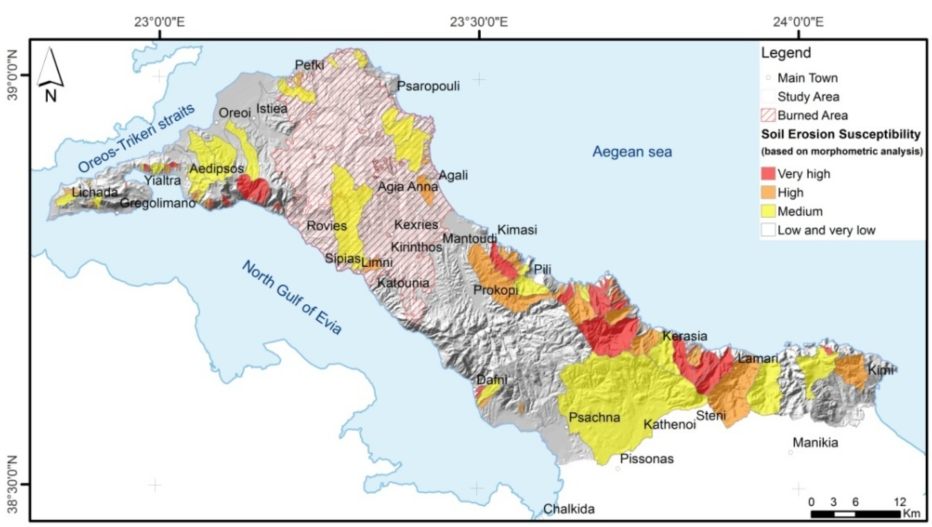

Figure 2. Final map of soil erosion susceptibility based on the geomorphometric analysis of the watersheds.

5. CONCLUSIONS

A quantitative geomorphological analysis that leads to the watershed prioritization with respect to erosion risk is the first step for the identification of the catchments that require soil erosion and flood management measures. The present methodological approach is based on the calculation of morphometric parameters that express the geomorphological characteristics of the catchments, and highlights the more susceptible to soil erosion watersheds of the northern part of the Evia Island. The results of the analysis showed that the most prone to soil erosion drainage basins are located at the south-eastern and north-western parts of the island. Twenty three (23) of the very high to medium priority watersheds, are located in the recently burned part of the study area, and need immediate conservation measures in an attempt to minimize the negative effects of soil erosion. To validate the results of this study, two more methods for the prioritization of the drainage basins (proposed by Gajbhiye, et al. [1] and Kadam et al. [10]) both based on morphometric parameters were carried out. The results of these two methods are in good agreement with the findings of the present study.

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SEISMIC RISK ASSESSMENT IN THE REGION OF ATTICA

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ABSTRACT
Reliable quantification of risk due to natural hazards and effective design of mitigation measures are of utmost importance for the Region of Attica, Greece, an area of particular interest due to its inherent characteristics, such as overpopulation, over-concentration of critical infrastructure and socio-economic activities, etc. In this paper, we present the methodology for the seismic risk assessment of the Attica Region, ongoing within the framework of an extensive research project entitled "Risk Assessment for Earthquakes, Fire and Flood in the Attica Region". This innovative work aims to provide support to the decision-making process of the relevant authorities and key stakeholders towards seismic loss reduction and effective disaster management, leading to more resilient communities, especially in urban areas.

Keywords: Attica Region, seismic risk, vulnerability, seismic hazard, earthquake disaster management

1. INTRODUCTION

In 2021, the Attica Regional Authority, the National Observatory of Athens, the International Hellenic University, the Aristotle University of Thessaloniki, the National Technical University of Athens, and the Institute of Engineering Seismology and Earthquake Engineering joined forces within the framework of an extensive research project entitled "Risk Assessment for Earthquakes, Fire and Flood in the Attica Region", intending to protect both citizens and the environment from natural disasters. The research, focusing on multiple natural hazards and analyzed on a buildings' block scale, is the first of its type to be conducted in Greece. The Attica Region is a key area with several particular characteristics, such as overpopulation, over-concentration of critical infrastructure and socio-economic activities, significant inland areas, and various geo-environmental units. At the same time, the area has experienced recent catastrophic events, such as the Athens 1999 earthquake, the flood in Mandra in 2017, and the fire in Mati in 2018, all being examples of the tragic consequences of the combination of natural hazards and man-made interventions in the region. Reliable quantification of risk and design of mitigation measures in the Region are, therefore, more imperative than ever before. The ongoing project will generate original knowledge in support of the Attica Region's optimal implementation of the envisaged National Civil Protection Plan, as well as the work of the Coordinating Bodies of Civil Protection.

This paper presents the methodology and preliminary results of the seismic risk assessment component for the Attica Region. The municipalities that have been selected for the seismic risk assessment are Alimos, Glyfada, and Elliniko-Argyroupoli in the Southern Sector of Athens, Heraklio and Nea Ionia in the Northern Sector of Athens, Agia Varvara, Agioi Anargiroi-Kamatero, Aigaleo and Ilio in the Western Sector of Athens, Aspropyrgos, Elefsina, Megareon and Fili in West Attica, Acharnes and Oropos in East Attica, Keratsini - Drapetsona in Piraeus and finally Kythera. Figure 1 presents the study area distinguishing the municipalities that have already been studied (phases 1-2; light blue) and the ones that are currently under process (phases 3-5; dark blue).

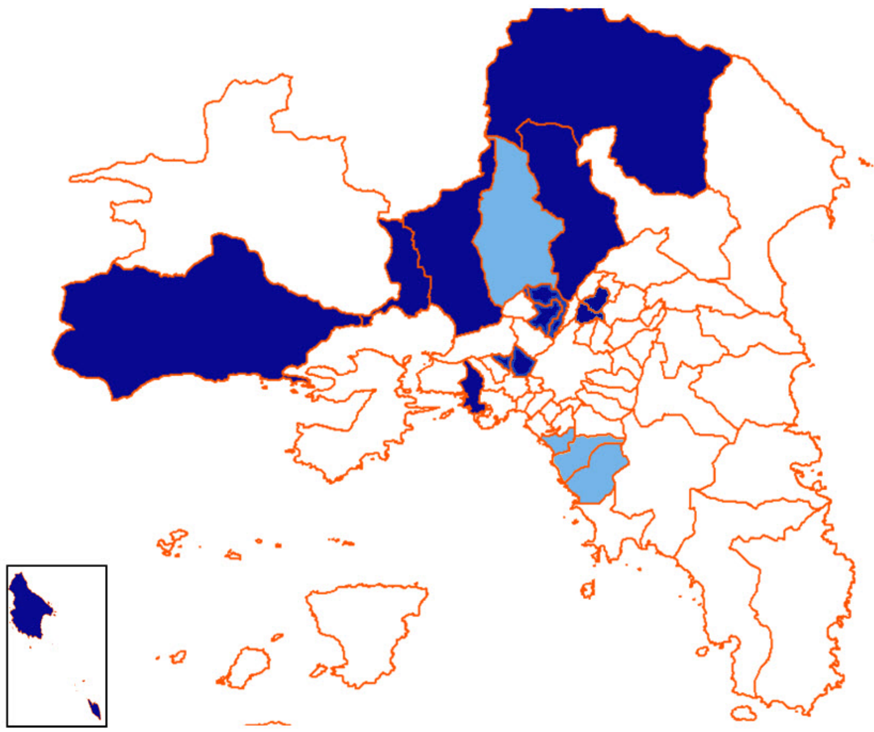

Figure 1. Study area

2. METHODOLOGY AND INDICATIVE RESULTS

The methodological framework adopted for the seismic risk assessment of the Attica Region is illustrated in Figure 2. The seismic hazard is computed for rock site conditions and different return periods using a Probabilistic Seismic Hazard Analysis (PSHA). The different intensity measures obtained from the seismic hazard assessment (e.g. peak ground acceleration, PGA, and spectral acceleration at different periods, Sa) are properly amplified to take into account the effect of local site conditions, based on the geological mapping of the area (e.g. Figure 3) and appropriate site categorization schemes (e.g. [1], [2]). These intensity measures are used as input in fragility curves [3] respective to the typology of the buildings included in the developed exposure model [4], which is constructed based on the National Building Census data as provided by the Hellenic Statistical Authority.

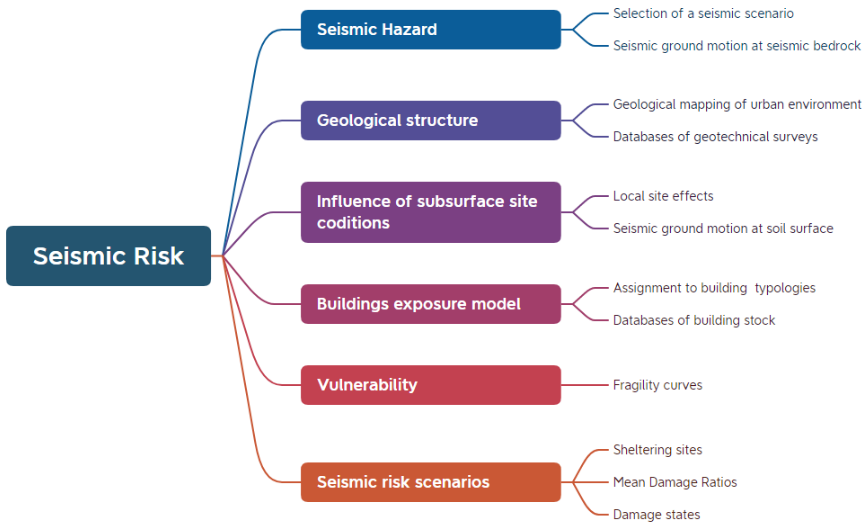

Figure 2. The Methodological framework for seismic risk assessment in Attica Region

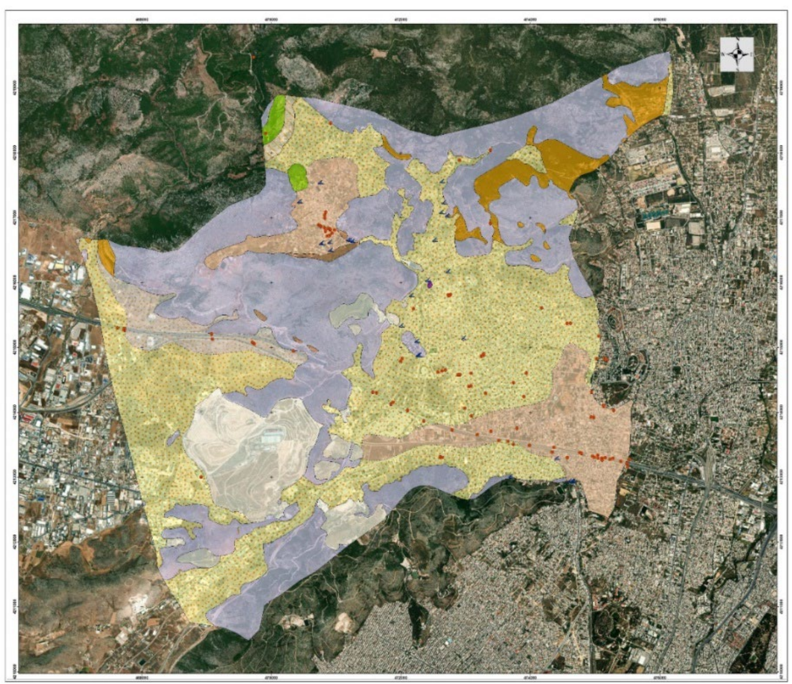

Figure 3. Geological map of the Municipality of Fili

The final risk estimates include the spatial distribution of physical losses (numbers of buildings expected to experience specific damages states), and economical losses (mean damage ratios). The combination of these risk estimates with the locations of the sheltering sites may provide useful information towards efficient earthquake disaster management procedures in the urban areas under study. Furthermore, an interactive web application is currently under development within the framework of the project and is expected to be a valuable tool for seismic risk management by the Attica Regional Authority Services. Indicative results in the Southern Sector of Athens are presented in Figure 4.

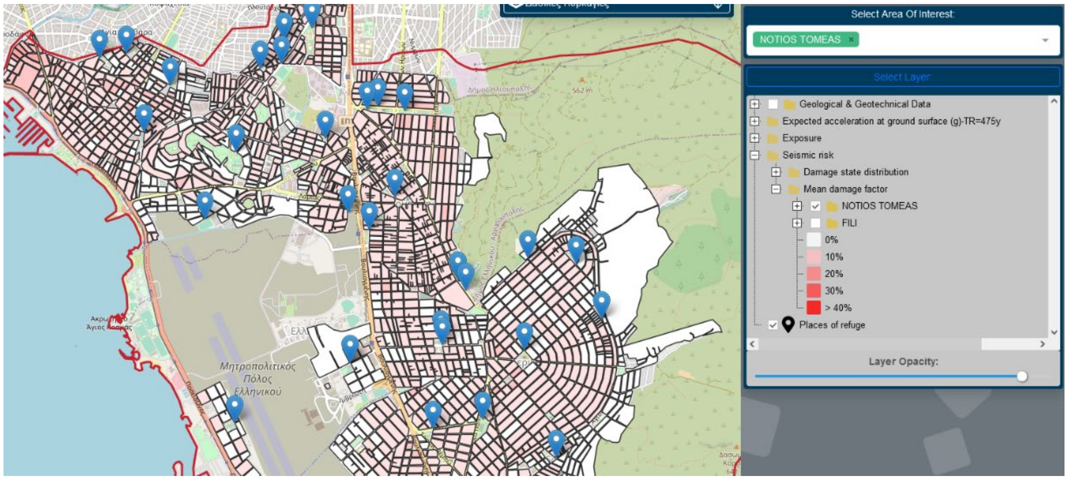

Figure 4. Spatial distribution of the mean damage ratio in the Southern Sector of Athens, along with the predefined sheltering sites, in the project's web application

3. CONCLUSIONS

The paper briefly presents the methodology and some preliminary seismic risk estimation results in several municipalities in the Attica Region. Estimates are combatible with the seismic damage actually occured in the 1999 earthquake [5]. More specifically, lower damage levels are expected in the Southern Sector of Athens, whereas it is interesting to notice the significant update of the building stock in the Municipality of Fili that was severely struck by the 1999 earthquake, with the demolition of heavily damaged (unreinforced masonry or low ductility reinforced concrete) older buildings and their replacement with modern reinforced concrete structures.

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This research has been supported by using data and resources from the project "Seismic, Fire & Flood Risk Assessment in Attica Region, Greece" funded by the Region of Attica. The authors would also like to thank the Hellenic Statistical Authority for providing the building stock data gathered in the 2011 National Census, as well as the GIS background.

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TOWARDS A COMPLETE LANDSLIDE INVENTORY FOR ASSESSING LANDSLIDE HAZARD AND RISK IN EAST MACEDONIA AND THRACE REGION, GREECE

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ABSTRACT
We present a new complete landslide inventory for the region of East Macedonia – Thrace, Greece with more than 10,000 landslides mapped. The creation of this manually-mapped inventory was needed to overcome the limited spatial and temporal information for landslides in the region. The new landslide inventory will be used as a baseline for the calculation of landslide hazard and risk in the Prefecture of East Macedonia and Thrace, within the Risk and Resilience Assessment Center (RiskAC) project implemented by the Democritus University of Thrace.

Keywords: landslide, mapping, hazard, risk, infrastructure, Thrace.

1. INTRODUCTION

The aim of RiskAC (Risk and Resilience Assessment Center –Prefecture of East Macedonia and Thrace, Greece) is to strengthen the risk and resilience decision-making process of those who manage important sectors in the Prefecture of East Macedonia and Thrace in Greece. A large part of the RiskAC project is focused on the establishment of a database of natural hazards in the region and the subsequent determination of hazard and vulnerability. The lack of a detailed landslide dataset ((rainfall- and earthquake-induced landslides) over the region, led us to the creation of a new landslide inventory for the Prefecture of East Macedonia and Thrace, with an approximate scale of 1:25,000-1:50,000. A consice landslide inventory should include landslide polygons and linear features traced in as much detail as possible, for both active/recent landslides and inactive/prehistoric landslides.

2. LANDSLIDE INVENTORY FOR EAST MACEDONIA - THRACE

2.1. Landside mapping

Landslide mapping was performed manually, using as baseline a detailed digital surface model (DSM) with 5m resolution, provided by the Hellenic Cadastre. Landslide polygons and scarp features were traced over the DSM by using key morphological features identified in relief and slope maps. Mapped landslide features were then checked using multi-temporal aerial and satellite very high resolution imagery, in order to check validity and age of activity. Supporting data such as reported landslide occurences and satellite-derivered displacement time-series were also used to identify activity of the mapped landslide polygons. Landslide inventory coverage is limited in areas of dense forest vegetation and major built-up areas, and in parts where the DSM is missing data or appears to have artifacts. We have mapped more than 10,000 landslide polygons in the area covering the region of East Macedonia and Thrace (Figure 1). Mapped landslides are mostly deep-seated landslides, rockslides and earthflows with a significant size (from ~30m up to 1-2 km). The inventory does not include individual rockfalls and debris flows.

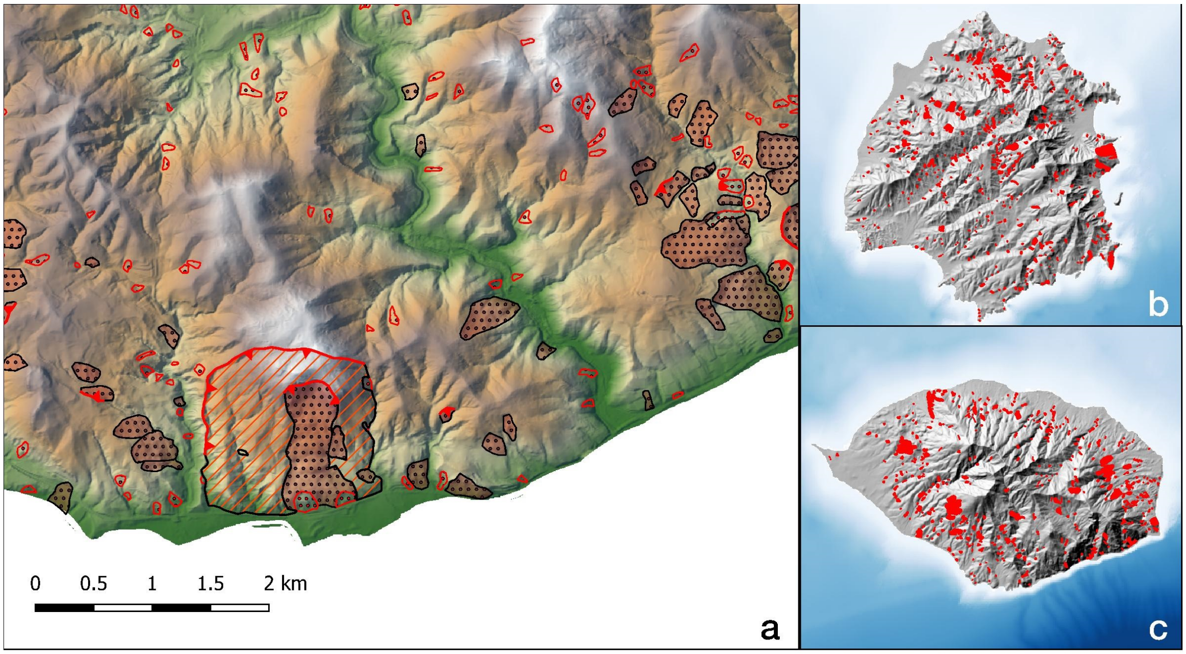

Figure 1. Examples of landslide inventory mapping in East Macedonia & Thrace Region: (**a**) Close-up of landslide polygons mapped in detail in the area of Loutra Eleftheron, Kavala; (**b**) Landslides (red polygons) mapped in Thasos Island; (**c**) Landslides (red polygons) mapped in Samothraki Island.

2.2. The next steps

A detailed inventory of active and inactive landslides in this scale can provide the basis for creating inventory-based susceptibility and hazard maps for rainfall- and earthquake-induced landslides in the region. We plan to expand the current landslide inventory by acquiring more detailed digital surface models in local and regional scale. Landslide polygons can also guide the future creation of detailed landslide maps in local scale.

Using the new detailed inventory, we examine the exposure and vulnerability of critical infrastructure (built-up areas, critical facilities, major road networks etc) in the Prefecture of EMTH in order to assess the risk from landslides within the RiskAC framework. The landslide inventory can also assist the study and management of other natural hazards within the RiskAC projects, for example upstream sedimentation and flooding hazard of major rivers and their tributaries.

ACKNOWLEDGMENTS

We acknowledge support of this work by the project "Risk and Resilience Assessment Center – Prefecture of East Macedonia and Thrace -Greece." (MIS 5047293), implemented under the Action "Reinforcement of the Research and Innovation Infrastructure", funded by the Operational Programme "Competitiveness, Entrepreneurship and Innovation" (NSRF 2014-2020) and co-financed by Greece and the European Union (European Regional Development Fund).

Equake: A MODULE OF THE LocalPro PLATFORM FOR SEISMIC RISK ASSESSMENT AT LOCAL SCALE

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ABSTRACT

Natural disasters impact the world, generating massive losses in terms of lives and economic costs. To minimize risk and the effects of disasters, the development of applications and tools supporting decision-making for prevenetion, preparedness, response and recovery phase is crucial. The LocalPro project aims at developing a unified technological platform to manage and facilitate the operational processes of local authorities in Greece in civil protection for natural disasters (flash floods, wildfires and earthquakes). The specific module related to earthquakes, namely Equake, integrates seismic hazard and vulnerability for risk assessment. Herein, the methodology and architecture of the Equake module regarding the assessment of seismic hazard at regional scale, and the static earthquake hazard assessment in the LocalPro platform,are presented.

Keywords: earthquake, seismic hazard, ground motion prediction, warning notification, civil protection

1. INTRODUCTION

Every year, natural disasters impact the world, generating massive losses in terms of lives and economic costs. A recently punlished report reveals that preliminary economic losses from natural hazards totaled $32 billion during the first quarter of 2022 [1]. The recovery phase also requires substantial money investment for governments, in order to rebuild the affected region. To minimize risk and the effects of disasters, the development of applications and tools supporting decision-making for prevenetion, preparedness, response and recovery phase is crucial. In Greece, the first and second-degree local authorities of the country undertake important responsibilities in disaster management based on the recent Greek legislation on Civil Protection (Law No 4662/2020). Current practice follows conventional methods in operational plans and only limited efforts have been made to incorporate novel technologies and automated processes to implement preparedness and emergency activity planning at local and regional level. To this end, under the LocalPro project, a unified online platform is being developed to manage and facilitate the operational processes of Greek Municipal and Regional Authorities according to national legislation for civil protection. The project is funded by the “Innovation Investment Plans” Programme of Central Macedonia Region (NSRF 2014-2020) in Greece and involves the joined efforts of two Greek SMEs; namely OMIKRON Environmental Consultants SA and Techniki Anaptixi ATEBE in close collaboration with CERTH/ ITI and REDi Engineering Solutions. The design of the platform allows easy configuration with functions that can respectively facilitate the specific operational processes of local businesses, such as touristic and others for the management of natural disasters. The LocalPro online platform includes features to facilitate processes and actions horizontally such as direct communication, two-way information, reporting, and awareness as well as an early warning for the readiness and guidance of staff, crews, and residents through an interconnected smart mobile application. In addition, the platform is developed with a modular architecture and can be expanded with specialized tools, based on the latest scientific methods and solutions, for managing local risk from specific natural disasters such as wildfires, flash floods, and earthquakes. The basic parts of the system are the web application and the mobile application, which work supplementarily and the communication channel they create with each other is the main advantage of the product. Herein, the methodology and architecture of the Equake module regarding the assessment of seismic hazard at regional scale, and the static earthquake hazard assessment in the LocalPro platform,are presented.

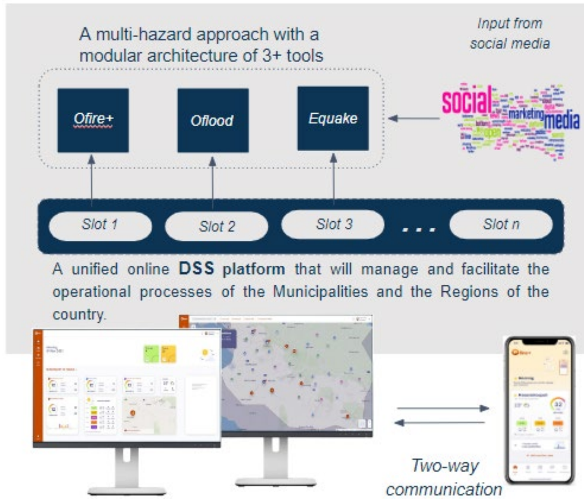


Figure 1. Modular architecture of LocalPro platform

2. METHODOLOGY FOR EARTHQUAKE HAZARD ASSESSMENT

In the framework of LocalPro, the seismic hazard for Central Macedonia is evaluated in the following two alternative ways and it is finally presented in a Geographical Information Systems (GIS) environment.

Initially, we evaluate the static seismic hazard for the study area, for specific seismic hazard scenarios with various return periods (e.g. 475, 975, and 2475 years, corresponding to exceedance probabilities of 10%, 5% and 2% at 50 years). The peak ground acceleration in rock conditions (PGA_{rock}) is taken from the available results of past European Research Projects and microzonation studies (www.efehr.org, [2]). The site conditions are taken into account through the appropriate aplification factors proposed in Eurocode 8 [3].

In order to apply the amplification factors, we should first categorize the study area into the soil categories of Eurocode 8, according to the shear wave velocity in the upper 30 m of the soil medium, $V_{s,30}$. For this purpose, the $V_{s,30}$ model of Wald and Allen, 2007 [4] is used, which has been derived from the correlation of $V_{s,30}$ with the topographic slope.

As far as the dynamic eaethaquake hazard is concerned, namely the hazard for a specific earthquake, we use appropriate ground motion prediction equations, GMPEs, proposed in literature for the Greek area [5, 6].

The steps of the two methodologies are descibed in sections 2.1 and 2.2.

2.1. Seismic hazard maps for selected return periods (static hazard)

The proposed methology for the evaluation of the static earthquake hazard, includes the following steps:

Step 1: For the study area, we select the appropriate seismic hazard scenarios through appropriate return periods (eg 475, 975, and 2475 years, corresponding to exceedance probabilities of 10%, 5%, and 2% in 50 years).

Step 2: For each seismic hazard scenario, we determine the peak ground acceleration in rock site conditions (PGA_{rock})
(for example one can use the ESHM20 included in EFEHR, http://www.efehr.org/start/).

Step 3: Categorize the area under study into the Eurocode 8 soil classes [3], which are based on the average shear wave velocity for the upper 30 m of the soil medium, $V_{s,30}$. For this purpose, the $V_{s,30}$ model of Wald and Allen, 2007 [4] can be used, which has been derived from the correlation of $V_{s,30}$ with topographic slope.

Step 4: The PGAs of the previous step are multiplied by an appropriate amplification factor, as provided by the current regulation, to take into account local soil conditions [3].

Step 5: The final output, which is the Peak Ground Acceleration on the ground surface can be depicted on appropriate hazard maps for the various return periods for the selected region.

2.2. Seismic hazard maps for a spesific earthquake (dynamic hazard)

The proposed methology for the evaluation of the dynamic earthquake hazard for a specific event, includes the following steps:

Step 1: Immediately after a seismic event, the magnitude M_L, as well as the location of the event in x,y coordinates, are available on the website of the Geodynamic Institute (https://www.gein.noa.gr/en/services-products/recent-seismicity/).

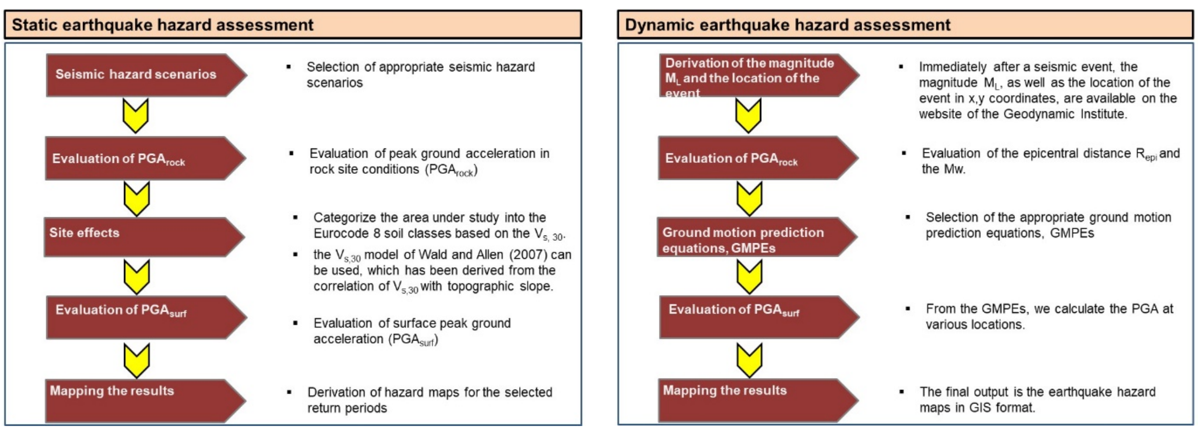
Step 2: Based on these data, we evauate the epicentral distance R_{epi} and M_w.

Step 3: Next, based on literature review, we select for the study area the appropriate ground motion prediction equations, GMPEs.

Step 4: From the GMPEs, we calculate the PGA at various locations.

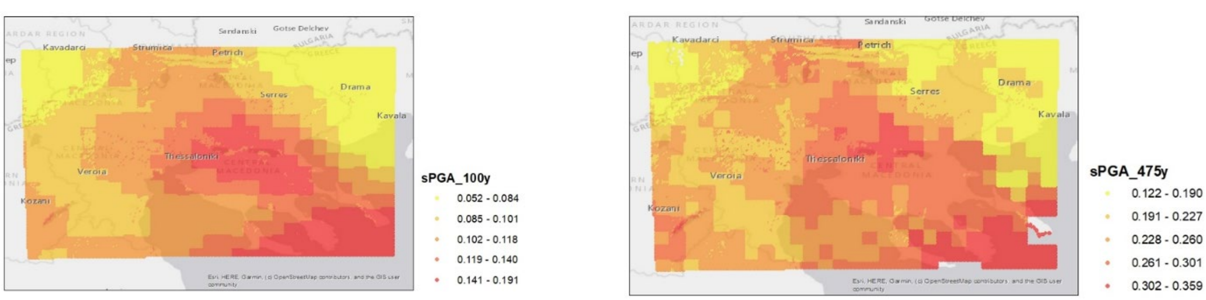
Step 5: The final output is depicted in GIS format.

Figure 2 shows the proposed framework for the assessment of both static and dynamic earthquake hazard, while Figure 3 presents the final static earthquake hazard maps for the region of Central Macedonia, Greece, for return periods equal to 100y, 475y, 975y, 2500y.



(a) (b)

Figure 2. Proposed framework for the assessment of a) static and b) dynamic earthquake hazard



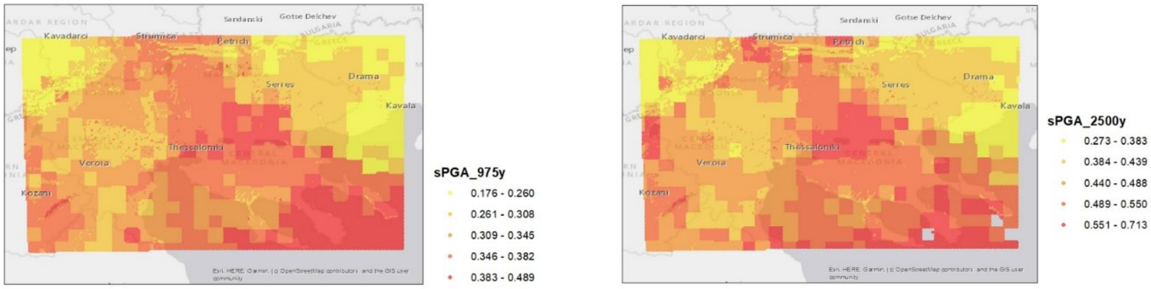


Figure 3 Static earthquake hazard for the region of Central Macedonia, Greece, for return periods equal to 100y, 475y, 975y, 2500y

CONCLUSIONS

LocalPro project aims at developing a unified technological platform to manage and facilitate the operational processes of the Municipalities and the Regions of Greece. The basic parts of the system are the web application and the mobile application, which work supplementarily and the communication channel they create with each other is the main advantage of the product. Herein, the methodology and architecture of the Equake module regarding the assessment of seismic hazard at regional scale, and the static earthquake hazard assessment in the LocalPro platform, are presented.

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The project is funded under the "Innovation Investment Plans" Programme of the Central Macedonia Region (NSRF 2014-2020) in Greece.

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MUNICIPAL WASTE LANDFILL [DUMP SITE] AT THIRA ISLAND (SANTORINI) - IMPACT ON ENVIRONMENT - ADMINISTRATIONS NEGLIGENCE TO SITUATE A LEGAL AND ENVIRONMENTALLY FRIENDLY RESIDUE MUNICIPAL WASTE LANDFILL (RMWL) – GREEK OMBUDSMAN INTERVENTION – PROPOSAL FOR LOCATING A RMWL ON THE ISLAND

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ABSTRACT
A significant number of dumb sites exist throughout the Greek territory due to municipalities reluctance to locate and construct legal Municipal Waste Landfills [MWLs] based on scientific research and Best Available Techniques (BATs). In addition, the incorrect siting of infrastructure projects [in this case RMWL], mandatory by the European Union (EU) as well as Greek legislation, very often lead to the cancellation of their implementation for legal and/or technical reasons. This results to serious impact on the environment – land – air - water resources – coastline & the sea, as well as economic sanctions on the country by the EU. The goal is to briefly present the: a) systematic and particularly problematic negligence of administrations over time, b) estimated impact of the Thira dump site operation on the environment and c) methodology used to investigate the optimization of sitting a residue MWL on Thera island or, if the conditions do not exist, to deduce possible locations to situate the landfill (zero solution). This case study for the siting is predominantly difficult due to "technical" (geomorphological, geotechnical, geological, hydrogeological, economic, archaeological, topographic, social, building - urban planning) legal issues and requirements. Also, rulings of the Greek Constitutional Court had to be assessed and considered in order to avoid legal complications [judicial involvement]. The problem of MW disposal in Santorini is one of the most exigent issues, especially during the summer season due to the sharp increase of tourists on the island. All of the above have also been recorded by the Greek Ombudsman [GO], quality of life "cycle", that is a constitutionally recognised Independent Authority which monitores and inspects the entire function of Greek Administration.
Key words: Illegal landfill, Administrations negligence, Greek Ombudsman, Impact on environment, Siting a RMWL

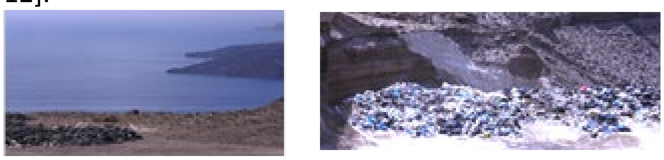
1. INTRODUCTION- GENERAL INFORMATION
The number of landfills that currently exist in Greece may be very different than the one that has been officially registered by the competent Ministry [1, 2, 3, 4, 5]. In several Municipalities, there are sites with large or small uncontrolled waste dumps, not been officially registered, restored & remediated. The rehabilitation procedures are not activated, unless there is a relevant complaint (at the GO and/or other environmental protection authorities etc.). In order to "terminate" the operation of a HADA (Uncontrolled Waste Disposal Area – Dump site) where systematic waste disposal is still taking place, the first step is to create a suitable legally located & properly constructed MWL. It is assessed that waste management policies in the country have overall failed. In addition, central and local administration, must significantly accelerate its interventions in order for Greece to make up for lost time and to reach, if not achieve, common European

goals, even with considerable delay. Some reasons for not solving the problem of environmentally friendly waste management are considered, among others, the following: • Lack of national spatial planning determining the land uses and the reception areas of the necessary infrastructure projects, thus solving the problem of the location of the processing and final disposal areas and the frictions that it creates.• Complex legal framework, which sought to transpose the relevant European directives into national law without success. The previous legislation provided for a number of stakeholders, divergence of responsibilities, and the possibility of drawing up the plan by various bodies, multiple opinions of collective bodies of the administration and so on.• Delay in approving a national solid waste management plan and the completion of the regulatory framework concerning the alternative management of packaging and other products with the issuance of all the foreseen acts.• Systematic abstention of the administration to impose the provided criminal and administrative sanctions for pollution even in cases where the identified problem of uncontrolled waste disposal.• Inability - negligence of administration and involved parties to follow “unbiased” decision methods for legally siting a facility and constructing it in accordance to BATs, to protect environment and convince citizens for absence & restriction of possible impacts [1, 2, 3, 4, 5]. In Santorini there is a serious problem of all kinds of uncontrolled waste dumping in the Caldera systematically used since 2008. A significant amount of waste dumped at the specific location ends up in the Caldera, which is a volcanic geotope of global interest [1, 4, 8, 9]. The GO [6, 7, 10] consists of six “cycles”: a) Human Rights, b) Social Protection, c) Quality of Life and d) State–Citizen Relations e) Childrens Rights and f) Equal Treatment. Via recent legislation it is the National Mechanicm for the Investigation of Arbitary Incidents. The GO Authority’s Head is assisted by six deputies. The submitted citizen’s requests (cases) are initially examined to verify if they fall within the GO’s juristiction, based on relative legislation provisions. If the cases can be examined and “founded”, a preliminary investigation is conducted. It is evaluated if there are maladministration acts, “bad administrative practices” or legislation violations by the public services - authorities. The Authority makes recommendations and proposals to all levels of the public administration. Furthermore, findings, conclusions, annual and special reports of the Authority are submitted to the Greek Prime Minister, the parliaments President, competend ministries, parliementary committies and goverment bodies, in order for new policies and good practices to be instituted. A significant ammount of the proposals and recommendations are accepted by administration thus resolving citizens requests (approximately 85% the of cases, within its juristiction, are resolved). It is noticed that the GO does not impose sanctions or annul public administrations illegal actions. Its aim is to convince administration to act legally and within the good practices framework. All public services have an obligation to facilitate the investigation in every possible way. Non-cooperation during an investigation by a public service (or public servant) may be the subject of a special report from the GO to his/her supervisor or the competent Minister and a disciplinary action may be taken. The GO has consistently dealt with MW handling issues, as well as the MWH in Santorini [1,2,3,4,5,7] and has issued numerous reports about maladministration and environmental impact.

2. SANTORINI’S LANDFILL & ENVIRONMENTAL POLLUTION

a. In the existing landfill at “Alonaki”, located within the Caldera old mines (an environmental and archaeological high protection area) garbage trucks empty all kinds of trash, without any control [1, 4, 5, 8, 9, 14]. The waste is buried with no provisions, which is an illegal practice based on the European directives & National legislation and is subject to substantial fines. The landfill receives tons of waste per month, in an area that is completely unsuitable, without any protective measures (ground sealing, waste drainage processing etc.). As a result, soil, water resources and sea areas are contaminated even through leaks of waste liquids. The island’s strong winds inevitably cause the dispersal of materials dumped in the area. Plastic bags and other light material end up in the vineyards and in the sea area of the caldera, just below. With a westerly wind, the stench is spread to the village of Fira, where many hotels are located. This imposes public health risks both to the residents and tourists in the area. Illegal dumping of waste and construction materials (rubble) also takes place in inaccessible areas of the Caldera or in streams and fields, such as the complex of

“Vlychada” gorges. Every guest or tourist who will visit the Caldera by sea, to admire this unique geotope, will clearly see that in the "Alonaki" location there is a landfill which is visible from all sides of the island and extends even in the sea. It appears that there is a leak of garbage directly into the sea, something that should concern the Municipality and the inspection authorities. A team of divers, in the summer of 2020 [13], during exploration of the marine area, estimated that the submarine waste dispersion reaches a depth of 70-80 meters (the divers reached up to 43 meters and then a robotic submarine was used). A huge number of “garbage reefs” were observed which start from a depth of 20-25 meters and reach a perimeter of 100 meters. According to posts, *"... there is scattered garbage even after 70-80 meters depth, which are obviously released from the sea currents and transported".* The problems and the need for immediate intervention by the competent authorities are obvious. The closure of the dump site [HADA] is imperative. Theoretically, the uncontrolled landfill area restoration has been initiated, with state funding within a specific implementation schedule. The Municipality of Thira announced the final inclusion of the landfill restoration project with a budget of 4,023,000.00 euros. According to reports, the Municipality started the expropriation process [11, 12].



Photos 1: The waste disposal site and the view towards the Caldera

Photos 2: Waste disposal site from the sea & a waste path to the sea.

b. The Municipality, via a study, designated, some years ago, the “Metaxa” mines as the new place for waste management. However, the process of selecting the site suffers procedurally and scientifically. It seems that the implementation of the project was not possible since the relevant decisions were challenged in the constitutional court [StE], it does not have the citizens’ support and was finally abandoned. The topic of dump sites restoration, the creation of proper RMWL and ultimately the suitable management of waste is not basically a planning issue, but the municipal, prefectural and state authorities’ willpower to apply legislation and scientific knowledge in the best way and with “unbiased & clear” decisions. After the "theoretical" closure of the existing dump site, the solution for waste management in the island [transitional period?] that is selected by the municipality, is the creation of a disposal waste site in a vineyard on the main road of Fira, next to the existing landfill. In this area it is planned to process 20 to 30,000 tons of mixed waste per year. Legislation dictates that the transitional period can last two years with the possibility of extension for another year [11, 12]. According to the Municipal Authority, the final location of the waste has not been selected and/or decided. **c.** Regarding the location of the Integrated RMWL it seems that the municipality’s choice is to proceed with a PPP (Public-Private Partnership) scheme. According to publications, the company that will be selected to carry out the project, will propose the location [!] which will then be approved by the Municipal Authority and competed agencies [the whole idea is procedurally irregular and scientifically deniable].

Photo 3: Existing dump site

Photo 4: «transitional» waste management site

In addition, the location chosen by the Municipal Authority for the interim solution – transitional period appears to be inappropriate, among other things, for the following reasons: a) The area is in public view, b) there is a large supermarket across the area, c) it is near businesses and hotels d) it is next to the existing dumb site and e) mainly it is within the protected area of the caldera. It is also located on the main transportation axis of the island, at the entry point to the city of Fira for all visitors coming from the port and a promenade all year round overlooking the volcano and the caldera.

3. METHODOLOGY FOR LOCATING A NEW RWRL - RESULTS

The utilized methodology in Santorini to locate a new site to construct the RMSW is the Method of *"Gradually Excluding Locations and selecting the relatively optimal one"* [4,5,10]. Geographic Information Systems (ArcGIS) are used to construct necessary maps. In this method, general criteria that define the location and construction of an activity, such as scientific, technical, legislative and jurisprudential data, are extensively studied. Areas and locations are excluded, so that the investigated locations are gradually reduced hence only one is left at end. As many criteria as possible are recorded on maps, to make the selection process easier (creation of thematic maps, which each one depicts each exclusion criterion separately). Then all the maps are merged into one final map. When all the layers are "displayed" at the same time, the final map "appears" which shows all the constraints at the same time. The study shows that there is no landfill location with all ultimate required standards. If financing criteria are slightly "bended" a location for siting the residue landfill may be found. An exception should be made due to current circumstances and restrictive standards must be applied. Inactive "Profiti Elia" mine is a rather difficult choice to situate the RMWL. could be utilized only with significant adjustments.

According to the study's results the wider vicinity of Kambia area in Akrotiri, might be a possible location. In this position, and if there is proper sorting and recycling, the possibility of economic recovery of waste could be weighed. The provisions also give the possibility, if technically feasible [not so easy], to construct a waste energy recovery area in accordance with Greek Legislation and standards. Additional studies must be performed to precisely locate the area to be used and its extension [acreage & availability].

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FIRE-IN: THE EU FIRE AND RESCUE INNOVATION NETWORK

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ABSTRACT
The FIRE-IN project is an initiative funded by the European Commission and has been launched on the 1st of May 2017. FIRE-IN established and supports a pan-European network of practitioners, industry and research with its main objective being of raising the security level of the EU citizens by improving the national and European Fire and Rescue capability development process. This study presents briefly the third and final cycle results of the project, in terms of practitioners' challenges and request for ideas and latest trends in five thematic working groups: (a) Search and Rescue and Emergency Response, (b) Structure Fires, (c) Landscape Fires, (d) Natural Hazard Mitigation, and (e) CBRNE. FIRE-IN addresses the concern that capability driven research and innovation in this area needs much more guidance from practitioners and better exploitation of the technology potentially available for the discipline. In addition, the project has launched a technological platform in which, various types of solutions, from best practices to market ready technological products are uploaded by practitioners and suppliers. FIRE-IN e-platform provides a fast way to practitioners to identify solutions that could help them in their daily operations and overcome specific challenges.

Keywords: civil protection, first responders, practitioners, research, innovation

1. INTRODUCTION – OBJECTIVE

FIRE-IN (https://www.fire-in.eu/) is an EU Horizon 2020 funded project consisting of 15 partners, 8 countries and more than 1000 experts. The main objective of FIRE-IN is to improve the national and European Fire & Rescue (F&R) capability development process by fostering innovation in this field and promoting innovative solutions to recognised operational needs. This may significantly reduce residual risks and raise the security level of EU citizens. Further, there is a need to develop a common research culture that is to be achieved by better cooperation between practitioner and research and industry organisations. The project addresses these objectives through four main areas of activity: (i) the identification and harmonisation of operational capability gaps based on the contribution provided by a significant and heterogeneous practitioner network, (ii) the identification of promising solutions to address those gaps through monitoring and screening of research outcomes and the continuous involvement of research and industry representatives, (iii) the definition of a F&R Strategic Research and Standardisation Agenda (SRSA) based on the previous elements as well as (iv) the development of a concept for more efficient use of test and demonstration and training facilities to support innovation and joint skill development.
FIRE-IN focuses on five thematic topics, the Thematic Working Groups (TWG) which are: (a) (a) Search and Rescue and Emergency Response, (b) Structure Fires, (c) Landscape Fires, (d) Natural Hazard Mitigation, and (e) CBRNE. Moreover, FIRE-IN has developed a web platform the e-FIRE-IN platform which hosts numerous solutions, of various types, that address the daily challenges of practitioners. The e-FIRE-IN platform is freely accessible through a simple registration and also supports the network of practitioners, researchers and industry.

Currently, the project is at its third cycle and towards its end. This study presented briefly the third cycle of common and future capability challenges, the traffic light system, a method for classifying solutions and the level of coverage of the current and future challenges.

2. METHODOLOGY

The methodological approach of FIRE-IN is briefly presented in the following sections, from the identification of challenges to the request for ideas and developemnt of research and standardization agenda. To ensure proper taxonomy, workflow and coherence between the five TWGs a common methodology has been followed.

2.1. Identification of Common and Future Capability Challenges

The methodological framework is based on the ACRIMAS taxonomy and framework [1] where operational, supporting and preparatory tasks during crisis management are identified. Questionanires for each TWG were prepared in order to point the key interest areas, potential scenarios and networks [2]. Then, a workshop for each TWG was carried out based on one or more scenarios for each cycle, thus leading to the identification of the challenges through a discussion among the experts following the prescribed scenario. The third cycle, focused on the future capability challenges and a low probability – high impact scenario for all TWGs.

2.2. Screening of solutions

The second phase is the review of solutions that can address the identified capability challenges. The solutions are mainly of three types: research items such as scientific papers, technological solutions that are available in the market or are the result of a research project or a standardization item, meaning an existing practice, an international guideline or an well established best practice of practitioners. The solutions are classified according to the identified challenges.

2.3. Traffic light system and the Request for Ideas process

The Request for Ideas is an interaction process between practitioners, researchers and industry, based on the screening of the solutions of the previous step. This process tries to identify the most useful results and practically to check which challenges have been already covered or not, and consequently which challenges are the ones that will be covered in the future.

One the main tools for this process is the traffic light system [3], a simple classification schema that considers specific criteria based on the type of the solution and provides a color for the challenge based on the results. The criteria checked are: the operational value of the solution, the access to knowledge, the solution maturity (technology readiness level) and the interoperability and standardization compatibility of the solution.

For third cycle of Request for Ideas the following actions were taken in order to boost the interaction between practitioners, researchers and industry [4]:

- two online questionnaires, one for practitioners and one for technology providers, were developed and distributed examining issues on the use of technology and standardization,
- organization of an online workshop that took place on 8th of January 2022 due to the situation with COVID-19 in relation with another similar project, the MEDEA project,

- discussions in the form of interviews with technology providers and,
- dissemination of the workshop through social media.

2.4. Strategic Research and Standardisation Agenda

Strategic Research and Standardisation Agenda is the last step that closes the loop of each FIRE-IN cycle. Results of FIRE-IN, from the identified challenges, the screenced solutions and the level of coverage of each challenge and the feedback from the request for ideas process, are transformed to an agenda that will provide input to the European Research Programming and the basic of the future policies in the security domain at EU level.

3. RESULTS AND DISCUSSION

In the first cycle, the identified Common Capability Challenges (CCCs) were 27, while in the second cycle findings were updated and the gaps and challeges prioritized into 12 Prioritized Commom Capability Challenges (PCCCs), which were the top challenges from the first cycle. In the third cycle, 24 challenges, 14 CCCs identified and new 10 Future CCCs. In Figure 1, the matrix of the third cycle of CCCs and FCCCs along with the level of coverage of each CCC/FCCC based on the traffic light system is presented [4].

A general outcome is that standardization addresses all capability challenges in a great extent without this implying that there is no need for new standards. Technological advancements are capable to cover many existing CCCs and FCCCs. “Incident Command Organization” capability is well covered by technology, standards (especially technical ones) and research. “Community Involvement” is also well covered in terms of research and technology. In addition, many standards exist that addressing these challenges. The “Knowledge Cycle” capability lacks of research items in terms of projects mainly, but this is afiled with an advancement for the future. This does not mean that there is not any knowledge, but more that this knowlegde is not well known and is more “closed” and has not yet been diffused. Capabilities of “Risk Reduction” and “Preparedness” are the ones that will be the ones with the highest interest for the future [4].

From the point of view of the Request for Ideas the following key points are the ones that we must focus on the future [4]:

- Data, data quality and proper sharing of the information
- Openness in data, data formats and source codes
- Experience and training help to take the right decisions and filter the information
- Isolation or fragmentation of technologies
- Conservatism of practitioners to use new technologies
- Risk awareness
- Interoperability and standardization with an increase in the use of standards

4. CONCLUSIONS

FIRE-IN has managed to create a large pan-European network of practitioners, researchers and industry, provide key technologies in one point accessible easily by practitioners, identify the main problems of practitioners, identify the areas that are covered and provide key interest points for the future. Currently, towards the end of the project the final Strategic Research and Standardisation Agenda is being prepared and efforts to sustain the network are being made.

	High flow of effort in hostile environment (HF)	High Impact, Low Frequency (HILOF)	Multiagency / Multileadership (ML)	High level of uncertainty (UN)
Incident Command Organization	CCC-1. Organize to sustain safe operations	CCC-2. Anticipate and prioritize avoiding the collapse of the emergency system	CCC-3. Build interoperability for a distributed decision-making based on a shared understanding of the emergency	FCCC-4. Strategic management focused on proactively reducing sources of uncertainty and building robustness and resiliency.
	T	T	T	T
	R	R	R	R
	S	S	S	S
Community involvement	CCC-5. Develop public self-protection and awareness	CCC-6. Involve communities and key stakeholders as active actors in risk management	FCCC-7. Negotiate the values with communities before the emergency	FCCC-8. Cultural change towards risk tolerance and resilience.
	T	T	T	T
	R	R	R	R
	S	S	S	S
Knowledge Cycle	CCC-9. Train specific roles and risks and invest in a robust knowledge cycle	FCCC-10. FRS empowered to innovate and build organizational learning	CCC-11. Build a shared understanding of the emergency, and train interagency scenarios	FCCC-12. Focus on capacity building towards more resilient societies
	T	T	T	T
	R	R	R	R
	S	S	S	S
Decision Making Cycle	CCC-13. Make operational decisions based on building an understanding of the emergency and its evolution	CCC-14. Choose a strategical scenario of resolution, and distribute tactical decision-making	CCC-15. Build a shared understanding of the scenario to synchronize decision-making	FCCC-16. Create certainty and shared vision of emergencies.
	T	T	T	T
	R	R	R	R
	S	S	S	S
Risk reduction	CCC-17. Focus encouraging self-capacities and safety	CCC-18. Negotiate solutions with stake holders for anticipated scenarios	FCCC-19. Integrate risk prevention and safety into other policies and actors	FCCC-20. Focus on governance and integral risk management.
	T	T	T	T
	R	R	R	R
	S	S	S	S
Preparedness	CCC-21. Pre-plan a time-efficient, safe response, minimizing responder's engagement	CCC-22. Plan in a more integral way	FCCC-23. Pre-plan interoperability and enhance synergies	FCCC-24. Focus on governance and integral risk management.
	T	T	T	T
	R	R	R	R
	S	S	S	S

Figure 1. The FIRE-IN third cycle of CCCs and FCCCs along with the level of coverage of each CCC/FCCC [4]. T refers to technology, R to research and S to standards.

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EMERGENCY RESPONSE PLANNING: EFFICIENCY THROUGH STANDARDISATION

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ABSTRACT

Nowadays, emergency response planning across the E.U. is regulated by national legislation and internal organizational procedures of the involved public services. Although the relative plans and procedures have several commonalities, they are not fully aligned, affecting interoperability in multiple ways. In cross-border crises, approaches may cause confusion or conflict among co-responsible first responders and civil protection agencies, introducing a significant overhead in terms of interoperability. Notably, in the case of large-scale crises, when numerous organizations need to be involved and cooperate, or in the case of cross-border incidents where international cooperation is required, lack of standardization may jeopardize the efficiency and effectiveness of the operations and sub-optimize the use of the resources. Acknowledging the above, the envisaged CEN Workshop Agreement (CWA) on "Structuring an emergency response plan for crisis management stakeholders" aims to reach an agreement with regards to a basis concerning the generic structure and content of the response plans whereby response provisions of the various stakeholders will fit in a homogenous synthesis with a positive impact on the underlying decision-making. Being an iterative process, elaborating the specific CWA leverages end-users expertise and is gradually validated through table-top and full-scale exercises towards achieving its objectives.

Keywords: CWA, standardization, response planning, interoperability,

1. INTRODUCTION

Diversity in response planning approaches followed by different crisis management stakeholders at a national level or across the EU increases the complexity overhead when it comes to (among others) exchanging operational information for optimizing coordination and interoperability. Effective crisis management and response requiring efficient coordination relies on information sharing to ensure the envisaged level of interoperability. In this respect, harmonizing approach that first responders and, in general, crisis management stakeholders plan their response greatly facilitates this sharing of information and interoperability across organizational, semantic, and technical levels. Provided the above, developing a typical structure of the emergency response plans, standardized procedures, and creating interfaces across the EU is thus essential for facilitating cross-border and multi-agency collaboration, helping protect assets and save lives. Provided the above, the EU-funded research project STRATEGY (https://strategy-project.eu), following investigation of the respective standardization universe and considering the relevant gaps as identified and prioritized against the needs of end-users,

has highlighted the opportunity to establish a coherent manner for end-users to base the response planning across a broad spectrum of disaster management activities.
In this respect, the CWA above led by Satways Ltd (privately held organization primarily targeted developing integrated geospatial command and control solutions for Security and Public Safety applications for police, coast guard, emergency medical service, civil protection, fire & rescue operations, critical public infrastructure protection, transportation security, and border monitoring. Organization Website: https://www.satways.net/) proposes a harmonized approach for crisis management stakeholders targeting public safety agencies, to elaborate emergency response plans based on a standard core structure to be further adapted to specific hazard types as per relevant guidelines also provided as part of the CWA.

2. STANDARDIZATION APPROACH

2.1. Selection of (pre-)standardization item

As part of its preparatory work towards the selection of work items to be promoted for pre-standardization, the STRATEGY project conducted a gap analysis across 8 thematic areas in crisis management (referred to as "streams) [1], considering the needs of practitioners as well as and existing related standards. In this respect, as far as response planning is concerned, 8 gaps were primarily identified and subsequently prioritized against the operational views of end-users, leading to the selection of 2 gaps for (pre-) standardization [2]. These referred to standards for facilitating interoperability between organizations as well as standards for tools regarding the management of resources. In this context, establishing a homogenous approach in response planning among co-responsible stakeholders (from the perspective of response plan documents) has been acknowledged as necessary for enhancing interoperability and improving the efficiency of the overall response through (among others) ensuring the availability of a common basis for exchanging critical information before, during, and after a crisis. Provided the above, the proposed *CWA on "Structuring an emergency response plan for crisis management stakeholders"* is a document that targets the (pre-)standardization of the structure/content of the response plans of stakeholders and does not introduce any technical solution that could leverage on the outcomes of this standardization activity.

2.2. Methodology

As per [3], *"CEN Workshop Agreements (commonly abbreviated CWA) are a reference document from the European Committee for Standardization* (CEN)." A CWA is a CEN/CENELEC deliverable, developed by a Workshop, which reflects an agreement between identified individuals and organizations responsible for its contents, and which is made available by CEN/CENELEC in at least one of the official languages. A CWA may take various forms such as text file or computer code and is developed and agreed by the participants in a temporary working group (CEN/CENELEC Workshop). It is designed to meet an immediate need, can be quickly developed and can be used as fast track to future standardization activities. From this perspective, the direct participation of interested parties, the possibility to indicate the participants and their organizations in the foreword and the rapid development process offered by a CWA, are particularly attractive for European research and innovation projects, which have to deliver results within the limited duration of their project lifetimes.

According to the CEN procedure thoroughly described in [3], upon approval of the relevant proposal/project plan by CEN, a workshop is established and it assumes the task of delivering the technical work envisaged by the CWA. In context of the CWA in discussion, the respective CEN Workshop was established and held its kick-off meeting remotely on the 27th of January 2022. Its composition encompasses various stakeholders, such as researchers, first responders, and industry, and is expected to have reached an outcome by the summer of 2023.

2.3. CWA Objective

The objective of the CWA in discussion is to propose and ultimately agree on the generic structure of a response plan to be considered by crisis management stakeholders across the EU to use as a basis for producing response plans as per the specificities of their operational mandate. Hence the scope is to pre-standardize the minimum and most important sections/subsections necessary to exist in such a document to ensure a coherent form and availability of operational information for enhancing interoperability (through information exchange) and efficiency of the response.

Provided the above, the proposed structure considers 10 primary sections that (besides the introduction) cover main operational domains. These include provisions for (a) Scope and Security Environment, (b) Plan Activation, (c) Command, Control, Communication, and Coordination, (e) Intelligence / Information management, (f) Administrative, Budgeting, and Logistics topics, (g) Liaisons network – interoperability, (h) International cooperation – assistance, (i) Training and Exercises as well as (j) Evaluation. For each of the sections above (including any subsections), specific guidelines to end-users are being provided regarding the expected content.

2.4 Validation Methodology - Exercises

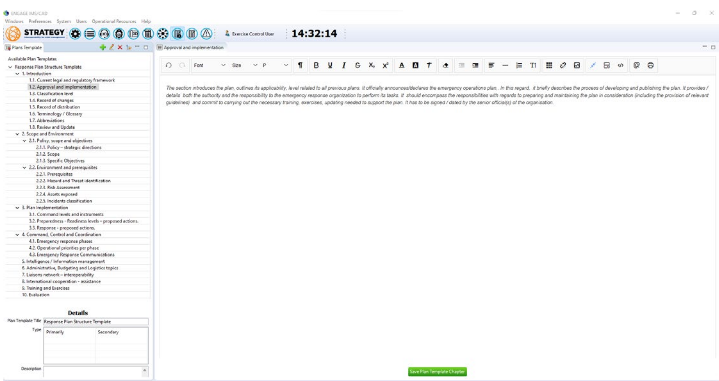
In the context of the STRATEGY project, the elaboration of the CWAs foreseen as part of the project (11 in total in addition to 2 Technical Specification Documents) entails a validation methodology for gradually evaluating/assessing the intermediate and pre-final results - thus ensuring their exploitation potential by the end-users (practitioners) they aim to support. In this respect, a series of tabletop exercises (TTXs) and a full-scale exercise (FSX) have been planned for collecting feedback through a realistic set of scenarios/use cases, to be later fed back to finetune and enhance the documents.

Provided the above, on the 9th of June 2022, the CWA on “Structuring an Emergency Response Plan for Crisis Management Stakeholders” was evaluated in a dedicated tabletop exercise hosted by the Hellenic Police Headquarters in Athens, Greece. The event was attended by 51 participants from 9 countries (Greece, Germany, Italy, Portugal, Romania, USA, Norway, UK, and Spain) representing numerous end-user organizations (including Fire Service, Police, Coast Guard, Emergency Services, Military as well as Critical Infrastructure Operators). Indicative instances from the event are provided in Figure 1 below. During the exercise in discussion, the players were divided into groups corresponding to the stakeholder's operational mandate (e.g., Police, Fire Service, Emergency Services, etc.) and provided the indicated template of an emergency response plan as considered by the CEN Workshop so far. The exercise was facilitated by an operational scenario unfolding in 5 distinct phases targeting interoperability demands addressed by the envisaged CWA. During each step, a storyline was narrated, setting the operating context for discussing the respective part of the considered response plan template.

3. CONCLUSIONS

The CEN Workshop in discussion has proceeded to the elaboration of a generic response plan template that is (upon hazard-specific parameterization) applicable across many types of hazards and may be adapted by different stakeholders within crisis management for elaborating their own response plans. The template consists of 10 main clauses referring to the core document structure (Table of Contents) that are further analysed to best reflect the necessary operational provisions.

Feedback collection as part of the tabletop exercise, has primarily confirmed the completeness of the proposed response plan template and its expected benefits, highlighting in some cases further finetuning requirements that will be considered for the pre-final version of the document to be subsequently validated in a Full-Scale Exercise (to be physically Organized in Spring 2023).



(a)

(b)

Figure 1. (**a**) Left: instance from the digitized version of the response plan template discussed through the tabletop exercise; (**b**) Right: A photo from the tabletop exercise held on the 9th of June 2022;

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EMERGENCY MANAGEMENT - EXCHANGING OF BUILDING AND INFRASTRUCTURE DAMAGE INFORMATION

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ABSTRACT
Past natural disasters have pointed to the significance of a rapid and reliable damage assessment to face short-term emergency response. Therefore, disseminating building and infrastructure damage information is essential for public services and practitioners to make timely and informed decisions following a disaster. The envisaged CEN Workshop Agreement on "Exchanging of building and infrastructure damage information with Common Alerting Protocol" aims to specify a protocol that will cover the communication of the status of buildings and infrastructures, after a natural disaster, in the form of an alert. The related results/alerts will be communicated to the command-and-control centres of the agencies that manage the emergency. This activity aims to specification an existing communication standard for exchanging damage information, in the form of an alert, of buildings and infrastructures, based on the Common Alerting Protocol (CAP). The proposed pre-standard will be tested and validated in the frame of a tabletop exercise and a full-scale exercise to demonstrate the standardization item in a natural environment and different scenarios.

1. INTRODUCTION

The accurate and quick acquisition of information about damaged buildings after hazardous events (i.e., earthquakes, tsunamis, floods, etc.) is essential to provide technical support and help in decision-making and fast response following a disaster. Usually, emergency inspections should start within hours after the disaster to identify the buildings that require urgent support to avoid collapse. Furthermore, some intervention is usually necessary to eliminate possible casualties due to indirect damages. However, in critical infrastructures (such as dikes and bridges), the assessment of the damages should be calculated rapidly, just a few seconds after the event or even before the actual disaster reaches the infrastructure (in case an early warning system is available). In such cases, the rapid assessment of the damages could be crucial to avoid any large-scale incident with severe damages in a large geographical area and affected people (e.g., the crack on a dike could cause the flooding of a large geographical area or a break on the tanks of a refinery that could cause a toxic cloud).
New technologies and methods can help in providing rapid damage assessment results, allowing a clearer view of how to prioritize the interventions. Several studies and experiments have been conducted, especially concerning earthquake-induced damages [1]. The common principle of all these studies is that early warning systems, sensor components, and rapid damage assessment tools could be combined to calculate the possible damage rapidly and on time (helpful to the first responders). The calculated results should be forwarded to the command-and-control systems of the first responders, alarming them about the situation and providing helpful information for the decision-making process.
The information exchanged among the various systems (such as early warning systems, sensors, and assessment tools) cannot be standardized as it contains specific (to each case) scientific data. However,

disseminating the calculated results to the command-and-control systems of several authorities could follow a common format based on the EDXL-CAP standard.
EDXL is a well-known suite of standards adopted by several command-and-control systems to exchange emergency data. For the EDXL-CAP standard, some enhancements are required to facilitate the sharing of the alerts and the related damage results.
Hence, a formalized way to describe the damages is needed, aiming to optimize the efficiency and effectiveness of the public safety agencies. This need is partially related to the operational requirement to share information on disaster damages among many public services involved in mitigation, response, and recovery activities. As such, the STRATEGY project decided to initiate a CEN Workshop Agreement (CWA) based on methodologies to monitor accurately and quickly the status/damages of buildings and/or infrastructure used by the safety agencies and the security officers of entities following a disaster. In addition, guidelines and protocols will be developed, formalizing how the information on the damage can be commonly shared.

2. STANDARDIZATION OPPORTUNITY

2.1. Building on the Standardisation landscape: Gaps and Opportunities

STRATEGY identified potential standardization gaps and opportunities that could facilitate the pre-standardisation process within the crisis management area of "Early Warning – Rapid Damage Assessment" (EW-RDA). End-users needs and requirements from past and ongoing projects, existing standards related to EW-RDA, opportunities that could be used in the pre-standardisation process of STRATEGY, and a list of standardisation gaps have been analyzed and prioritized. As a result, seven standardisation gaps were identified for EW-RDA, addressing both technical and procedural interoperability.
An online survey was created to collect feedback on the gaps considered more relevant by experts and end-users to evaluate the identified gaps. The participants were asked to express their opinions on the relevance and importance of each standardisation gap based on their knowledge and expertise. Additionally, several bilateral remote meetings were organized with the project's end-users and technology providers to discuss the standardisation gaps; verify the technical solutions available and identify the most relevant standardisation opportunities for EW-RDA.
As part of that process, it has been highlighted that the Rapid Damage Assessment (RDA) has less global attention and a lack of standardisation, compared with the Early Warning (EW) systems sector. The standardisation opportunity identified for the RDA is related to the enhancement of the EDXL-CAP [2] standard to include information regarding damage to buildings/infrastructure and associated alerts, estimated by RDA, sensors, and early warning systems.
Appropriate and comprehensive alerting is complicated by the wide variety of command-and-control (C2) centers and incident management systems (IMS). In addition, some alerts are specific to a particular type of hazard, such as an earthquake or typhoon, or a specific kind of alert, such as a siren or television announcement. CAP is compatible with all kinds of public alerting information systems, enabling the provider to communicate alerts to targeted users [3].

2.2. Proposed CWA: Scope and Objective

CAP is a digital format for exchanging emergency alerts that allows a consistent alert message to be disseminated simultaneously over many different communication systems. It provides a "standard business form" for alerting, designed for any media, to communicate information about any kind of hazard situation. However, damage assessment is not addressed in the current version of CAP. Thereby, using an enhanced version of the EDXL-CAP standard would be beneficial for improving public alerting in situations of potential damage. Regardless of the type of hazard situation, the authorities should have the information needed to make timely, accurate, and informed decisions following a disaster and warn people at risk, using all available communications media.

The CEN workshop entitled "Exchanging of building and infrastructure damage information with Common Alerting Protocol" has resulted from the STRATEGY project, and its purpose is to specify a protocol that aims to cover the dissemination of the status of buildings, after a natural disaster, in the form of an alert. The related results/alerts will be communicated to the command-and-control centers of the agencies that manage the emergency or are involved in (meaning that information is shared with them) the crisis. It has been identified that the information about the damage to buildings/infrastructure and the related alerts should follow a standard format to enable an easy and effective report to the control systems of the authorities.

The planned CWA is intended to be used to support the actions of the operators/security officers of the critical infrastructures that will be monitored for damages and the officers of the authorities that should be informed about a damaged building to coordinate the response activities, and the Command-and-Control system manufacturers and developers.

The proposed protocol will be independent of the methodology used to assess the building's damage grade. As illustrated in Figure 1, the CWA is planned to provide a structure that will be used to share information generated by damage assessment components integrated with the CAP alert message. Guidelines and protocols will be developed, formalizing how the information on the damage can be commonly shared. An enhanced CAP profile is proposed with the respective CWA considering using customized parameters and defining new attributes (using the generic "parameter" attributes of the CAP) to host the damage building information. These attributes, the so-called "Descriptors for the CAP," cover the following categories:

- Building and infrastructure descriptors
- Damage descriptors
- Assessment descriptors

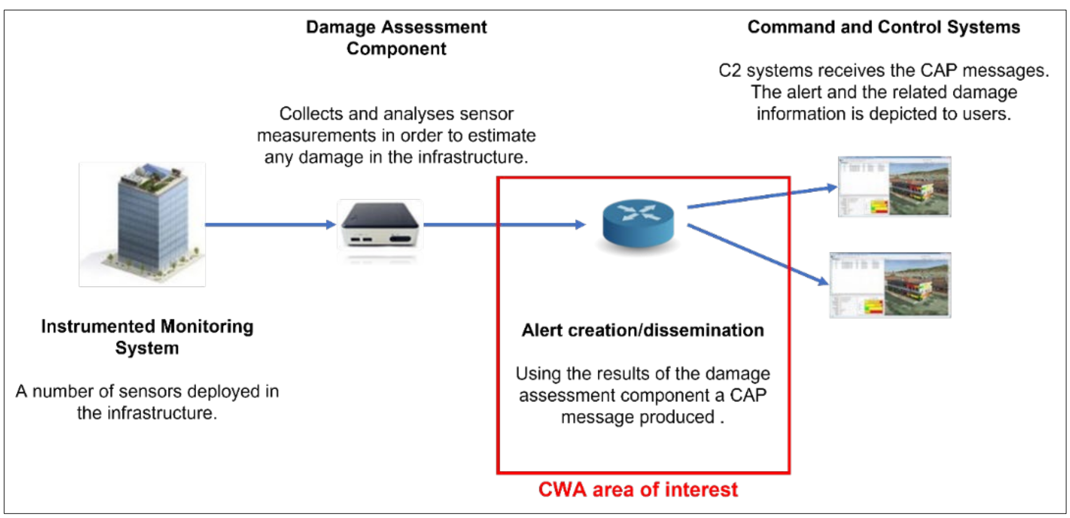

Figure 1: CWA area of interest in an indicative process of instrumented RDA

2.3. Evaluation of the proposed CWA via Tabletop Exercise

The CWA on "Exchanging of building and infrastructure damage information with Common Alerting Protocol" was tested and evaluated through a dedicated TTX, hosted by Safety Region IJsselland in Zwolle (Netherlands) on the 7th of July,2022. The TTX was organized as a demonstration of the proposed methodological approach of the CWA in the discussion, which was assisted by a technical solution when applicable and necessary. It was based on escalating scenarios, with the occurrence of a combination of incidents from the spectrum of natural hazards (i.e., flood and fire incidents).
During the TTX, the participants were informed of the proposed approach, and discussions on the envisaged communication format template were conducted. The scenario was unfolded in 2 distinct phases, which targeted specific aspects of the proposed communication protocol addressed by the CWA. The stakeholders involved as practitioners provided feedback on the proposed approach and the newly identified descriptors that should be included in the CWA. Moreover, 2 individual questionnaires have been circulated to the participants to collect data to be later used for a) validating and evaluating the intermediate results produced in the context of the CWA and (b) the tabletop exercise itself.

3. CONCLUSIONS

The envisaged CWA in discussion will be based on methodologies to monitor accurately and quickly the status/damages of the buildings/infrastructure. Furthermore, it aims to standardise a formalized way to describe and communicate the information deriving from a damage assessment following a disaster to the safety agencies and the security officers of buildings/infrastructures.
An enhanced CAP profile will be created, defining new attributes, including building and infrastructure descriptors (identity, use, etc.), detailed and synthetic damage descriptors, and assessment descriptors providing helpful information related to the operational status and potentially affected services of the building/infrastructure.
Following the TTX, the collected feedback will be analyzed, leading to tangible and intangible results that will be used to validate and evaluate the content of the proposed CWA as currently developed. In this respect, the CWA under study shall have the opportunity to be further elaborated, updated, and enhanced based on these outcomes.

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COLLABORATIVE EMERGENCY RESPONSE – THE PATHWAY TO STANDARDISATION

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ABSTRACT

Command and control cover the decision-making and coordination activities that are implemented during an emergency by the commanders of the safety agencies. Usually, these activities are guided by various guidance, legislations and emergency response plans that are defined at local, national and/or EU level. A number of standards and directives are available worldwide, describing the structure of the procedures and the information that has to be used and shared by these agencies. However, several gaps exist in the information sharing and the collaboration among the agencies during an emergency. A survey on these gaps has been prepared, specifying and analysing these. This process provides useful information to the technology owners and the public safety agencies' policymakers, highlighting the gaps in the procedures and technology that are required in emergency management situations.

Keywords: CWA, standardization, command and control, collaboration, interoperability,

1. INTRODUCTION

According to the ISO 22300 [1] the term "command and control" refers to activities implemented and executed during an emergency situation by the first responders in order to carry out efficient incident responses, independently as well as jointly, with other involved parties. Activities that are covered by this process are related to the decision-making, assessment of the situation, planning, implementing and controlling of the effects of the incident, etc.

The systems that support the management of operational information and the implementation of various standard operating procedures are the "Command and Control" systems. Through these systems, commanders and first responders, are able to be informed about the situation, check the content of the emergency response plans that are related to the event, dispatch the required resources and share operational information with the other agencies that are involved in the incident management.

A number of command and control systems are available in the market, each of them focuses on specific agencies characteristics and on the execution of specific operational procedures. Nowadays, collaboration among the safety agencies is crucial in order to achieve an effective response to large-scale disasters. A key role in such collaborative activities is played by the sharing of the operational information among the involved agencies and among the related command and control systems. Currently, several, directives and guidance are available, setting the structures that the operational information should follow in order to be shared among the different agencies.

2. STANDARDIZATION GAPS

In the context of the STRATEGY project the existing standards (related to the command & control systems) have been analysed, concluding with a list of gaps that could proceed to a new standard or standardisation item. In total, 28 gaps were identified and twelve of them are considered “Very Important” for end-users. The command and control activities and the related systems play a key role in the overall management of a situation. As a result, the identified gaps and needs are quite extensive, describing the real operational requirements that the first responders have, during emergencies. Many of the gaps related to standardisation are relevant both to technical and/or procedural interoperability. The identified needs are related to all levels of commands, covering from inter-organisation to cross-border collaboration activities.

An initial analysis of the gaps revealed that a categorization of them, based on the type of operation that is focused on, is possible. Thus, five different categories have been identified. These categories are:

- **Information Sharing** - This category contains the gaps that are focused on the sharing of information in such ways that can enhance C2 operations, enable collaboration among the agencies and make them more efficient.
- **Data Security** – Refers to gaps that are focused on data security.
- **Symbology** - Gaps in this category are focusing on the usage of common symbols in the situation response and management operations.
- **Procedures** – A number of the gaps are focused on operational procedures that should be standardized. These gaps are placed in this category.
- **System Development** – Some of the gaps are proposing a functionality (which is not part of the other categories) and the design of a system that will be able to support it.

Next, several users from different disciplines (First responders, Public safety agencies, policy makers, Technology providers, Standardization bodies, and Researchers) were involved in the process of discussing, analysing and prioritising this list of gaps, taking into consideration their day-to-day operations and requirements.

The gaps that were highlighted as more interesting and relevant to the end-users and stakeholders' activities are:

<u>**Information Sharing**</u>

- CC-1 “Standardisation of interfaces, to promote data interoperability to get the same picture of the disaster.”
- CC-3 “Standardisation of information and information management exchange across borders and organisations.”
- CC-5 “Agreed and standardised format of data commonly shared and standardised situation report, to avoid loss of time in the data homogenization process.”
- CC-17 “Interoperability of Systems and Real-Time Situational Awareness in Firefighting.”

- CC-19 “Need for standardised process and technology for obtaining and share Common Operational Picture among all stakeholders.”

Symbology

- CC-10 “Standardisation of information display (e.g images, videos) for specific tools and GUI of CC systems.”

For each group of gaps, a corresponding standardisation opportunity was identified. Regarding the gaps that are related to the standardization of the information sharing process, a number of relevant standards and directives are available worldwide. However, during the consultation process with the end-users, they highlighted that there is a strong need to conclude a structure/protocol/standard that would be used for the exchange of operational information and collaboration among the agencies at the EU level. Thus, the CEN Workshop Agreement on "Collaborative Emergency Response – Communication and sharing of operational information among multiple public safety agencies" [2] was proposed in the context of the STRATEGY project.
Regarding the gap that is related to the standardization of the way, the information is displayed to operators, the CEN Workshop Agreement on "Management of forest fire incidents – SITAC-based symbology" [3] was proposed in the context of the STRATEGY project.

3. CONCLUSIONS

The domain of Command & Control covers crucial activities and processes that have to be implemented during an incident management process, in order to have effective response activities. A number of processes that could be standardised have been identified and documented in this document. In the context of the STRATEGY project, two pre-standardisation activities have been initiated, having as a scope to standardise the symbology used during forest fire incidents by the public safety agencies and the sharing of information among multiple safety agencies, respectively. These pre-standardisation activities will be further refined and evaluated in the context of the STRATEGY project, through a number of exercises with real end-users.

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STANDARDIZATION IN EVALUATION OF EXERCISES FOR CRISIS MANAGEMENT

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ABSTRACT

Exercises are essential component of crisis management primarily aiming at preparedness enhancement. During a gap analysis among technological and methodological tools available to first responders and crisis managers, it has been revealed that the evaluation phase of exercises is not adequately documented and despite the specificities that each exercise is governed by, guidance on its implementation is highly requested. Hence, within the STRATEGY project, a CEN Workshop Agreement (CWA) which aims to standardize the evaluation scheme of operational exercises and exercises that aim to the validation of solutions (*trials*), is being developed with the participation of various experts in the crisis management domain. Data collection through various means, mostly focusing on the content of the evaluators' guiding document and the questionnaires addressed to the participants, is analysed and reference to data compilation and analysis methods is made. Furthermore, the structure of a few-pager and concise after-action report to document the main exercise identifiers and the evaluation outcome is proposed to be used for various purposes. The effectiveness and efficiency of the proposed CWA content is tested and validated via table-top and full-scale exercises.

Keywords: evaluation, CWA, standardisation, exercises, trials

1. INTRODUCTION

Exercises, in different types and levels, are (or should be) widely employed in crisis/disaster management with various objectives, all of which have as upper scope the eventual operational and/or strategic capability upgrade. Exercises are controlled activities during which specific actions are simulated and demonstrated aiming to the enhancement of knowledge and skills, the strengthening of collaborative response, the testing and validation of protocols and tools, the identification of strengths and areas for improvement and the overall preparedness upgrade [1]. Exercises are, moreover, recognized as an excellent technique of experiential learning and training, especially in the operational world, in which experience obtained in safe yet simulated environment is critical for effective response [2]. A special form of exercises are the so-called *trials* (per [3]) which are events deployed in the form of an exercise with their particular aim being the validation of solutions (i.e. a technological tool, standard, protocol, etc.) by practitioners in the context of realistic situations and operational environment. Evaluation is an essential part of the exercise process and although it is often depicted as the last phase of the exercise cycle which will feed corrective actions for exercise improvement and capabilities upgrade [4], it is yet running across all phases of an exercise from planning to reporting of evaluation outcomes. The evaluation is strongly correlated to the scope and objectives of an exercise, it requires identification of data to be collected and experienced professionals to carry out the tasks. Therefore, evaluation planning needs to be initiated together with the exercise planning, so that all scope-related and organizational (logistics, human resources, etc) aspects are addressed timely and effectively. Currently, different national guidelines (e.g. [5]) as well as an international standard [1] exist on the planning, conduct and evaluation of operational civil protection exercises, not always with details explicitly on the evaluation phase. In STRATEGY project, which aims to the development of CEN Workshop Agreements (CWAs –preparatory activities towards standardization supported by CEN/CENELEC) in different aspects of crisis management, the need for a standardized proposal on guidelines on implementation of exercises evaluation has been recognised. Hence, the CWA under the name “Evaluation of exercises – Implementation Guidelines” is being developed with the support of Austrian Standards and the participation of various experts, internal and external to STRATEGY consortium.

2. METHODOLOGY FOR STANDARDIZATION AND TESTING

2.1. Identification of needs

Within STRATEGY project, a gap analysis in crisis/disaster management and its eight (8) domains was initially conducted in order to identify the most emerging needs for harmonization at European level and standardization [6]. Practitioners’ needs, as recognized through various past and ongoing projects and consultations, were compared against existing standards in the broad area of crisis/disaster management. Approximately 100 standardization gaps were revealed, while in the Training domain six gaps were revealed addressing the needs for harmonized procedures in training and exercising and their various aspects. The final selection of the standardization item to be developed was performed after prioritization of the gaps by practitioners and the cross-correlation with available opportunities (technological, methodological, knowledge) within STRATEGY consortium. The Center for Security Studies (KEMEA) due to its expertise in the organization of exercises and trials for various purposes, undertook the leadership of the development of the CWA under discussion.

2.2. Development of CWA

CEN Workshop Agreements are CEN/CENELEC deliverables which reflect an agreement among workshop participants on a topic that aims to be standardized [7]. The process is more flexible and rapid than a traditional standard development while its inclusivity, which stems from the participation of numerous experts in the workshop meetings as well as the writing itself and the open public commenting period, make their development easily feasible when the need for standardization arises. According to CEN procedures, a proposal for a CWA is submitted to CEN and after its acceptance, a project plan is submitted. The workshop is constituted after its announcement and is composed by all interested stakeholders that need to approve all steps of the process and the content of the developed document. Two meetings have been already held remotely and were attended by a large number of participants, such as researchers, first responders, civil protection and exercise experts and technology providers and was supported by standardization experts. KEMEA associates, as CWA proposers and workshop chairs, presented a tentative table of content and initial content which was further formulated during the meetings and bi-lateral consultations. The draft of the 13th of May is being tested in tabletop exercises, is open for comments and will be updated based on the feedback received. It is expected that the CWA will be completed in summer 2023.

2.3. CWA content

The scope of the current CWA is to provide the basic guidelines on the creation of an evaluation scheme for exercises, including trials, for crisis/disaster management. The guidelines focus on the actual process of the evaluation, spanning from data collection during the exercise conduct, to data analysis and proposal of documentation of the evaluation outcome in a structured and concise manner. The CWA does not aim to duplicate the content of the existing standard [1], thus not all stages of an exercise evaluation are presented in details, e.g., the skills of evaluators, their training etc. Focus is given to the implementation phase of the evaluation and the different means of data collection, mainly via the *participant feedback form*, the *evaluation guide* of the evaluators and the post-exercise debriefing. Special attention is given to the evaluation during *trials*; the different dimensions that the validation of a solution by end-users may encompass are enlisted, being based on the evaluation of the solution's usability (e.g. by [8]). Moreover, without duplicating the content of an After-Action Report (AAR), i.e. a document that records, describes and analyses the exercise, drawing on debriefs and reports from observers and derives lessons from it [1], a so-called After-Action Resume is proposed. The latter is a
few-pager report with the minimum necessary information that is often required for filing and reporting to the upper management purposes.

2.4. Testing of CWA

Within STRATEGY project, the content of the CWAs under-development (11 in total) and two CEN Technical Specifications are being tested through a number of table-top exercises and a full-scale exercise. These so-called exercises are *trials* which aim is to validate the content of each standardization item as a solution. Practitioners and experts that participate are not evaluated against their performance, while on the contrary they provide their feedback on the CWA tested through discussions during an evolving scenario and by means of the evaluation process.
The CWA "Evaluation of exercises" was employed horizontally in all exercises (ten so far) that were conducted aiming to the testing of different CWAs in the domain of command and control, response planning, critical infrastructure protection, early warning, search and rescue and digitization of scenarios. Questionnaires were prepared by exercise managers following the Guidelines of the proposed CWA. The evaluation was composed by two sections, the evaluation of the exercise planning and conduct and the evaluation of the solution that was being tested in the exercise. Each exercise manager interpreted individually the Guidelines and prepared questionnaires for the players, evaluators and observers. Following the end of the table-top exercise cycle, all exercise managers will be also requested to evaluate the usability of the current CWA for the evaluation of their exercises/trials.

3. CONCLUSIONS

Experience and impressions communicated have revealed that the development of the current CWA, consisting of implementation guidelines on the crucial field of evaluation, will be of great assistance to professionals of crisis/disaster management (planners, decision makers, first responders e.tc.), as well as to researchers and technology providers. The former will be supported for the preparation of a holistic evaluation scheme and documentation by practical guidelines rather than generic approaches, while the latter will be equipped with a non-exhaustive list of components adapted to crisis management solutions, to be examined for testing of the latter. The development of the CWA is being achieved through numerous contributions by operational and scientific experts in the field of exercising and in particular of evaluation, who have expressed their interest in further making use of the guidelines in their professional activities. The input provided (still to be finalized) by the testing of the CWA through the evaluation of multiple exercises within STRATEGY project, is really valuable and useful. As a matter of fact, the implementation of proposed standardization items in realistic conditions, by the employment of exercises in form of trials, can be further proposed for testing under development standards and protocols.

ACKNOWLEDGEMENTS

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CRITICAL INFRASTRUCTURE PROTECTION: STANDARDISATION AND EXERCISES

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ABSTRACT

Information sharing in the field of Critical Infrastructure Protection (CIP), although the confidentiality constraints, is of outmost importance for timely response, organizational and societal resilience. This work describes the development of a new CEN Workshop Agreement (CWA) which aims to the standardization of the reporting form of incidents that may occur in or affect critical infrastructures. The need for the under-development pre-standard (CWA) has been revealed after identification of gaps in the field of CIP after current and past consultations with different stakeholders. The proposed content of the CWA has been matured within the Greek national programme "*Targeted actions for enhancing the protection of national characterized European critical infrastructure*" in the framework of which a pilot coordination center has been developed in the principles of the EU Critical Infrastructure Warning Information Network (CIWIN) (COM/2008/676) and tested via a number of tabletop exercises. The standardization of incident reporting responds to the requirements of the current EU Directive 2008/114 about establishing a communication mechanism for information exchanging, as well as the envisaged more specified conditions of the proposed new directive (COM/2020/829) on incident notification of the competent authority. The content of the proposed CWA is being validated through table-top and full-scale exercises.

Keywords: CWA, standardisation, incident reporting, exercises, critical infrastructures

1. INTRODUCTION

Effective crisis management and response highly relies on information sharing, requires efficient coordination and interoperability. The latter can be better achieved through standardization of operations, technological tools and other aspects that govern crisis management. Standards help to the achievement of interoperability at organizational, semantic and technical level, supported by instruments of legal interoperability. This common language, common processes and common specifications are established, allowing for the creation of processes commonly understood by a wide variety of first responders, civil protection agencies as well as CI operators. Interoperability is the tool to facilitate collaboration between organizations and nations and consequently to save lives and protect assets.

The Center for Security Studies (KEMEA) in Greece is the National Contact Point for European Critical Infrastructures (CIs) located in Greece and has established a National Pilot Coordination Centre for Critical Infrastructures with the aim to strengthen the cooperation between first responders and CI operators and to train both of them in crisis situations. In the framework of the above-mentioned activity a dedicated incident reporting form and a risk application have been developed and deployed during a series of national multi-stakeholder exercises.

Considering, thus, its role and expertise, KEMEA participates in the EU Horizon 2020 funded project STRATEGY, developing standardization activities and hosting a table-top exercise in Greece. In the framework of STRATEGY, two European Committee Standardization (CEN) Workshop Agreements (CWA), i.e. *a CEN/CENELEC deliverable which reflects an agreement among workshop participants on a topic that aims to be standardized* [1] are developed in the field of CI protection with the support of the Spanish Association for Standardization (UNE):

(a) CWA 1 – Semantic layer definition and suitability of EDXL-CAP+EDXL-SitRep standards for crisis management in Critical Infrastructures,
(b) CWA 2 - Emergency management – Incident situational reporting for Critical Infrastructures.

The two CWAs (also mentioned as *pre-standards*) are being carried out under the CEN workshop "Improvement of information processing in crisis management of critical infrastructures for computer assisted data gathering, display and reporting" supported by CEN and the Spanish Association for Standardization.

These pre-standards are also being tested and validated through a table-top and a full-scale exercise within STRATEGY project. The present work focuses on the latter CWA 2 - "*Emergency management – Incident situational reporting for Critical Infrastructures*".

The development of a standard that could facilitate the notification of competent authorities due to disruptive events occurring in critical entities is expected to support information sharing at national and EU level, what is being required by the existing EU directive on CIP (2008/114/EC) and more explicitly the proposed new directive (COM/2020/829) which introduces the incident notification obligation by operators to competent authorities. Thus, CWA 2 focuses on standardizing the minimum information that is necessary to be exchanged in order for a competent authority to get improved situation awareness. In addition, guidelines for designing and printing a report template of the incident report are detailed.

2. STANDARDIZATION ACTIVITY

2.1. Selection of standardization items

STRATEGY project conducted a standardization gap analysis [2] in crisis management domain based on the correlation of practitioners' needs and existing standards related to crisis management. In total, approximately 100 standardization gaps were revealed that were also cross-checked with the results of past projects and stakeholders' consultations. Additionally, opportunities (e.g. technological tools, guidelines, experience) that could facilitate the standardization of the topics revealed by the gaps and the importance with which practitioners characterize them, were employed for prioritising the most emerging needs.

For the critical infrastructure domain, 13 gaps were identified. Prioritization led to the selection of three gaps for further standardization, among which is the standardized format of an incident reporting module that could be embedded in a decision and support system [3]. In order to proceed to this, it is important to have identified the minimum information that is agreed as necessary to be exchanged during a crisis from a critical infrastructure to a coordination centre. Thus, the proposed *CWA 2 – "Emergency management – Incident situational reporting for Critical Infrastructures"* is a document that aims to the standardization of the information exchanged and does not identify any technical language or module.

2.2. CWA development methodology

CEN Workshop Agreements provide the opportunity for a flexible and rapid development of a document that has the possibility to become standard. CWAs are not considered as official standards and are the most tangible result of what is called a “pre-standard”. Nevertheless, they are written in a way similar to the official standards and have a public and wide acceptance, thus making them an excellent basis for the development of an official standard. According to CEN procedures, a proposal for a CWA is submitted to CEN and after acceptance a project plan is submitted. The project plan provides more details for the proposed CWA such as the scope, the time plan and interested parties, it is publicly open for comments and after its submission, a workshop is formed in order to start the development of the CWA by its participants. The final step of a CWA is the public commenting period for the draft CWA. After this period, the CWA is finalized and published.
The kick-off meeting for the proposed CWA held remotely on 6th of April and various types of stakeholders, such as researchers, critical infrastructure operators, first responders and industry participate. It is expected that the CWA will be completed at the summer of 2023.

2.3. CWA content

The scope of the proposed CWA is to standardize the minimum and most important information in case of an incident to a CI, that should be communicated to competent authorities. This information is related to the incident time and location, type of incident, hazard type and impacts, casualties, actions taken or planned to be taken and resources that are necessary or may be necessary in order to respond to the incident. Depending on the type of the information, these are mandatory or optional. In addition, rules for designing the print-out report are also provided. For its development other similar existing standards, such as the ISO/TR 22351:2015 [4], the OASIS-EDXL SitRep [5] standards and the M/ETHANE framework [6] that describe situation reports in cases of emergencies or information exchange between first responders, have been also employed.

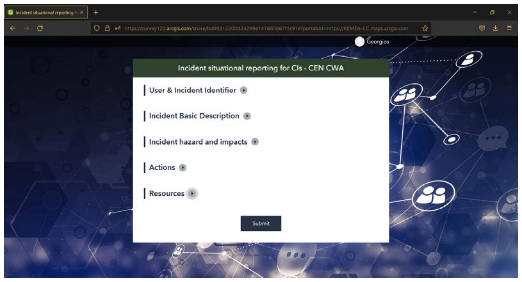
2.4 Table-top Exercise planning and conduct

STRATEGY project uses table-top exercises and a full-scale exercise as means of validation of the under development standards, trying to create an innovative, end-user (practitioners) driven pre-standardization framework that will facilitate the development of a new standard in crisis management domain or the improvement of an existing one.
In 8th of June 2022, a table-top exercise was organized at the premises of Center for Security Studies, in Athens, Greece, in order to test both the aforementioned CWAs. Focusing on CWA-2, the exercise scenario was designed in a way to facilitate the testing and examination of the content pre-standard (CWA) with selected independent events without any kind of escalation. The scope of the exercise wasn’t to evaluate or train participants competences and processes, but participants were requested to provide their feedback based on their professional experience on the content and the fields of the proposed CWA. Reporting of the incidents was supported by a dedicated online form built according to the proposed CWA. The main outline of the online form, an example of the print-out report and a picture from the exercise are depicted in Figure 1.

3. CONCLUSIONS

The development of the under-discussion CWA is being achieved with contributions, consultations, operational and professional input from a number of practitioners in the field of CIP, operators (senders) and first responders (recipients of the message transmitted). In particular, the exercise provided

significant feedback on the CWA content and its potential implementation and proved that an exercise is a means not only for training and education but also a tool that can support the development of standard.
The publication of the CWA is expected to improve the collaboration of CIs and competent authorities, improve response in case of incidents affecting CIs, improve restoration times and provision of services.



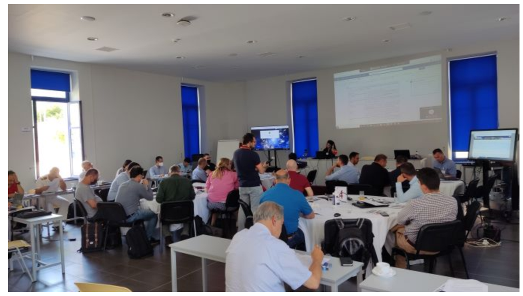


Figure 1. (**a**) Left: instance from the online form that support the exercise; (**b**) Right: A photo from the exercise.

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INTEROPERABILITY IN CRISIS MANAGEMENT: SPECIFICATIONS FOR DIGITAL SCENARIOS TO ENHANCE ACQUISITION OF TRIAGE INFORMATION DURING SEARCH AND RESCUE OPERATIONS

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ABSTRACT

Within the content of STRATEGY EU project "Specifications for Digital Scenarios for Crisis Managements" and "Requirements for acquiring digital information from victims during Search and Rescue operations" pre-standardization items that are in progress to produce two CWA (Cen/Cenelec Workshop Agreement) under the European Committee for Standardization. In this paper we are presenting the results of the developments and the output of the table top exercises organised to validated them with the presence of various stakeholders such us first responders, academia and researchers, industry and public authorities.

Keywords: Digital Scenarios, Search and Rescue, Tabletop exercise, Crisis management, First Responders, Triage

1. INTRODUCTION

Technical and organisational interoperability in a fully transboundary configuration is considered of key importance considering that relevant authorities are required to manage a range of natural and human-made hazards which significant impact and cascading effects to critical infrastructure and societal functions [1,2]. Exercises are employed by crisis management authorities in order to enhance preparation and training to effectively manage and respond to hazardous events. However, the majority of crisis management exercises are following traditional approaches such as paper-based scenarios. This is considered an insufficient practice leading to complications in the design phase of an exercise and increased costs during the operation phase (e.g., training staff exceeds the number of trainees). The design phase is also considered to be of key importance for the successful operation and completion of an exercise. However, exercise planners have currently limited options in terms of available digital solutions to enhance the preparation of the design phase but also to guide effectively a planner through the process of large-scale exercises in crisis management field where numerous scenarios and events exist targeting also different purposes.

First responders are faced with a number of competing challenges and responsibilities to take control of the situation and deal effectively and efficiently with the wounded and deceased. As healthcare resources are limited or strained due to the number of injured individuals, triage systems are implemented to offer the greatest good to the greatest amount of people. The goal is to determine as quickly as possible the priority of victims' treatment based on the severity of their condition, and to move patients away from the incident toward resources that offer comprehensive care [3,4].

The study presents the development of an interoperable and harmonised process that aims to provide specifications for digital exercise scenarios and assist exercise planners focusing particularly on the acquisition of triage information during SaR operation. This will assist exercise planning teams to precisely plan all the successive steps of a preparedness scenario and will enable the effective preparation of large-scale exercises involving multiple agencies and cross-border interoperability. The digital exercise scenario specifications will also involve the combination of different elements such as hazards, actors, assets, pre-set of cases and event sequences, with particular focus on different command levels and departments/organisations, giving exercise planners the option to target specific groups of first responders.

2. VALIDATION OF PRE-STANDARDISATION ACTIVITIES IN TABLE TOP EXERCISES

The following pre-standardisation activities are part of STRATEGY project which focuses on selecting and implementing existing, evolving and new standards within solutions, tools and procedural guidelines and recommendations to enhance interoperability in crisis management area. The pre-standardization were validated through extended Table Top Exercises (TTX), in which key stakeholders participated.

2.1. Digital Scenario Specifications

The pre-standardisation item aims at specifying a digital process for the planning of crisis management exercises. This will involve providing recommendations on the type of digital information exchanged for scenarios in crisis management area, the use of data models for exchanging scenario characteristics and the interoperability characteristics that digital scenario specifications need to have in order to be able to be employed by the majority of scenario building tools. Main target groups are organizations responsible for planning and implementation of exercises, and particularly local, regional, national and international emergency management authorities, exercise planning teams, trainers and first responders. The CWA is also of interest to technology providers focusing on the development of scenario building tools for crisis management activities.

During the TTX the pre-standardisation item was tested and evaluated. First, the participants were introduced to the Trial Management Tool of DRIVER+ [5], which will be employed by the TTX for demonstration purposes. The exercise involved two parallel scenarios that were used to facilitate the demonstration of the proposed CWA. A detailed demonstration of the given scenario into the TMT tool was then performed. After the demonstration, both the players and the observers participated in an open dialog to summarize their experience during the TTX. Finally, questionnaires will be distributed to the participants to gather their feedback most appropriately and coherently, completing the evaluation procedure.

2.2. Triage

The current pre-standardisation item aims to enhance the acquisition of triage information during search and rescue operations. This will involve providing recommendations on the whole chain of the digital triage solution. Classification of patients into classes that represent their immediacy of need of a) medical treatment and b) transportation to hospitals. A complete and integrated digital triage system must consist of three main parts:

- a wearable device (digital triage tag) that presents in a visual way the emergency status of the victim,

- a mobile application that controls the wearable device and can collect information about the victim
- a platform that collects the victim's information and distribute it to other components, applications or platforms.

An indicative solution for the triage used is depicted in Figure 1 including all the components of a digital triage solution during a rescue mission.

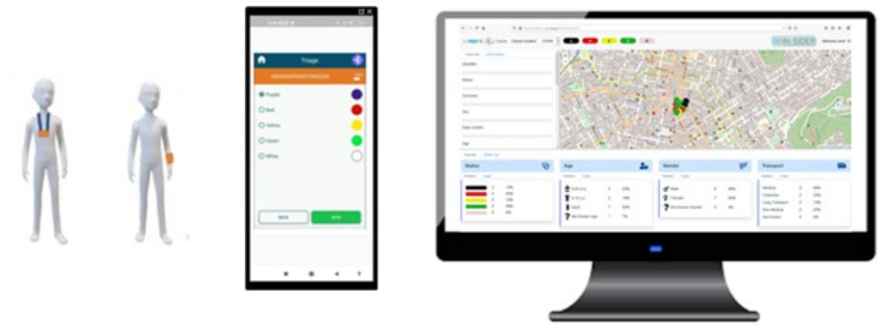

Figure 1. Digital triage system consist of a wearable, a mobile app and a platform

During the exercise we used an existing triage system already developed in the INGENIOUS project to facilitate the conduction of the exercise. Specific requirements collected for the development of the hardware up to the design and the implementation of the platform. Main scope of the CWA is to acts as a guideline for the technical providers building similar solution.

3. CONCLUSIONS

The tabletop exercises involved the presentation of existing solutions for planning scenarios through digital tools and a complete digital triage solution and provided a fertile ground for open dialogue to collect feedback by key stakeholders, such as first responders, researchers and industry in regards of building a common solution. Specifically, for the digital scenario an extended data model was presented which aims to specify the characteristics of an exercise with potential to provide a common method to increase interoperability of scenario builders. On the other hand, in regards to the triage technical requirements on the device, in the collection of the data from the field and interoperability aspects to exchange information with third-part applications and be part of an ecosystem with hospitals, ambulances, other local or international emergence response teams to have a common view during the operations.

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NATURAL DISASTERS & CLIMATE CRISIS IN GREECE FROM 2000 TO JULY 2022

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ABSTRACT

The rapid increase in extreme weather events have led to natural disasters worldwide affecting billions of people, while destroying properties, infrastructure, important ecosystems and protected areas. Greece is particularly susceptible due to its geographical location and increasing vulnerability. The purpose of this study is to highlight the increasing frequency of catastrophic events and the necessity of adapting/adjusting societies and their resilience, worldwide and especially in Greece, to climate crisis. By recording, evaluating and presenting natural disasters -except earthquakes- of approximately the last 22 years, with significant impact, it is attempted to record data and evaluate their increasing frequency. It is observed that the occurrence frequency of such phenomena increases significantly, for example, in 2021 & 2022 compared to 2000 [noteworthy increase since 2019]. This trend appears to be fixed and clear. Adaptation actions based on recent data are immediately required to reduce vulnerability in Greece. The enactment and/or enhancement of a legal framework is essential in order to support & impose these actions and set specific objectives over time, both for the transition to climate neutrality and for reducing the vulnerability.

Key words: Natural disasters, climate crisis, vulnerability, adaptation, Trend [R^2], resilience.

1. INTRODUCTION

It appears that global mean temperature has increased rapidly since the end of the 19th century and continues to this day with certain regional variations. The increase in Earth's temperature is an undeniable fact, with consequences to the natural & anthropogenic environment, to living organisms and ecosystems, as well as to human society and economy.

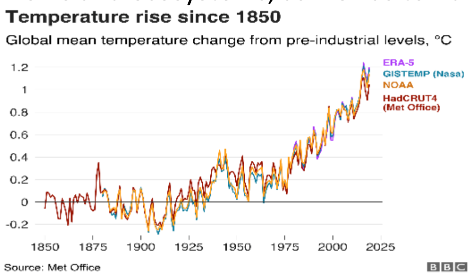


Figure 1. Climate crisis is "imprinted" in the most typical way, by the increase in the average temperature of the planet. This results in the rise of sea level, floods, droughts, extreme weather events, extinction of species and ecosystems. Globally, mean temperature is about 1.2° C above pre-industrial levels.
https://www.bbc.com/news/science-environment-51111176

According to the Intergovernmental Panel on Climate Change [IPCC] predictions, in most regions of the planet, the rising trend in atmospheric temperature will continue during the 21st century, depending on the evolution of greenhouse gases concentrations. This expected increase will be accompanied by the growing frequency of extreme weather events. For decades scientists have been warning about the enormous social and economic effects that will result from climate crisis. Among others: spread of diseases, massive waves of immigration, reduction of production, loss of jobs and ultimately the change of the earths inhabitant's way of life through the anthropogenic point of view. [1]

2. CLIMATE CRISIS & NATURAL DISASTERS

The number of disasters has been increasing since 1960s, with the largest increase, of nearly 35% every ten years, from the 1990s onwards [figure 2B]. Over the decades, technological development has given researchers the ability to record more phenomena. Illegal and inadequate studied residential development, the destruction of forest areas and waterways have contributed to the transformation of natural phenomena into potential disasters. Catastrophes caused by extreme weather conditions have affected 1.7 billion people and killed more than 410,000 in the past ten years, the majority in middle - and low - income countries. Heat waves followed by storms were the deadliest. If current trends continue, the number of disasters per year globally may increase by 40% during the lifetime of the Sendai Framework from 2015 to 2030. According to the latest United Nations report, almost 7,350 major natural disasters occurred in the last 20 years. They caused losses of nearly $3 trillion, nearly double the losses of the 1980s and 1990s. In the last two decades floods and storms have been the most frequent natural disasters, while for the next ten years, UN estimates that heat waves will be the major problem [2, 9, 10]. Climate crisis is now a direct threat to some countries. Scientists argue that if, over the next 20 years, extreme weather events continue to increase at the same rate, the future of humanity appears uncertain. However, the industrialized nations are not substantially reducing greenhouse gas emissions. EU Parliament declared climate emergency on 28 November 2019 and approved the EU climate directive on 24 June 2021. It commits the EU to reducing greenhouse gas emissions by at least 55% by 2030, and to become climate neutral by 2050. [3]

3. CLIMATE CRISIS IN GREECE & NATURAL DISASTERS

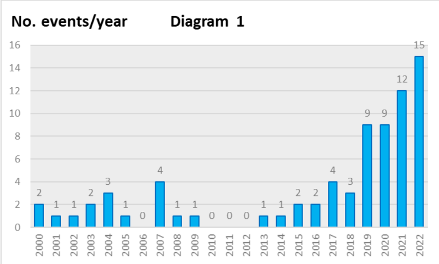
The wider Mediterranean region is characterized as a vulnerable region in terms of climate crisis effects. Research has shown that, in the future, the intensity of hot invasions and the duration of drought periods will increase the risk of fire in these areas by 13% compared to today's data. As a result, significant impacts on the ecosystems is expected. According to the National Observatory and the Academy of Athens, due to its geographical location, between temperate Europe and the desert of North Africa, Greece belongs to the regions that are significantly affected by the climate crisis. Studies show that 20% of its entire coastline consists of coasts with moderate to high vulnerability to climate crisis [4]. Every decade that passes in Greece the number of very hot days increase significantly and at the same time the frequency of extreme weather phenomena occurrence is intensified. Desertification, dryness and forest fires are some of the main problems that many regions of Greece will have to face in the coming decades [1]. Research published in June 2011 by the IPCC shows that temperature increases are likely to reach up to 6^o C by 2100 if there is no global action to halt climate change. The increase will be greater on the mainland than on the islands, stronger in summer and autumn and milder in winter. The effects of climate crisis are likely to be particularly significant because of the more frequent occurrence of extreme weather events and not so much because of a long-term change in the "average" climate. [5] Climate crisis requires the planning of adaptation actions in order to limit the damages it entails..

3.1 Disasters in Greece during the last 22 years

Table 1 [1,9] presents, in chronological order, the most important disasters. The selection criteria are based on the large effects, according to available data, in human losses and in the destruction of the natural & anthropogenic environment (only the event is registered not the intensity or magnitude of impact. For this reason, a systematic bibliographic research was carried out, while it seems that the events are also related to climate crisis in Greece. Additional disasters -not registered in table- are included for 2022, since significant fires took place during the 19^{th} – 31^{st} of July in Penteli-Attiki, Dadia forest-Evros, Vatera-Lesvos island, Krestena-Ilia, Valia Kalda-Grevena, Rethimno-Crete & Itea with noteworthy impact on natural and anthropogenic environment, increasing the events for the seven months of 2022 to fifteen. [https://www.naftemporiki.gr/story/1887381?fbclid=IwAR0JFZ-MITK9NJ-sYZqFsTxqAjhXami9DVGEfWlE2f93jCqspOqdsGig2bM]

Table 1: major climate related catastrophic events in Greece (2000-2022)

No	Date	Place	Fact	No	Date	Place	Fact
1	July-2000	Ilia	Fire	35	August-2019	Samothraki	Fire
2	August-2000	Hpiro, Corfu	Flood	36	October-2019	Skopelos, Messolonghi	Floods
3	January-2001	Athens, Corinth	Flood	37	October-2019	Attiki, Evia	Heavy hail
4	July-2002	Attiki	Flood	38	December-2019	Attiki, Pieria, Larissa, Magnesia	Floods
5	February-2003	Preveza	Flood	39	December-2019	Attiki, Boeotia	heavy snowfall
6	July-2003	Oinofyta Boetia	Fire	40	January-2020	Athena	Floods
7	February-2004	Attiki	Snowfall	41	January-2020	Attica, Boeotia	Hephaestion: Stormy winds
8	September-2004	Thessaloniki	Heavy Rainfall	42	June-2020	Leros	Heavy rains
9	November-2004	Attiki	Heavy Rainfall	43	August-2020	Evia	Flood
10	July-2005	Rafina, Attiki	Fire	44	August-2020	Epirus, Corfu	Fire
11	June-2007	Central Greece, Peloponnese	Extreme temperature	45	September-2020	Ionian and Thessaly.	'Ianos': Mediterranean Cyclone
12	June-2007	Parnitha	Fire	46	October-2020	Heraklion - Chania	Heavy rains
13	August-2007	Penteli, Attiki	Fire	47	October-2020	Heraklion, Attiki	Tornado
14	August-2007	Central Greece	Fire	48	November-2020	Crete	Flood
15	August-2007	Ilia	Fire	49	January - 2021	Whole country	Intense & Lasting African powder
16	August-2008	Aetolia- Acarnania	Flood	50	February-2021	Sterea - Evia - Attiki	Heavy Snowfalls
17	September-2009	Evia	Flood	51	February -2021	Eastern and Northern Greece	Heavy Snowfalls
18	February-2013	Athens	Storm – Flood	52	March-2021	Attiki	Heavy Snowfalls
19	October-2014	Attiki	Rainfall	53	April - May-2021	Whole country, especially Crete	High temperatures for the season - 39 ^{0}C
20	January-2015	Epirus, Thessaly, Peloponnese, Macedonia, Sterea	Heavy rains	54	May-2021	Corinthia	Fire
21	February-2015	Evros	Floods	55	July - August-2021	Whole country	Heat
22	September-2016	Kalamata, Thessaloniki	Floods	56	August-2021	Attiki	Fire
23	November-2016	Attiki, Lesvos, Chios, Zakynthos	Strong storms	57	August-2021	Evia	Fire
24	January-2017	The whole country	Frost, Snowfall	58	September-2021	West Greece	Mediterranean Cyclone
25	October-2017	Chania, Marathon, Lokris, Fthiotidas, Skyros, Patras.	Daedalus: devastating floods	59	October-2021	Evia	Heavy Rainfall
26	November - 2017	Corfu	Flood	60	November - December-2021	Whole country, mainly West and North-East	Strong Winds and Gales up to 10 BF
27	November - 2017	Mandra Attiki	Flood	61	January-2022	Whole country	Diomedes:Heavy snowfall, gale force winds
28	June-2018	Northern and Central Greece.	Floods	62	January-2022	Central Greece, Attiki	Elpida: Extreme snow-freeze
29	July-2018	Mati Attiki	Fire	63	March-2022	Attiki - Boeotia	Snowfall
30	September-2018	Evia, Fthiotida, Argolis, Corinthia, Laconia, South Attica	floods-landslides	64	May-2022	Thessaloniki	Flooding - heavy rainfall
31	January-2019	Messinia	Torrential rains - floods	65	May-2022	Attiki	Strong winds
32	February-2019	Crete	Torrential rains - floods	66	June-2022	Kozani, Patra, Kavala, Xanthi, Orestiada, Attiki.	Genesis: Floods
33	February-2019	Southern Greece - Crete	Heavy rains, strong winds	67	June-2022	Thessaloniki	Flooding - heavy rainfall
34	July-2019	Chalcidiki	Heavy Rainfall	68	July-2022	Central and Northern Greece	Rains storms,high frequency of lightning and hailstorms



According to the presented events per year and the diagram 1, a rapid increase in extreme phenomena that led to disasters in Greece from 2000 to2022 is estimated.

4. DISCUSSION & CONCLUSIONS

It is assessed that in the coming years the intensity and frequency of natural phenomena will be such that adaptation of the society is required at many levels so that these phenomena do not develop into disasters. The population of vulnerable areas should be aware of the risk and be prepared to take appropriate action when they receive the corresponding warning. In order to reduce the vulnerability of specific areas that, according to existing studies and recorded experience, show great vulnerability to certain phenomena, appropriate infrastructure and bold policies are required. In conclusion, ways must be found to reduce the vulnerability of almost the entire country since its geographical location makes it vulnerable to climate crisis. Some thoughts are presented in the following figure 2 where the Coefficient of Determination [CD] - R^2 is calculated and evaluated [6].

Based on the above and assumptions presented, it appears that: **1.** There is certainly a trend of increased disaster events for the upcoming years. **2.** The best prediction estimates [CD > 0,78] differ significantly on the number of expected events. For 2030, from approx. 24 to 80. With a CD > 0,9, which is considered much better, [fig. A,C, D & E] events are approx. between 50 & 80. The country must prepare and adjust to handle, a min. and max., of a variety of large-scale disasters in the near future, taking into account data from latest years for prediction, planning and preparedness measures. **3.** Adjustment must be rapid since significantly increase of the catastrophic phenomena the next years might lead to disasters that will alter natural and anthropogenic environment, in a way that future large-scale natural phenomena, in the same form & areas, will not result in disasters. As a result, the expectation of increased disaster frequency after some years may not be as predicted. **4.** The scientific community role in the climate governance system must be boosted. It is crucial that political willpower & legislation foresees and makes sure the operation of a unified scientific monitoring body of the country's progress towards climate neutrality with strong and substantial responsibilities. [5,7,8].

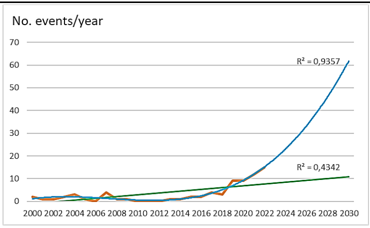
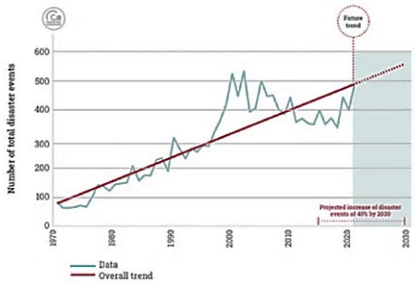
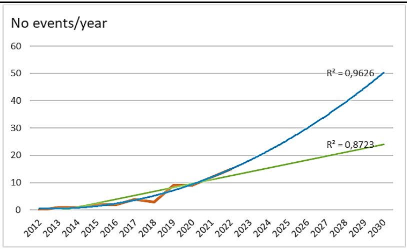


Figure 2. A. Disaster events in Greece per year, and the prediction trend line, utilizing linear regression analysis [green line] based on 21 years & 7 months of data. The CD (R^2) indicates that the model rather poorly predicts the outcome. **A** way for a potential better prediction is the usage of a polynomial regression. Then, a linear regression model and a polynomial regression model are fitted and the adjusted R-squared values for both are calculated. The model with the higher adjusted R-squared represents the model that is better able to use the predictor variable(s) to explain the variation in the response variable. [11] The same data are utilized to produce a prediction for future events with a third-degree polynomial regression analysis [blue line]. It appears that the CD indicates a much better prediction outcome. In both calculations there are incomplete data for 2022.

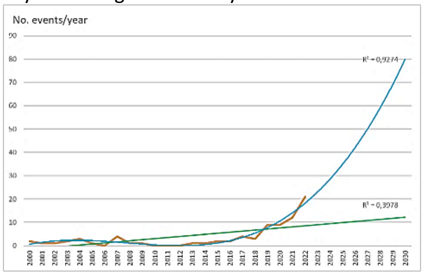


Source: UNDRR analysis based on EM-DAT (CRED, 2021)

B. World disaster events in 1970–2020 & projected increase in 2021–2030 via prediction trend line. Estimated that, the world will face around 560 disasters every year by 2030 [UN, GAR 2022, March 26 2022]. The rapid rise in the disaster frequency can be attributed to climate crisis and inadequate risk management, according to IPCC. It appears that the two trend lines in figure 2A & 2B are similar. Note, there is no CD reported for figure 2B. The two trend lines [and polynomial approaches] do not consider future climate crisis impacts, which are accelerating the pace and severity of hazard events, nor the fact that current choices mean the world is set to exceed the Paris Agreement's global average maximum temperature increase target of 1.5°C by the early 2030s (IPCC, 2021). [9, 10].

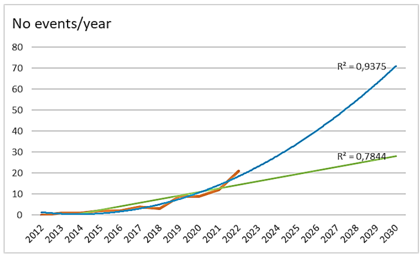


C. If data from 2012 [i.e. last decade] are used, it appears that both prediction approaches produce a good CD. This possibly indicates that current data may be more appropriate for prediction, planning and preparedness measures. However, there is significant difference in the predicted number of events between the trend line and polynomial regression analysis.



D. Since 2022 is not over yet an assumption may be to expect a total of 17 to 25 catastrophic events. Number of events between 17 & 25 produce CD values > 0,9 [best value for 17 events-0,9403. For 26 events then CD<0,9]. Here [D] the trend line and a third-degree polynomial regression analysis are presented for 21 events.

E



E. If data from 2012 [i.e. last decade] are used and same as D number of events for 2022 are assumed, it appears that both prediction approaches produce a very good or good CD. However, there is significant difference in the predicted number of events. The polynomial regression analysis [blue line] results very good CD's [reaching 1] for other degrees as well [3rd to 6th] indicating a significant increasing number of events [very extreme hypothesis].

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THE HISTORIC CITY OF NAFPLION: AN APPROACH TO ESTIMATING THE EFFECTS OF GEOHAZARDS ON THE BUILT ENVIRONMENT

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ABSTRACT

The city of Nafplion was the first capital of Greece from 1821 to 1834 and today is a historical port in Peloponnese, Greece. The initial part of the city was built on coherent geotechnical formations while significant expansions took place mainly across the coastline. The softer subsoil along the coastline is prone to settlements while at the same time it is of interest to investigate the possibility of liquefaction. In any case, there is a danger of foundation settlements, which will increase the vulnerability of the historical buildings. STABLE introduces a strategy and select most efficient methods and tools for harmonization of data, criteria and indicators to be addressed for tracking of impact of environmental changes on tangible cultural heritage assets, buildings and monuments, including structural deterioration processes at a city/village scale. The city of Nafplion is studied under STABLE (STructuralstABiLity risk assEssment) project a co-funded by the European Commission and the project is carried out in the context of the HORIZON 2020 programme supervised by EU Authority. Grant Agreement No: 823966.

Keywords: STABLE research Project, risk maps , risk forecasting models, InSAR, CosmoSkyMED, Cultural Heritage

1. INTRODUCTION

The STABLE project is addressing risk maps of Cultural Heritage (CH) at medium scale (block of buildings and large structures) to derive similar damage maps but before the event occurs addressing damage forecast for seismic movements impacting on the structural stability of the CH. This valuable information needs to be complemented, calibrated and tested using Earth Observations InSAR techniques (using VHR SAR time series from CosmoSkyMED satellite) combined with ground data (e.g. geotechnical and geophysical information), site scale monitoring and risk forecasting models (earthquake) to derive enduser driven products (e.g. deformation maps, vulnerability and damage maps). The project addresses the design and development of an IT service platform, combining advanced satellite technologies with existing ground-based data and risk forecasting modelling for the long term and continue monitoring and update of structural stability of the architectural heritage and in particular of historical centers affected by geo-hazards. In order to carry out the demonstration and validation of the Platform, three case studies have been selected: the city center of Rieti in Italy, the old town of Nafplion in Greece and Strovolos in Cyprus. This article is specifically focusing in the old town of Nafplion.

2. NAFPLION STABLE RISK MAPS

2.1. Persistent Scatterers Interferometry, Cosmo Skymed Stripmap HIMAGE acquisitions used for Nafplio

Land subsidence is the gradual settling or sudden sinking of the Earth's surface due to removal or displacement of subsurface earth materials. In the cases of the displacement of buildings and especially the case of differential settlement adversely affects the foundations and hinders the structural integrity of buildings. The monitoring of such displacements can provide important information which can be utilized by the engineers to design mitigation works. InSAR is a method that can map land deformation over large areas, with accuracy on the order of centimeters to millimeters depending on the terrain, at a spatial resolution of ~100 m. The use of this non-destructive method has proved to be very effective in the monitoring of land subsistence as it provides the ability to compare displacements over large periods of time. In this project the aforementioned method is used to monitor the displacements of the three case studies of the STABLE project which refer to the areas of Nafplion. Stacking interferometry methods are ideal to exploit a series of N SAR images (Interferometric stacking) in order to identify areas (pixels) that show coherent and consistent signal (displacement) over the time. The Persistent Scatterers (PS) is intended for the analysis of point targets. The resulting product is relevant to the measurements of linear displacements and the derivation of precise heights of local scatterers, which are typically characterized by high coherence. The identification of PS is generally considered reliable when 20 or more acquisitions are used and regular, in temporal terms, acquisitions are available. PS should exclusively be used in urban areas, or in general, where scatterers remain stable in radiometric and interferometric phase terms. Depending upon the scatterer stability (time coherence), the achievable displacement precision can reach the precision of millimeters, while the maximum velocity is limited by the minimum time distance between the acquisition and the sensor wavelength. (Shamshiri 2018) [3]. In order to produce ground deformation velocity maps, time series of displacement and coherence changes maps we acquired 109 SCS Cosmo SkyMed StripMap HIMAGE images from year 2013 to 2019. COSMO-SkyMed carries SAR-2000 on all four satellites. SAR-2000 is a multi-mode instrument, a programmable system providing different performance characteristics in terms of swath size, spatial resolution, and polarisation configurations. The SAR transmitter/receiver system operates through an electrically steerable multibeam antenna which concentrates the transmitted energy into narrow beams in the cross-track direction while the characteristics of the transmitted pulses and the echo signal determine the spatial resolution and coverage. The SAR rasters are initially in .h5 format, a data file in Hierarchical Data Format. It is a kind of library file used for storing large amounts of numerical, graphical and text data, organized hierarchically. Hence it can manage a huge amount of data very efficiently.

2.2. Ground deformation

As regards the city of Nafplion, the soil surface shows a tendency to rise, slightly (5 mm/year); however the overall behavior is rather stable. No worth mentioning subsidence of soil can be noticed. Throughout the various areas, the soil displacement time series show a tendency to remain stable, with only slight ground movements between 2013 and 2019. By the end of the process the velocity maps provide information regarding throughout the selected time period of image acquisitions.In the wider area of Nafplion there is a general stability of the soil. Checking the values of displacement at selected reference points we can see that the deformation values over time are negligible. Nevertheless, we find that in the old town of Nafplio there are many points that show moderate to large subsidence, in the order of -3mm to - 10mm on the south side of the old town.

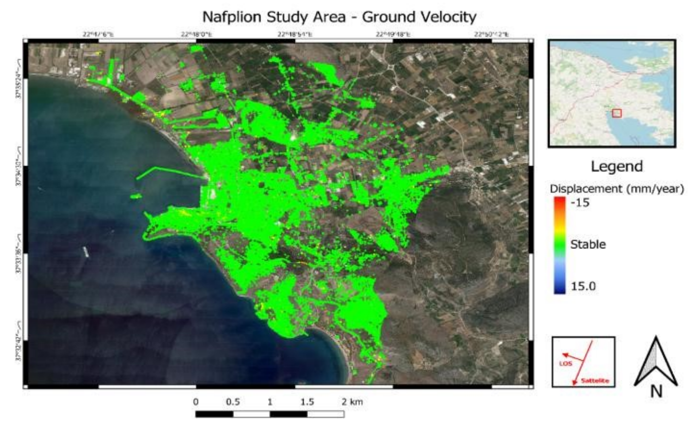

Figure 1 Nafplion Velocity Map

The interferometric process successfully reflects the trends of surface deformation of each area. The territorial background of the city of Nafplio shows stability at a depth of 8 years while also areas with intense impending soil subsidence are identified. In particular, the impending deformations in the north wing of the old city are quite rapid, reaching up to half a meter every two years, while subsidence is also found in the eastern zones.

These deformations may be due to the geomorphological background of the area or to tectonic activity. The relationship between subsidence and recorded seismic phenomena is supported by some time series diagrams but not by others, necessitating further study of the area for possible relationships between the two.

2.3. The seismic assesment

Table 1 Building typology classification

Typologies	Building types	typo 1
Unreinforced Masonry	Rubble stone	1
	Adobe (earth bricks)	2
	Simple stone	3
	Massive stone	4
	U Masonry (old bricks)	5
	U Masonry–R.C.floors	6
Reinforced/confined masonry	Reinforced/confined masonry	7
Reinforced Concrete	Concrete MomentFrame	8
	Concrete Shear Walls	9
	Dual System	10

For the assessment of seismic risk, a simplified mechanical method is applied with the help of a computer code written in MATLAB. The seismic assessment is made for a range of buildings located in the abovementioned areas, for which an extensive survey was made in order to collect structural data that are essential to perform the calculation of structural vulnerability. In order to perform the seismic risk calculation of a building stock, the development of a categorization system for that building stock is adopted, as shown on Table 1 (Grunthal 1998[17]; Lagomarsino 2006[18])..

2.4. Description of stuctural data

For the implementation of the simplified mechanical method, 91 buildings were selected for Nafplion study area, as highlighted in Figure 1. They are all made of simple stone (typo1=3). The selected buildings have been classified based on number of storeys in four classes: single-storey (NS=1), twostorey (NS=2), three-storey (NS=3) and multi- storey (NS≥4). It comes out that the most typical building in the study area is the three- storey one (43%) followed by the two-storey (29%), assuming an approximate storey-height equal to 3.0 meters. Building height distribution as well as building footprint area is measured using digital phorogrametrical aiborne stereopairs (0.20m pixel size). The mean total height is 8.7m, while most selected buildings correspond to heights from 4 to 10 m and occupy a footprint area less than 147 m^2. The elastic eigenperiod (parameter T1) for every building ranges from almost completely rigid to 0.44 sec. It should be mentioned that for the needs of the calculation part, appropriate assumptions were made regarding the structural parameters for which there was no detailed information. The reliability of the calculations is directly related to the accuracy of the input data. The architecture of the platform developed in the framework of the STABLE project allows the integration of more accurate data which may be available in the future. These data may concern, as an example, accurate knowledge of masonry quality and accurate knowledge of the non-linear behavior of the constructions by developing appropriate computational models and performing more elaborated analyses (Spyrakos 1994[19]; Spyrakos et al, 2015[20]; Spyrakos et al, 2018[21]; Maniatakis et al, 2018[22]).

Figure2 Nafplion buildings

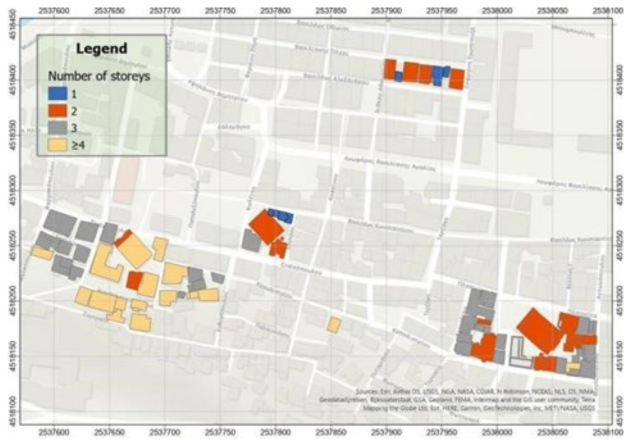

Figure 3 Number of storeys distribution

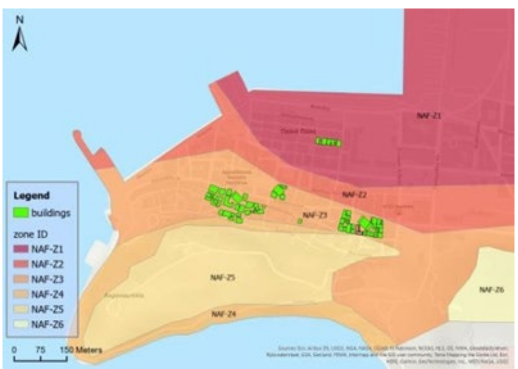

Figure 4 Zones in Nafplion study area

2.5. Selection of Earthquake Scenario

Pseudo-spectral acceleration (PSA) was obtained by 2D modelling with LSR_2D.

-Four (4) seismostratigraphic cross-sections were modelled with inputs relative to three (3) return periods (Tr): 50 y, 475 y and 2000 y accordingly

-Six (6) zones were identified, as shown

-a mean PSA (g) value was appended to each zone for each return period.

3 buildings in the central study area fall within zone ''NAF- Z3'', except a very few ones which fall within or at the boundary of zone ''NAF-Z4''. The northest building cluster, bounded by Vasilissis Olgas and Vasileos Alexandrou streets, falls within zone ''NAF-Z1.'

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AN INTEGRATED APPROACH USING OPTICAL AND SAR MULTI-TEMPORAL DATA, GEOSPATIAL TECHNOLOGY AND WEB-GIS VISUALIZATION FOR CULTURAL HERITAGE SITE MONITORING: THE CASE OF MANTINEA SITE

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ABSTRACT
The cultural heritage is a fundamental and integral part of the history of humanity. The archaeological sites comprise part of this cultural heritage and contribute to connecting people with their cultural origins, with the result that some of them are considered cultural heritage sites. According to UNESCO, cultural heritage sites (CHS) are works of art or monuments of posterity which must be handed down to future generations. The protection and conservation of CHS from natural and anthropogenic factors is a major issue. Considering all the above, this study aims to examine how space-based monitoring data and geospatial data can contribute to the monitoring and protection of the archaeological site of Ancient Mantinea from natural and anthropogenic hazards. In this study, satellite-based images from the Copernicus program were used, in particular, Sentinel-1 SAR and Sentinel-2 Optical ones. Furthermore, from Copernicus services spatial thematic data produced by the Copernicus satellite program were obtained. For the processing and the analysis of data the software ESRI's ArcGIS Pro and ESA's STEP SNAP were utilized. The final results of the analyses produced in ArcGIS Pro were uploaded to a database. The results showed that the risk for the ancient site of Mantinea is low, yet it proved that remote sensing and GIS are useful for the protection of the archaeological sites.

Keywords: Ancient Mantinea, Cultural Heritage Sites, Remote Sensing, Web-GIS, SAR.

1. INTRODUCTION

In the last few years, cultural heritage sites are facing many dangers and are at risk both from natural disasters and human intervention as well as the climate change [1]. Natural disasters can alter CHS through natural phenomena (earthquakes, landslides, floods, and soil alteration), and human interference can destroy CHS through urban expansion, pollution and mismanagement. As far as climate change accelerates the rate of deterioration because climate change exacerbates the physical and chemical mechanisms of deterioration [2]. As Cultural Heritage Sites (CHS) are considered to be all the sites that are the posterity of the human species from the past and must be handed down to future generations [3]. More than a few studies have used space-based monitoring data and geospatial data for the assessment of the impact and protection of CHS [1,4,5]. The study area is Ancient Mantinea (Figure 1) which is located in the Prefecture of Arcadia, Greece. The study area belongs to the Eastern Peloponnese Water District (EPWD) which extends into the eastern and southeastern Peloponnese. The catchment areas belonging to the EPWD are three: The catchment area of the Tripoli Plateau, 2) the Argolic Gulf and 3) the Eurota River. Ancient Mantinea belongs to the Tripoli Plateau Watershed and specifically in the sub-catchment of Mantinea (Figure 1). Sub-catchment of Mantinea is one of the four sub-catchments of the catchment area of the Tripoli Plateau. It is located on the northern side of the catchment of the Tripoli Plateau and its western side is the Mount Mainalo. Moreover, on the northeast side of the sub-catchment is the Mount Oligyrtos. The nearest settlement to the archaeological site is Milia with 86 inhabitants, according to the latest census of the Hellenic Statistical Authority in 2011, while the most populous of the nearest settlements is Nestani with 486 inhabitants. The archaeological site of Ancient Mantinea occupies a large area of the Mantinean plain, which belongs to the sub-catchment of Mantinea and which is named after the ancient city-state. Ancient Mantinea is considered to be one of the largest and best-preserved cities of antiquity and in the Archaic period was considered an important city-state of Arcadia. According to the prevailing view, the foundation of the ancient Mantinea was established immediately after the end of the Persian wars, in 470 B.C [6]. Ancient Mantinea contributed to the shaping of historical events both those related to local Arcadian history and those related to developments in Greece in antiquity. In 385 it was destroyed by the King of Sparta Agesipolis due to the competition between the two city-states for control and domination of the wider region of Arcadia. Although in 370 B.C. the Theban general Epaminondas re-founded the city in the exact same place where it was before its destruction by the Spartans [6]. The first excavations for the discovery of the city were carried out by the research team of the French School of Archaeology in 1887-1889 and the director of excavations was the French archaeologist G. Fougeres. In the archaeological site, the most important exhibits that still exist today are the Ancient Theatre, the city walls, the temple of Hera, and the Roman bath (Figure.1). Ancient Mantinea has been the focus of other research groups in the past, both for the study of antiquities and for the study of the spread and form of the settlement in antiquity [7,8].

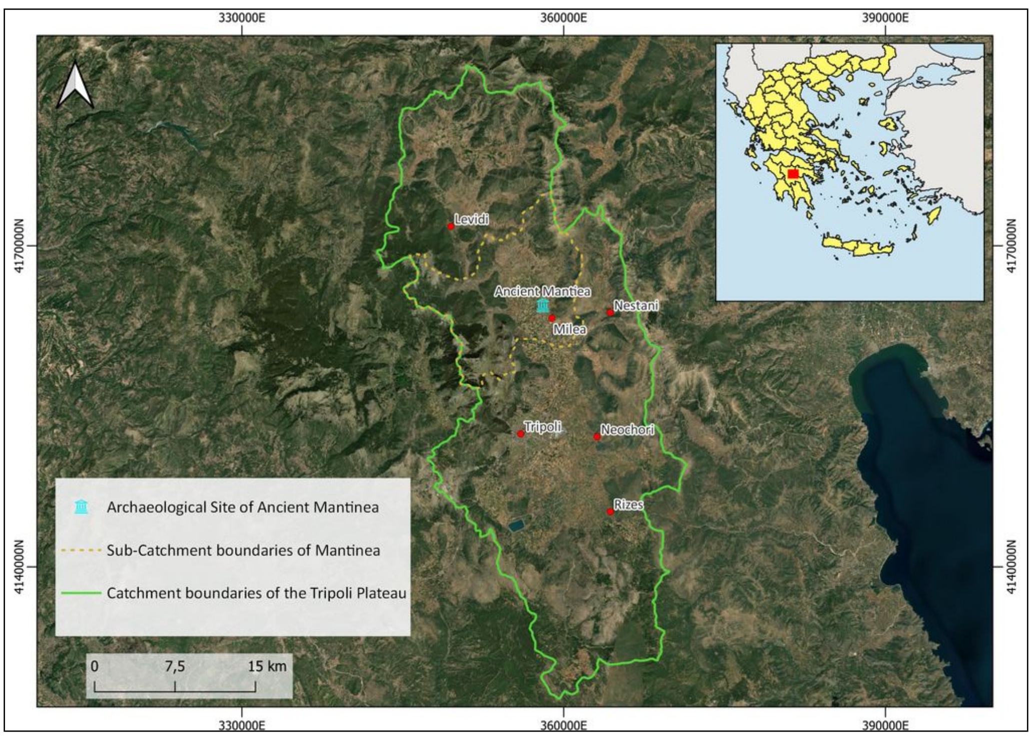

Figure 1. The catchment and sub-catchment of the study area

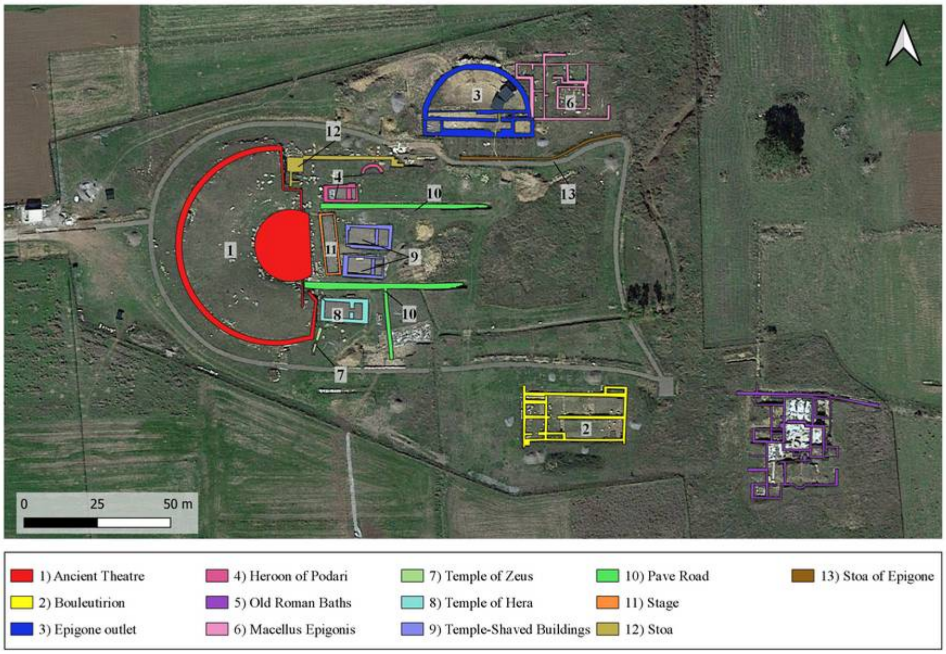

Figure 2. The ancient site of Mantinea

2. MATERIALS – METHODS

For the study, high-resolution satellite images were used and the final results of the analyses were posted in a database that can be used in the future as a tool for monitoring and recording the risk of C.H.S. The software used is the ESA STEP SNAP and the ESRI ArcGIS Pro. The ArcGIS Pro software was used to process the geospatial data, map the results and for the creation of database, while the software SNAP was used in order to process the satellite images.

3. RESULTS - DISCUSSION

Taking into consideration the process data both earth observation and geospatial, the risk for the ancient site and the urban centers within the basin is relatively low. That is to say, there are no natural or anthropogenic hazards that threaten the study area.

4. CONCLUSION

Remote sensing and geographic information systems (GIS) can be proved useful tools for identifying and estimating the magnitude of natural and man-made disasters to which the study area is exposed. Ancient Mantineia is one of the largest and best-preserved cities of antiquity and was considered a great city in the Archaic period. That was the reason why ancient Mantinea was chosen as the study area. It is located in the Prefecture of Arcadia and occupies a large area of the Mantinean plain. Although it was not proven that there is any danger for Ancient Mantinea from natural and anthropogenic hazards, it was shown that remote sensing and GIS can be essential and useful tools for the monitoring, conservation, and protection of archaeological sites and cultural heritage from natural and anthropogenic hazards.

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THE CUMBRE VIEJA ERUPTION, 2021: VOLCANIC CRISIS MANAGEMENT. THE GREEK SCIENTIFIC MISSION

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ABSTRACT

After 50 years of quiescence, Cumbre Vieja volcano in the island of La Palma, Canary Islands, went to eruption, after 8 days of signals. Swarm of earthquakes in shallow depths and ground deformation, led to the eruption on September 19, 2021. In September 13, the Special Plan for Civil Protection and Emergency Care for Volcanic Risk in the Autonomous Community of the Canary Islands (PEVOLCA) was activated. There were no fatalities or even injuries. The population was well informed by the authorities and several evacuations were ordered. The local authorities declared the official end of the volcanic activity after 85 days, on December 25, 2021.
October 1st, a three-member Greek Scientific Team from Earthquake Planning and Protection Organization (EPPO), as well as National Kapodistrian University of Athens, travelled to the island of La Palma. The aim was to collect scientific and operational data, gaining experience for the volcanic crisis management by having meetings with the scientists and other local stakeholders and on-site autopsies in the prohibited area. Valuable was the contribution to this scientific team, the Greek volcanologist from National Geographic Institute (IGN), Dr. Meletlidis Stavros.

Keywords: Cumbre Vieja eruption, Volcanic Crisis Management, PEVOLCA, La Palma, Canary Islands, EPPO.

1. INTRODUCTION

The Canary Islands are located in North Africa's west coast (Western Sahara and Morocco). It is a chain of volcanic ocean islands. The islands are oceanic hot spot volcanoes above a slow-moving, thick oceanic plate. The Atlantic plate slowly moves ENE above the Canarian hot spot, so the age of the volcanism decreases from east to west. La Palma and El Hierro are the youngest of the island chain. The latest volcanic activity in Canary Islands was a submarine eruption in El Hierro, in 2011 [1].

In La Palma, the latest eruption broke out in 1971, at the Teneguía volcano, in an almost uninhabited area, which killed a man who was photographing the lava, but that natural event had a limited impact on the population and caused no other material damage. In recent years, the Volcano of Cumbre Vieja has experienced seismic swarms, one in 2017, one in the 2018 and 2020, and three in 2021 [2]. The eruptive process started 8 days after the first signals, began on 09/19/2021 at 14:10 UTC, ended on 12/13/2021 at 22: 21 UTC and lasted 85 days and 8 hours [3].

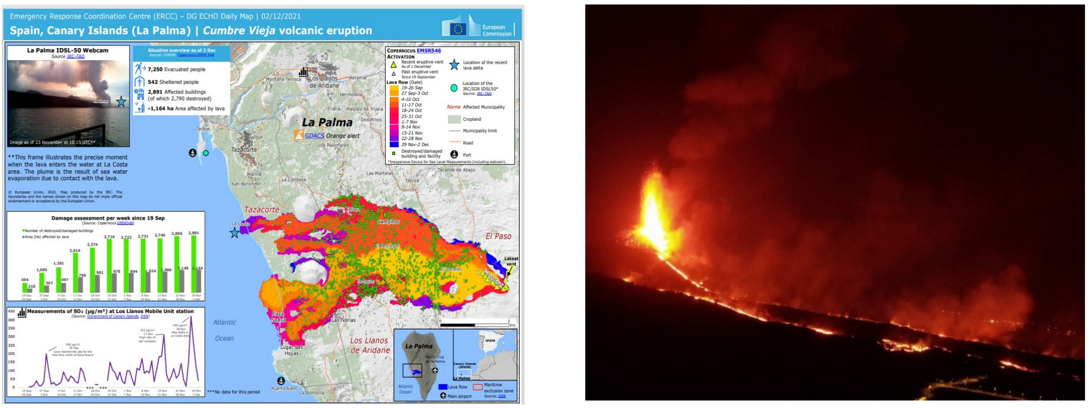
2. METHOD AND DATA

After more than 25,000 small earthquakes that hit the island for eight days, the eruption began in the southern part of the Spanish Canary Island of La Palma (Cumbre Vieja region). There were several indications of the pending volcanic eruption such as the increasing frequency, the magnitude and the shallowness of the events [4]. Its typology has been Strombolian fissure with phreatomagmatic pulses. The eruption initially had two fissures separated by 200 meters. In the eruption, a volcanic cone has been built with a highest point located at an altitude of 1.121 m above sea level, rising about 200 m above the pre-eruptive topography. The maximum height of the eruptive column was reached on

December 13, in a measurement of 8.500 meters above sea level. The estimated volume of the constructed eruptive cone is 34 Mm^3 and the estimated total volume of volcanic material emitted exceeds 200 Mm^3 [5].

In September 29, a platform of about 500 meters wide, had already been formed. It is a low island called "fajana". The lava inlet was being calm and plumes of potentially toxic gases were dissipating without causing health problems. 9.090 earthquakes have been located, with maximum magnitude 5.1 R and IV-V the highest intensity. The maximum recorded deformation of the earth's surface was recorded on October 24 and was 33 cm in the vertical [5].

Unfortunately, around 2.100 persons were left homeless, 1.219 hectares of land and 73.8 km of the roads were covered by lava. More than 500 flights were cancelled. The estimated economical loss exceeds the amount of 843 million Euros [6].



(a) (b)

Figure 1. (a) lava extent, air quality parameters, monitored SO_2 emissions into the atmosphere, data acquired by the Los Llanos Mobile Unit. (Sourse: ERCC portal)[4,7] **(b)** Eruption of Cumbre Vieja at night, 10/01/2021 (Sourse: Efthymios Lekkas)[8]

3. DISCUSSION

Approximately 7.000 people were evacuated in a security perimeter and about 1000 of them, began to return on January 3, 2022, those cases in which their homes had not been damaged by lava. In June 2022, the Special Commissioner of the Government for the Reconstruction of the Island of La Palma was established. The Commissioner is in charge of the coordination and promotion of the actions adopted by the General Administration of the State for the reconstruction of the Island of La Palma [9].

3.1. The Special Civil Protection Emergency Plan (PEVOLCA)

The volcanic activity in Spain is registered in the Canary Islands. The characteristics of a volcanic emergency, its probability of occurrence, as well as the important consequences for the population, the property, or the environment, in a limited and widely populated territory make it necessary to develop a quick, effective, efficient, and coordinated response, aimed at minimizing possible damage and allowing the restoration of basic services for the population in the shortest possible time [10].

The Special Civil Protection and Emergency Attention Plan due to volcanic risk in the Autonomous Community of the Canary Islands is called PEVOLCA. It aims to ensure a coordinated, agile, effective, and efficient response of all public administrations to deal with seismovolcanic crises, in subarea or submarine eruptions, and emergencies arising from them. An also effective respond to ensure compliance with the prevention measures, contemplated in current regulations. The Director of

PEVOLCA is the one who activates and deactivates the Plan, in order to take the prevention measures so as to avoid, at all costs, the risk to people's lives [10].

Worldwide, it has been established a system of alert to the population based on the selection of four colors. With the so-called volcanic traffic light, the population can adopt certain behaviors for prevention measures (figure 2a). Its objective is that citizens always identify the same language by public authorities regardless of the nature of the risk [10].

The Scientific Committee includes representatives of the following bodies/institutions:
National Geographic Institute (IGN), Spanish National Research Council (CSIC), Spanish Meteorological Service (AEMET), University of La Laguna, University of Las Palmas de Gran Canaria, National Center of Volcanology or Volcanological Institute of the Canary Islands (INVOLCAN), Geological and Mining Institute of Spain (IGME), Spanish Institute of Oceanography (IEO) [8,11].

A total of 743 security and emergency personnel were the device of the various commands working in shifts in the volcanic eruption in La Palma, including Cabildo de La Palma, Volunteer Firefighters of La Palma, Fire Brigade Consortium of Tenerife and Gran Canaria, Military Emergencies Unit (UME), Press Units, Civil Guard, Emergency Intervention Team (HAGS), Civil Guard, National Police, Local Police and General Corps of the Canary Islands Police. To all these, were added municipal employees, Civil protection and other services of the districts of the island (figure 2b) [12].

SITUATION	VOLCANIC TRAFFIC LIGHT OF INFORMATION TO THE POPULATION	NIVEL DE ACTIVIDAD VOLCÁNICA
PRE-ALERT	Develop your activities normally. Know your physical environment and find out what to do in case of volcanic activity.	Parameters established in a **normal situation**.
ALERT	Be alert to communications from civil protection authorities. Preparation of preventive evacuation.	Increased seismicity, gas emission and ground deformation. Eruption without risk for the population.
MAXIMUM ALERT	It implies the start of preventive evacuation. Make yourself available to the authorities.	Records of seismicity, ground deformation and geochemical data warn of an imminent eruption. Eruption without risk for the population.
EMERGENCY	Total evacuation of the population that may be affected.	Volcanic eruption without significant risk to the population.
	Active measures of Civil Protection.	Volcanic eruption with significant risk for the population, infrastructure and environment.
	Active measures of Civil Protection.	Volcanic Eruption of high power and difficult behavior prediction.

(a)

(b)

Figure 2. (a) Situations and Volcanic traffic light to inform the population **(b)** Lava flows destroying houses and plantations (photos on top, Sourse: Facundo Cabrera, photographer) and volcanic crisis management (photos on bottom, [12,13])

3.2. The Greek Scientific Mission in Cumbre Vieja

The Greek Scientific team launched on the island of La Palma, on the 1st of October, consisted of Prof. Dr Lekkas Efthymios, Professor of Natural Disaster Management of the Department of Geology and Geoenvironment of the University of Athens, President of EPPO, Prof. Em. Dr Kyriakopoulos Konstantinos, Emeritus Professor of Volcanology in the University of Athens and Mrs. Manousaki Maria, Geologist, MSc, employee of the Department of Emergency Plans – Prevention in EPPO. All the members of the team were also members of the Permanent Scientific Committee Monitoring the Greek Volcanic Arc which belongs to EPPO. The team was well informed by Dr Meletlidis from IGN for the current situation of the eruption, the monitoring system, the volcanic crisis management in the island. The team had the chance to approach very close to the lava flow to the prohibited zone (figure 3a). Very fruitful was the meeting with the local authorities in the Base of Operation (figure 3b). By the time the team left, there had been evacuations of about 5000 inhabitants while the first lava flows had already reached the sea [14,15].

(a) (b)

Figure 3. (a) The Greek scientific team with the Greek volcanologist from IGN, Stavros Meletlidis close to lava flow (Sourse: Stavros Meletlidis)[14] **(b)** The Greek team with the Technical Director of PEVOLCA and some of the members of UME in the Base of Operation (Sourse: Foto archive of Maria Manousaki)[15]

4. CONCLUSIONS

In La Palma, the continuous monitoring, the precise models of the lava flow, the very good cooperation between scientists and the local authorities, the decision makers and the population, all these, led to a successful management with no casualties. In addition, La Palma, like all the other Canary Islands, is a very touristic place. Therefore, there are more particularities in volcanic crisis management. These are some of the best practices and the lessons learnt that in Greece have to take into consideration, concerning a possible future volcanic activity in the Hellenic Volcanic Arc.

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A CRITICAL APPROACH ON PROVISIONS OF THE NATIONAL CIVIL PROTECTION LAW – IMPLEMENTATION, THOUGHTS AND PROPOSALS – PART I (GENERAL)

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ABSTRACT

The purpose of this study is to evaluate provisions of law 4662/2020 -as amended- entitled: "National Crisis and Risk Management Mechanism, restructuring of the General Secretariat for Civil Protection (GSCP), upgrading of the Civil Protection (CP) voluntary system, reorganization of the Fire Service". It was published in February 2020 and includes 199 Articles. Law evaluation will be done in two parts. The first will present some general provisions and remarks while the second will refer to specific articles of the law. The law aims, according to the parliament's explanatory report, to adapt the national institutional framework to the new conditions imposed by climate crisis, its consequences in the Mediterranean countries, and more specifically in Greece, weighing the effectiveness of the older provisions and drawing on the experience of previous years. There is widespread criticism of the law, but an attempt will also be made to refer to provisions that could be considered as "positive". It is not possible to critically present the numerous law articles. Some of them are evaluated, since there is greater experience & knowledge on the issues that they are dealing with, and because it is considered that their application affects the handling of risks & disasters. Of course, due to the fact that the provisions of these articles have not been applied, because there is reluctance on applying the entire law, it is not possible to present "hands on experience". However, they are mentioned since it is thought that they need improvement and specific suggestions are outlined. If there is willpower to enhance the new Ministry of Climate Crisis and Civil Protection (MCCCP) it must have "true" decisive and crucial responsibilities in its area of responsibility.

Key Words: Civil Protection, Legislation Implementation, improvement suggestions, Climate Crisis.

1. INTRODUCTION

In Greece, over the years, legislation on CP has been revised several times. Each of these modifications was made at different times and for different reasons. Hence, it may be a result of the country's political situation, need to adapt to new conditions [ex. climate crisis, mixed environments etc.], scientific and technological developments etc. Climate crisis in combination with the complexity of modern natural, technological disasters and other threats make it imperative to adapt to rapidly changing conditions. At the same time, the heterogeneity of the affected population groups, made the previous legislative framework insufficient to deal with climate crisis, the Greek society needs, and the new "disaster data". According to the explanatory report of Law 4662 "*… the growing trend of the intensity and extent of the number, of natural, technological disasters and other threats that Greece has suffered in recent years, made urgent the adoption of a modern, flexible and effective National Crisis and Risk Management Mechanism. This mechanism must give priority and guarantee the security of human life, property, natural wealth and cultural heritage, as fundamental and constitutionally imposed obligations of the state…* ". Regardless of the acceptance, or not, of the law's adequacy, the exercise of criticism or reference to its positive provisions, the need to reorganize and operate a competent National CP Mechanism is a non-negotiable countrywide priority.

2. LEGISLATION UNTIL 2020

The recorded experience showed significant operational weaknesses and structural problems, mainly in terms of coordination and logistics of the factors involved in the prevention and management of risks and threats. For example, Law 4249/2014 remained unimplemented for the most part in terms of CP, as the necessary regulations to implement the provisions of the law were never issued. Indicatively, some weaknesses, according to the explanatory report of Law 4662/2020, could be summarized as follows: "*1. There was no single national mechanism for holistic management of risks and threats covering emergency management from the prevention phase to the recovery phase. The responsibilities of civil protection bodies at central and regional level were fragmented and, in many cases, ambiguous, which inevitably led to overlap and frequent conflict. 2. The Civil Protection Operations Center, which (article 108 par. 5g of Law 4249/2014) had to coordinate and manage, at national level, the emergency response actions in cases of mobilization of civil protection in order to minimize their consequences. It was observed in practice that it did not function according to its legitimate purpose, but was limited to a support structure. 3. There was no process of cooperation with the scientific-research community and therefore the civil protection system was not able to take advantage of the achievements and possibilities of science and technology, remaining almost cut off from research and innovation. 4. There was no risk analysis procedure as well as a National Risk and Threat Database [it only refers to the maintenance of a special Disaster Record]. Consequently, contingency plans were general and did not have a specific scope. 5. There have been significant shortages of equipment and means of civil protection, as over time the provisions of Law 3013/2002 on the financing actions have not been implemented in practice. These shortcomings have resulted in the civil protection mechanism under-functioning with a key impact on its effectiveness.*"

3. LAW 4662/2020

A. The enacted law in an effort to correct previous weaknesses, establishes the National Crisis and Risk Management Mechanism (Nat-CHAMM). It is a network in which the functional, executive and support structures of CP coexist. The aim is to create a single CP national system with a "vertical" structure which will operate entirely through specific authorities and which will cover the whole spectrum of the disaster cycle. The vertical organizational structure is a strict hierarchical structure with power emanating from the top to the bottom. With a chain of command well defined, decisions usually move from the top down through layer by layer, and people at the bottom have the least autonomy. Vertically structured organizations have clear lines of authority, with quicker decision making and better designation of tasks to employees. Staffs in a vertical structure have well-defined roles and responsibilities, which reduces duty ambiguity and encourages high production efficiency. For employees who are seeking for a job promotion, there is a clear path to career planning. Employees are motivated to work hard to achieve a higher level. The vertical organizational structure also has lots of disadvantages. Due to the lack of autonomy, employees from the bottom may have lots of limitations to share their constructive ideas or creative proposals. Vertical structure is likely to be rigid, which might hamper the company from accepting innovative concepts and trap a company in outdated techniques. What's more, because of multiple layers of powers, it will take more time to respond to a problem or implementing decisions [1]. Action must be taken to eliminate, as much as possible, the disadvantages. In addition, coordination structures and bodies are integrated at central and regional level trying to have clear responsibilities and tasks for all levels of government (central, regional and local level) as well as all involved parties, in order to shorten time-consuming decision-making processes in actions such as strategic, operational and tactical level. The law also aims to eliminate bureaucracy. This does not seem to be achieved when, for example, the regional and municipal CP services have to send every month a list of available personnel and technical infrastructure. Risk and threat analysis are now considered as a necessary condition and component both for the preparation of the National CP Plan in the framework of the National Disaster Risk Reduction Policy, as well as for the elaboration and implementation of the Emergency Response and Management Plans. It prescribes substantial specialization of the plans, depending on the risk to be faced and the particularities of each case, while at the same time facilitating the timely and efficient transfer of instructions from the National Mechanism to the bodies and institutions responsible for planning the operations. Also, in order to create an administrative model harmonized with the technological and scientific developments of the country, the necessary tools are foreseen for the utilization of scientific knowledge, the findings of applied research & innovation, and the country's infrastructure. The GSCP, as a prominent structure of the National Mechanism, is being upgraded administratively and functionally in matters of prevention and management of risks and threats. Law 4662/2020 provides: a. Vertical structure for all disaster management cycles, with a National Commander, 13 Regional Coordinators and 13 Regional Operational Centers, which will have specialized personnel and advanced communication systems and will ensure the coordination of all stakeholders. b. Establishment of a Crisis Management National Coordination Center for operation (ESKEDIK) at the level of operational coordination, located at the ministry facilities. c. Creation of a fund for Disaster Prevention and Restoration as well as a Center for Crisis Management Studies, in order to absorb European funds. d. Establishment of a permanent Scientific Council for CP connecting with the scientific community. e. Creation of a Crisis and Risk Management National School, including the Fire Academy, the CP Academy and the Special Training Center. g. Establishment of a European Center for Forest Fires (EKEDAP). h. Founding of a National Risk and Threat Database and i. Development of a National Risk and Disaster Reduction Policy within the National Crisis and Risk Management Mechanism. [2]

B. The law does not include a definition for "crisis" and "interoperability". *A crisis (from the Greek κρίσις-krisis; plural: "crises"; adjectival form: "critical") is any event that is going (or is expected) to lead to an unstable and dangerous situation affecting an individual, group, community, or whole society. Crises are deemed to be negative changes in the security, economic, political, societal, or environmental affairs, especially when they occur abruptly, with little or no warning. More loosely, it is a term meaning "a testing time" or an "emergency event". Crisis has several defining characteristics. Seeger, Sellnow, and Ulmer say that crises have four defining characteristics that are "specific, unexpected, and non-routine events or series of events that [create] high levels of uncertainty and threat or perceived threat to an organization's high priority goals." Thus, the first three characteristics are that the event is 1. Unexpected (i.e. a surprise) 2. Creates uncertainty 3. Is seen as a threat to important goals. Venette argues that "crisis is a process of transformation where the old system can no longer be maintained." Therefore, the fourth defining quality is the need for change. If change is not needed, the event could more accurately be described as a failure. Apart from natural crises that are inherently unpredictable (volcanic eruptions, tsunami etc.) most of the crises that we face are created by man. Hence the requirements of their being 'unexpected' depends upon man failing to note the onset of crisis conditions. Some of our inability to recognize crises before they become dangerous is due to denial and other psychological responses that provide succor and protection for our emotions.* [3] However, particular provision should be made in ensuring Interoperability in Risk and Disaster Management. Political willpower and planning for interoperability are an important element of successful disaster management and a catalyst for strengthening disaster risk management policies. Under the European Framework, Interoperability is defined as the ability of a system or process to share and use information and/or functions of another system or process. The ability of the systems, factors and all the structures involved to communicate is the most important for an effective disaster management in all phases of cycle management. [4, 5, 6, 7] Also, it is proposed that the Precautionary Principle should be included in legislation as a general rule of dealing with risks and disasters *[enables decision-makers to adopt precautionary measures when scientific evidence about an environmental or human health hazard is uncertain and the stakes are high. This principle allows action to be taken to protect the environment at an early stage. It is now not only a question of repairing damages after they have occurred, but to prevent those damages occurring at all. This principle is not as far-reaching as the precautionary principle. It means in short terms: it is better to prevent than repair].* [8] This would definitely enhance the ability to use further measures to specifically protect public health and the environment. It would provide another "tool" for timely and preventive treatment of all issues related to CP.

C. Via specific legislation [article 4, par. 4 of the Legislative Content Act of 14-3-2020 [ratified by Law 4682/2020], that was urgently enacted to address the Covid-19 pandemic, law 4662/2020 was "suspended " until the ministerial decisions (MD) that would define – clarify law provisions are issued. In addition, to cover the gap and absence of provisions on how the CP mechanism will operate, previous law provisions have been reinstated. Note that, some or many of them, as well as the structure and procedures foreseen in the older legislation, were alleged, by the parliament’s explanatory report for law 4662/2020, essentially unsuitable for the protection of citizens' lives and property. Nevertheless, in reality, articles from the newest law are applied selectively while others do not, with no clear explanation [i.e. even if MD are not needed for their utilization]. [9, 10, 11] Note, that almost three years after law enactment there is no excuse for the MD & PD issuance delay. Therefore, as previously mentioned, the law has not been entirely applied [Articles & provisions related to Fire Service are enacted and applied] and cannot be judged adequately.

4. DISCUSSION – CONCLUSIONS

Law 4660/2020 wanted to change-evolve previous legislation and address operational issues in CP & in crisis-disaster management. The process followed, regarding its incomplete implementation with selective use of newer & older provisions [which were initially repealed but then re-established] failed to help reduce the effects of disasters, moreover to significantly reduce or prevent them. Hence, the occasional [?] dysfunction of the CP Mechanism is somehow apparent and primarily expected due to the coexistence and implementation of two legal frameworks, with different structural compositions (dissimilar philosophy, administrative bodies, functions, procedures, etc.). The National Crisis and Risk Management Mechanism has not yet sufficiently and effectively functioned. It is organized and should operate through the following structures: a) National Coordination Center, b) Coordinating Bodies of CP (i.e. Regional and Local [municipalities] CP Operational Coordinating Bodies, c) the 13 Regional Operational Centers of CP [i.e. PEKEPP] as well as the 64 regional CP centers [i.e. TOKEPP] and d) the new Emergency Management Frameworks. [10, 11] Unfortunately, the above-mentioned bodies of the National Mechanism have not yet been established, as well as other administrative structures, according to the new institutional and legal system, and therefore the planned reform of the CP system has not yet taken place [i.e. National School of Crisis & Risk Management - Upgrading of the Fire Academy, Crisis Management Studies Center, Permanent Scientific Council for CP, Risk Assessment Committee etc.]. An idea could be to apply the new CP philosophy on existing coordination and administration bodies, with any required upgrade & adjustment. In addition, a series of web-based tools supporting a national approach to resource management preparedness, a National CP Resource Hub should be created. 1. Access and automate the use of National Incident Management System (NIMS) resources, staff & their positions qualification (where available) and position workbook templates. 2. Inventory of individual resources: In particular, a) personnel, b) equipment, c) teams, d) supplies and e) facilities are recorded in it. 3. Management of staff qualifications, certification and credentials. 4. Support existing guidelines, policies, practices and mutual assistance agreements related to resource management. Organizations and resource owners do not lose control or ownership of information about their resources.] and operated by the MCCCP. It is expected that climate crisis will significantly increase the occurrence of extreme phenomena. The only way to protect human life, property and the environment is to adapt to these phenomena as societies.

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A CRITICAL APPROACH ON PROVISIONS OF THE NATIONAL CIVIL PROTECTION LAW– IMPLEMENTATION, THOUGHTS AND SUGGESTIONS – PART 2 (ARTICLE REVIEW)

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ABSTRACT
The purpose of this study is to evaluate provisions & articles of law 4662/2020. There is widespread criticism of the law, but an attempt will be made to refer to provisions that could be considered as "positive". This second part refers to specific articles of the law. It is not possible to critically present the 199 law articles. Some of them are evaluated since there is greater experience & knowledge on the issues that they are dealing with, and because it is considered that their application affects the handling of risks & disasters. Due to the fact that the provisions of these articles have not been entirely applied, since there is reluctance on applying the entire law, it is not possible to present "hands on experience". The specific articles are referenced since it is thought that they may need improvement and some suggestions are outlined. If there is willpower to enhance the new Ministry of Climate Crisis and Civil Protection (MCCCP) it must have true, decisive and crucial responsibilities in its responsibility.

Key Words: Civil Protection, Legislation Implementation, Climate Crisis, article review & suggestions.

1. INTRODUCTION
Climate crisis, in combination with other factors [i.e. vulnerability], the increasing complexity of present-day natural, technological disasters and other threats make it imperative to adapt and organize civil protection (CP) according to the rapidly changing conditions. At the same time, heterogeneity of the affected population groups, among other things, made the former legal framework insufficient to meet the Greek society requirements and expectations of climate crisis, and new data should be used in destruction & crisis management. Regardless of the acceptance, or not, of law adequacy, the criticism or reference to its positive provisions, the need to reorganize and effectively operate a National CP Mechanism (NCPM) and the General Secretariat of Civil Protection [GSCP] is a non-negotiable countrywide priority.

2. EVALUATING ARTICLES OF LAW 4662/2020
2.1 This law established the National Mechanism for Crisis & Risk Management and attempted to reorganize the GSCP. According to Article 198, law application initiates from its publication in the Government Gazette *[07-02-2020].* This could not happen holistically since, in order for its provisions to be implemented, a total of about 125 regulations must be issued [i.e. ministerial decisions (MD) and/or presidential decrees (PD)]. This task requires political will and an adequate time period. Article 182 explicitly abolishes the previous legislative framework of CP (ex. Law 3013/2002 & 4249/2014 as amended - supplemented) without any transitional provisions for the "smooth transition" from the old to the new CP legal system. An explanation may be that initially it was thought that all required decisions would be issued very quickly. However no further action towards implementing aspects of the law has been taken place. This problem was soon realized and with an act of Legislative Content [14/3/2020] previous regulations were restored. Fact is that until today the law is not applied in its entireness. The framework of Emergency Management has not been activated and consequently the bodies of the NCPM have not yet been established. Other administrative structures have also not been initiated according to the new institutional framework, and thus the plan and attempt to reform the CP system is "put on the brakes & blocked", and can only be judged, in some issues, theoretically.

2.2 Presentation of articles

Article 13 - Creation of Regional Civil Protection Operational Coordinating Bodies (i.e. PESOPP). One of the participants is the CP Regional Coordinator [RCCP] [article 93, law 4623/8-2019]. There is, possibly, a duplication, overlap & confusion of responsibilities with the head of the Regional CP Directorate. In any case, the regional head, services and executives probably have a better knowledge of the region, society, historical data & events as well as any particularities that should be considered. No reference is made to voluntary groups active participation among the participants in the coordinating bodies, [article 13 and article 15], despite that PART B of the law deals with the *UPGRADE OF CIVIL PROTECTION VOLUNTEERING SYSTEM*, intending to upgrade volunteering in conjunction with Article 34. Suggestion: Enact clear provision in legislation so that volunteers can participate at all levels of action and decision-making and coordinating bodies. [2,3]. It appears that the Regions, Municipalities via their Directorates and CP Departments, do not have the right to mobilize the voluntary groups that are within the limits of their responsibility. Suggestion: a. Removal of the provision for the appointment of a RCCP and, if considered necessary, replacement with representatives of the competent Ministry or decentralized administration. These personnel will function as communication contacts, transfer knowledge, policy – strategy needs, etc. b. Participation of volunteer's representatives in all relevant coordinating bodies. c. Foresee CP coordination bodies at the prefecture level. d. Representatives of each level of local administration should participate in each coordination structure. Article 18–Construction-organization and operation of the Regional CP Centers ("PEKEPP") & the similar centers per prefecture [TOKEPP]. The construction of these operational establishments is foreseen in the "AIGIS" program. "AIGIS" is a funding tool (approx. 1.7 billion euros - national & European funds), aiming to upgrade the NCPM of Greece. It includes four main axes of financing actions that intend to cover the creation of a vertical, modern and effective mechanism, with state-of-the-art means and equipment, as well as thorough training of its executives. It appears that lately, there is a particular delay in the creation and operation of the centers. Suggestion: All regional and similar services should be housed in the centers under the responsibility of the Regional Governor & the competent Head of the Autonomous Regional CP directorate. There could be a Ministry representative (mentioned above) as a "liaison". *Article 21-Mandatory creation of an Independent Civil Protection Department in each Municipality.* The law leaves no room for misinterpretation by the Municipalities. However, many municipalities have not established the relevant autonomous departments and do not have, adequate, specialized, trained staff. Also, the PD "*upon proposal of the Ministers of Finance, Citizen Protection and Interior, the organizational positions, specialties, job descriptions are determined based on the respective Internal Organization Service, the recruitment process, the staffing criteria of the Independent Civil Protection Departments and any other necessary details"* that should have been issued within six (6) months from the publication of the law [article 21 para. 3] has not been enacted. Another issue is that according to par. 2 of the article *"…In municipalities of less than ten thousand (10,000) inhabitants, an Independent Civil Protection Office may, exceptionally, be established"*. Suggestion: a. Mandatory creation of an Independent CP Department in each Municipality irrespectively of their population. b. Immediate issuance of the required PD. Accelerated hiring procedures, with specific criteria for the Independent CP Departments staffing. It is an outstanding matter of public interest and public health. Immediate operation & staffing of the departments, regulated and supported by the Ministry until the completion of the hiring procedures. *Article 29-par.1.a*: The GSCP should elaborate, plan, determine, monitor, control, assist in the implementation and resolution of strategic planning, policy issues and provisions in the field of CP. Par.4. f states that the GSCP should take care, in case of an ongoing or imminent disaster, for the organized evacuation of citizens from an area for their life or health protection *[This was foreseen also in article 18 par. 2 of law 3613/2007].* Suggestion: a. It must be clear that its responsibilities also include ensuring the implementation -even enforcement- of law provisions. b. Mandatory plans, should me foreseen in legislation, for the organized & plan based evacuation order when it is sent from 112. c. This article should also include provisions to evacuate & save all animals in a disaster area, especially those who are in any form of a shelter. A plan is needed for the animals' protection, removal, management in case of catastrophes of any kind. Also, provisions for specialized planning, protocols, emergency procedures and knowledge are required in areas where "extreme sports" activities. To achieve this goal there should be cooperation with experts and certified associations for general instructions and directions, specialized by region, municipality and location. *Articles 25 & 26 - on State of Emergency &*

State of Special Mobilization of Civil Protection in order to mobilize the state mechanism faster. Both articles have been used extensively and repeatedly, even though some required decisions for their detailed application have not been issued. They are vital for the implementation procedures of the current law. *Articles 32, 33 & 42: Created a Directorate of Technical Works & Environment [DITEP] and a Risk Assessment Committee [RAC]*, respectively. The committee can *"… regardless of the declaration of an area in a State of Special Mobilization of Civil Protection, may characterize, as urgent and immediate implementation, preventive works or works of Municipalities or Regions or the General Secretariat of Civil Protection or any other competent body of the Municipality".* These articles are evaluated together because, by way of derogation from the applicable general provisions, if and when required, the approval of any environmental impact studies, environmental conditions and other licensing requirements is carried out by DITEP of the GSCP, within 90 days. However, these article provisions cannot be fully implemented, because of the organizational chart of the Ministry issuance delay to date, and the non-issuance of the Ministers – General Secretary's decision for the Directorate responsibilities & operational guidelines (concerns also other organizational units). Suggestion: Immediate elaboration and issuance of the Ministries organizational chart and the regulatory decision describing each units' responsibilities. DITEP should be able to intervene at every stage and case of disaster-danger. Issuance of a regulation or amendment of the law -where required- to clarify: a. The procedure for submitting a request to the RAC of Article 42. b. Which exactly projects it concerns. c. The procedure provided in article 42 par. 3 of the law *[after RAC decision DITEP licenses the projects that will be considered urgent with the addition of specifications - provisions of Environmental Terms and based on best available techniques].* d. That it does not concern - refer only to works -projects of a precautionary nature but of restoration as well, leaving no doubts for other interpretation. In any case, it should be clarified that it concerns any project that will be judged by the committee as urgent and immediate implementation. The issue of infrastructure in CP emergencies could also be mentioned in this article. e. That the GSCP, through DITEP, can submit to the committee projects that are considered to be urgent. f. That in the Committee of article 42 there is also appointed a representative of the Geotechnical chamber of Greece [GEOTEE], of DITEP [of the critical specialty and its director]. g. That the consent of GSCP - DITEP is required during the environmental licensing process of projects that fall within its competence (should be qualitatively determined whether it will be for all activities that may relate to CP issues, Seveso etc). During this process the Ministry can set environmental conditions and prerequisites for the public health and environment protection, based on legislation & best available techniques (BATs]). The collection of existing data can created a database. Article 32 was amended by article 40 of law 4760/2020 [11-12-2020]. Based on this revision, the Ministry's structure includes an Inspection and Control Unit [ICU] based in Athens *"… which reports directly to the General Secretary of Civil Protection … has as its mission the determination of compliance with measures of competence that it has or is assigned … and the imposition of administrative sanctions…".* The specific duties of the unit and any other necessary details are determined by a regulatory decision of the GSCP. To date, the unit has not been activated and there is no description of its responsibilities *[Indicatively, it is recommended that: The Inspection and Control Unit has the authority to intervene in any appropriate way & with a view to the protection of public health, the precautionary principle, preventively and to resolve, address the effects of any kind of risks, disasters and crises… examines whether the risks arise from the actions of individuals, from their illegal actions or from the omission of due legal action. When examining documents and other information available to public services, their classification as confidential cannot be used. The employees of the unit have pre-investigative duties, can examine suspects and accused individuals … carry out autopsies … order expertise … to conduct investigations … obtain evidence and act in accordance to articles of the Criminal Procedure Code. The unit may request the assistance of the competent prosecutor if there are indications of illegal actions leading to the risk of disaster or refusal to act to address them].* It is a unit for external investigation and may operate on a case-by-case basis by decision of the GSCP. Suggestion: Immediate regulation issuance, that will define the unit's responsibilities & jurisdiction. Interdisciplinary - interdepartmental staffing with competent personnel is recommended, high level computerization-database and logistical infrastructure. *Article 41-A Scientific Council for Civil Protection is established.* It reports to the GSCP. As far as it is known, it has not been established yet. Article 53-This article allows the funding of a budget for secret national needs at the GSCP, following a decision by the General Secretary and an opinion of the Special Expenditure Committee [article 53 par. 6]. There is a three-member advisory Committee on Special Expenditure, consisting of one Fire Brigade Senior Officer, the Head of the GSCP General Coordination Directorate, and the Head of the Financial Services General Directorate (G.D.O.Y.). Nevertheless, its need must be re-examined and if necessary a cross-parliament committee should be involved in relative decisions. According to the law, it aims at the most effective defense of national interests by the GSCP, in the context of fulfilling its mission. However, it appears that Its necessity has not been sufficiently justified and it has provoked strong reactions regarding the transparency and the financial resources use. *Article 54 par. 3.* [as amended by Par.1 Article 97 LAW 4821/2021 with effect on 31/7/2021] *"… If there is an urgent need, which requires the immediate adoption and implementation of measures for national security issues, protection of public order and safety, health and life of citizens, their property and protection of the natural wealth of the country, and only to the extent that is absolutely necessary to address this need, the GSCP can make new contracts and / or modify existing contracts of works, services and supplies at its absolute discretion and to immediately address this need by way of derogation, of any provision of Law 4412/2016 (A '147), as applicable, and any relevant provision of existing national public procurement legislation… ".* This article enables immediate response to disasters and risks at a faster rate, even than the one provided by the relevant provision of Law 4412/2016. Suggestion**:** This "tool" should be used sparingly & carefully, if deemed necessary by the Ministry. A committee or some kind of administration consulting body should be formed to assist in making the appropriate decision. In addition, quotes and cost estimates should be requested, even if law provision does not require it, in order to assure, with no doubt, that there is complete transparency, control of the allocation of financial resources.

3. DISCUSSION

The law has not been entirely applied and the foreseen administration bodies, units', directorates, committees etc. have not been set up. The organization chart and the relevant decisions that will dictate responsibilities have not been issued. However, the law is not canceled or even entirely inactivated, since some of its articles are selectively utilized [ex. Articles 25, 26 & 54]. This creates problems and malfunctions to the CP system. It appears that there is a tendency to introduce new legislation or revision of current one, since the existing one is criticized - considered, already, as inadequate. Also, it appears that the Ministry & GSCP is less involved in handling issues and relative projects giving the impression that it is by some means "marginalized" on its own will or from other factors. An example is the issuance of a joint MD *[43903/28/April 2022]* for funding preventive and restoration works-projects for disasters, without the participation & involvement of the Ministry that is supposed to be (co-) responsible for such issues. Inevitably, questions are raised on why this is occurring and what kind of CP is anticipated – required in Greece. Is the new MCCCP needed and will it be maintained in the future? Should the law be entirely rewritten? Should there be a vertical structure, minimize – eliminate bureaucratic procedures and in the same time assure transparency in decision making and fund handling? It is estimated that a new modern and quick responding CP structure is a nationwide priority and therefore a Ministry could ensure its existence. An idea could be to apply the new CP philosophy on existing coordination and administration bodies, with any required adjustments and upgrades. The current legislation has positive aspects that should be utilized and enhanced. Among other things, improvements and fine tuning of legislation may be needed, interoperability of involved parties is definitely necessary [1] and GSCP could be foreseen as an Independent authority within the MCCCP, catastrophes and dangers will not delay. Any decisions and planning must be done rapidly and efficiently. Provisions of the law must be applied and the GSCP must act towards their implementation by mobilizing every possible tool. If there is willpower to enhance the new MCCP it must have true, decisive and crucial responsibilities in its area of responsibility.

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THE DISTINCT IMPORTANCE OF "INTEROPERABILITY" AMONG ALL INVOLVED PARTIES & THE CATALYTIC ROLE OF CLIMATE CRISIS IN THE MANAGEMENT OF FOREST FIRES

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ABSTRACT

The subject of this paper is the importance of "interoperability" among involved agencies & parties for the management of forest fires during the last two decades. The importance of interoperability lies in the capabilities of a system, to be linked and to function with other systems without limitations and barriers to implement its purpose. Interoperability for managing and preventing forest fires refers to the co-operation among parties involved. So, it deals with a system in which operators must be connected & function without obstacles to protect the forest environment. This issue should be examined with particular emphasis on the term "interoperability" especially under the catalytic role of climate crisis and increasing vulnerability. The strong housing development (mixed environments) and the appearance of extreme weather phenomena as a result of climate crisis acting catalytic. Identified malfunctions in the management of forest fires are also an indication of the unsuccessful practical application of this requirement. Furthermore, knowing that interoperability among competent bodies is a factor of successful management of forests & fires, it is supposed that it is either absent or operates inadequately under pressure.

Key words: Management of Forest Fires-Forest Fire Fighting - Involved Parties - Interoperability – Climate Crisis.

1. INTEROPERABILITY

Particular provision should be made in ensuring Interoperability in Risk and Disaster Management hence in dealing with forest fires as well. Political willpower and planning for interoperability are an important element of successful disaster management and a further catalyst for strengthening disaster risk management policies. Under the European Framework, Interoperability is defined as the ability of a system or process to share and use information and / or functions of another system or process. The ability of the systems, factors and all the structures involved to communicate is the most important factor for effective disaster management in all of its possible phases. The fact that enormous losses of forests/woodlands are recorded every year, which have also a social impact, testify to the consolidation of pathologies and deficiencies (either in technical means and/or in human resources). However, in any attempt to investigate the causes of inefficiency in putting out fires, the occurrence of extreme weather events owed to climate crisis should also be a catalytic factor. This fact makes more difficult the effective prevention and dealing with forest fires. Climate crisis cannot be ignored by any planning, as it is directly related to the increase in the risk of ever-increasing forest fire outbreaks worldwide. Interoperability is a "contract of cooperation" among the competent and involved bodies, which in this case aims to deal with fires. A condition which is deemed necessary as the main competent body (Fire Service) is unable to achieve the best possible handling of forest fires by itself. Interoperability between the relevant agencies involved, in the broadest sense, could be identified with what is named "State Mechanism". Nevertheless, the description of the term should be given strictly, as a generalization does not help to deal with problems related with the poor cooperation among Services, Agencies, Volunteers etc. that have a common goal of preserving forests in Greece. However, in any effort to investigate the causes of inefficiency in extinguishing fires, the occurrence of extreme weather events, within the context of climate crisis, should be of crucial importance [9].

Interoperability, in forest fire management can be defined as the system that connects the agencies involved in this field, applying all the capabilities that exist per agency, avoiding any barriers and limitations that arise to achieve the goal. This, in general, is the protection of public health, the woodlands of the country and the successful forest fires extinguishing when this need arises. Barriers and obstacles are understood as those vulnerabilities that prevent, do not facilitate or simply delay the effortless - smooth operation of the "system" that refers to the prevention - suppression, but also the restoration of the forest fires effects. Since interoperability does not have a negative character, the existence of imperfections/deficiencies in it, implies the non-realization of this condition.

This fact makes the effective prevention and extinguishing of forest fires difficult. Climate crisis cannot be ignored by any planning, as it is directly related to the unprecedented increase in wildfires and their impacts worldwide. Interoperability is a “contract” of cooperation between the competent and involved bodies, which in this case aims to deal with fires. A necessary condition as the main competent body is unable to achieve the best possible handling of forest fires by itself.

2. PREVENTION & MANAGEMENT OF WILDFIRES

Main conditions that vary the severity of wildfires over the years are directly related to the management of forest fires, which includes their prevention and fire extinguishing. More specifically, forest management (forest clearing, opening and maintenance of fire zones) is not done systematically (even rarely), resulting in a dramatic increase in fuel material and making it harder to manage & put out a fire once it starts, as it helps it spread faster. The Agencies responsible for prevention are primarily the Forestry Departments, and secondarily the 1st & 2ond degree local authorities. Hence, this fact indicates a lack of cooperation between competent and involved bodies that should have a common goal of preventing forest fires. It is therefore an indication of the incomplete "interoperability" among competent bodies as well as Fire Service.

Prevention, should not be neglected as managing and extinguishing wildfires becomes extremely difficult. The fact that Environmental Education in Greece is equally deficient should not be ignored. This is demonstrated (among other things) by the large number of forest fires started due to negligence and under conditions where caution should be increased the citizens.

3. Climate Crisis & forest fires

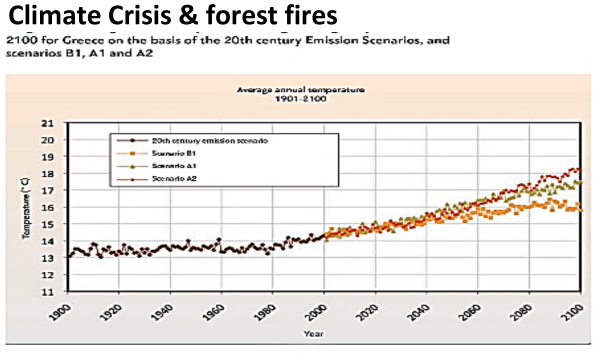

Figure 1. Average annual temperature changes 1901-2100

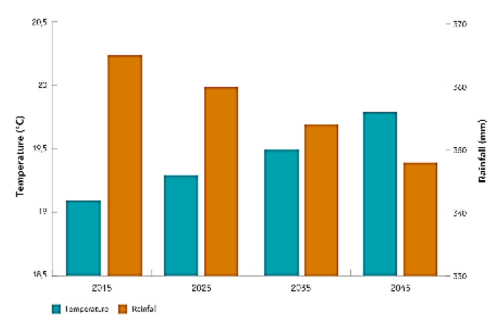

Figure 2. Change of climate variables of temperature & rainfall, Athens 2015-2045

Climate crisis is decisive in everything related to Forests and their management [1,2]. Some of the consequences of this are: **a.** Increasing temperature and decreasing average precipitation, leading to an increase droughts and heat waves frequency and intensity **b.** Rising ocean surface temperature, causing more and more intense hurricanes which will possibly be followed by floods. **c.** Intense drought, leading to an increase in forest fires. **d.** Winds and rainfall greater intensity causing intense floods and landslides. As the drought conditions are related to the extreme weather phenomena and the high temperatures of the Mediterranean climate, in Greece the most immediate impact of climate crisis is the forest fires frequency and intensity increase. Forest ecosystems of Greece are expected to become increasingly vulnerable, especially where land use changes are frequent.

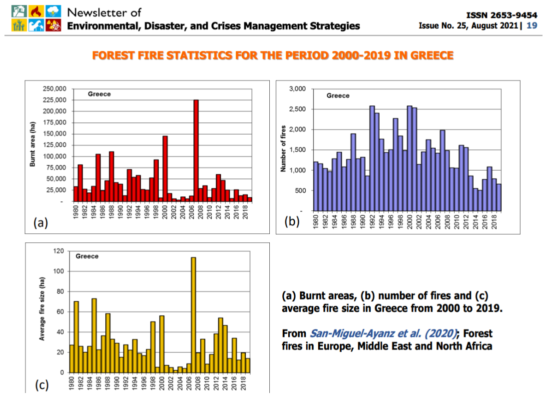

Figure 3. https://edcm.edu.gr/images/docs/newsletters/Newsletter_25_2021_July_August_Wildfires_in_Greece.pdf

Area burned by wildfires in Greece from 2009 to 2022
(in hectares)

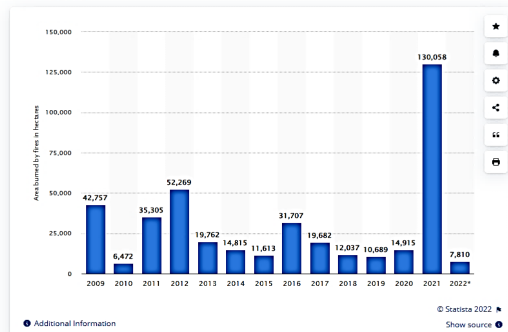

Figure 4. https://www.statista.com/statistics/1264709/area-burned-by-wildfire-in-greece/

Climate conditions in Greece are expected to change, resulting in immediate or indirect effects on forest areas in the near future. Forest ecosystems will become more vulnerable, especially during the period 2021-2050 [3]. Wildfires are, along with overgrazing (increases after a fire), the main cause of the country's bare mountains. In Greece, a mountainous country with forests mainly on steep slopes, the soil is washed away by the rains after the fires, making the forest regeneration almost impossible. Within the last hundred years the percentage of forest cover has been reduced to less than half [4]. The Mediterranean climate [5] of Greece favors the occurrence and spread of forest fires, as it is characterized by prolonged dry summers and strong winds. This, in combination with the combustible [burnable] types of vegetation [6] across the country increase the problem of forest fires, a major concern in recent decades. The increase in burned areas per decade is significant. The increase in forest fires in particular contributes to the formation of ecology: they affect the physicochemical environment by acting as regulators of biomass accumulation [7]. In addition, they determine the biotopes structure and arrangement and regulate biodiversity, as well as other ecosystems characteristics (productivity, nutrient cycle, etc.) [8].

4. DISCUSSION

All of the above-mentioned make it necessary to change or abolish ineffective «strategies» and measures for the protection of forests in Greece. The cooperation of the competent authorities is imperative nowadays. In fact, a cooperation based on the absolute implementation of Interoperability in order to achieve the best possible performance and not the search for responsibilities, omissions and errors of the agencies. According to the existing legislation framework, the main responsible body for the operational planning to extinguish fires, as well as the provision of assistance for the rescue of people and material goods threatened by them is the Fire service and firefighters. The other organizations that are called to help are the: forestry service, armed forces, police, coast guard, local authorities, voluntary organizations, etc. Nowadays the Forestry Service has a limited ability and hence responsibility for prevention and fire protection due to lack of funding & personnel. However, it must be upgraded overall since forest Management is its responsibility, which in recent decades has been carried out with huge deficiencies or not at all. Here, the causes of this overriding of the process should also be sought as a successful firefighting includes a previously successful Prevention. The lack of this is an example of non-interoperable cooperation, with prevention reflected only in the design of the legal Framework. During the research on the pathogens and deficiencies in the Forest Service, the responses of the representatives of the main forest firefighting agency were sought and recorded as well as the

employees of the Fire Department [9].
In these, their common concerns on specific issues and specific deficiencies and malfunctions are identified, generally and jointly summarized as follows: **1)** They request the timely assistance of the other competent bodies as well as the volunteers in order to cope more effectively with extinguishing the fires. **2**) They request the mediation of the State, to find more effective solutions. **3)** They refer to an inappropriate way of communication as it wastes valuable time. The Fire Service, having the "general order" has wireless communions with involved staff and secondary informs those who assist, via telephones (mobile or landline). This makes communication difficult and consequently delays the coordination among those involved, with possible consequences delays in dealing with the escalating environmental crisis. **4)** Prevention is considered insufficient by fire officials. Specifically, they refer to the accumulated vegetation in forested areas, which contributes to the likelihood of forest fire starting and spreading. Interoperability, currently, does not appear to work, since its essence as a concept, includes the perfection in the cooperation of all involved bodies, regardless of their degree of involvement with the object of forest management. The Mechanism, ideally, works as a whole and inseparable from obstacles and malfunctions. It should not be based on the moral efforts of the services that are on the “front line”. For the subsidiarity (co-)competent bodies, the concept of assisting in this case not being accountable for incomplete tasks, does not mean that substantial collaboration is achieved in the problem. Highlighting the weaknesses of the natural environment protection system is everyone's duty and interest. The continuous degradation of forest ecosystems, with the interrelated effects on the environment (floods, drought, desertification, etc.) is a reality that cannot be ignored. It is absolutely useful to understand that prevention and fire extinguishing should not be separated / differentiated, as this creates the gap that allows any omissions in the application of the regulatory provisions concerning the general protection of the natural environment. The object of forest management should be done with a single coordination and not in individual actions. It is important to take care of the protection of natural ecosystems, at an earlier stage, instead of focusing on forest fire fighting. Finally, it would be crucial if the academic community had an enhanced role in decision-making on issues related to data evaluation. This is only possible by scientifically trained people who can connect the knowledge with all possible risk and crisis scenarios and indeed propose countermeasures and practices for each of them. In addition, the evaluation of data after a catastrophic fire or other environmental crisis is of particular value as it is also the one that protects against possible future similar mistakes.

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5. The Mediterranean climate is characterized by very hot and dry summers. Winters are milder and not particularly rainy. (from: Konstantinidis, 2003, p.32).
6. All grassland species. Highly flammable: Shrubs: holly, dogwood, heather. Trees: Aleppo pine, Thassos pine, cypress. Less flammable, the wild or black pine, the Macedonian pine, the various types of oak (except holly and chestnut). Low flammability: firs, beech, Scots pine. (from: Vorisis, 2001, pp. 45-46).
7. The dry weight of all the organic matter of an ecosystem. It also refers to the plant material that can be consumed during the fire, (from: http://www.fria.gr-Institute of Mediterranean Forest Ecosystems and Forest Products Technology).
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FOREST FIRE PREVENTION, PREPAREDNESS AND RESPONSE PLANNING 2022

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ABSTRACT

Based on the legislation and my 25 years of experience and, my objective is to point out in my opinion the negative steps on the forest fire prevention, preparedness and response planning in the effort to reduce the adverse effects, so that they can be corrected. The upgrade of the General Secretariat of Civil Protection to a Ministry of Climate Crisis and Civil Protection after the disastrous 2021, where more than 1,800,000 acres were burned, was a positive step. However in many cases there was no implementation of the provisions of the laws, as a result of which neither the goal of the legislator nor the harmonization of laws were realized. I believe that admitting the mistakes of the past and using resources and human resources more rationally will could get better results.

Keywords: Legislation, Meetings, Volunteers, Communication, Resources

1. INTRODUCTION

The current and past legislation in Greece is complicated, while new measures are constantly being introduced. In addition in many cases there was no implementation of the law provisions, reducing or eliminating the legislation effectiveness.

An example is the non-harmonization of legislation over a decade of the new administrative division of the country (Kallicratis Plan) with the issuance of a law that will define the responsibilities of each body, so that there are no overlaps and coordination problems. At the same time, many pieces of legislation are based on older pieces of legislation, which do not correspond to today's reality and the needs. All institutional bodies (Government, Decentralized Administrations, Regions and Municipalities) are responsible for the planning of prevention, preparedness, response and recovery in relation to forest fires. It is not correct to allocate millions of euros to the Municipalities based on the population and not the area of forests in their area of responsibility.

2. METHODOLOGY

The facts in relation with the legislation concerning the forest fires in Greece during the latest year, as well as my 25 years' experience on Civil Protection have been used, in order to point out the pros and cons of the forest fire prevention, preparedness and response planning legislation in Greece

3. DATA

The establishement of the Ministry of Climate Crisis and Civil Protection created a positive impression on all citizens.

Especially for the 2022 fire season, institutional changes were made, namely:

i. Passage of Law 4892/22 (article 38) and establishment of EMODE (Special Units of Forestry Operations), with bonuses for the recruitment of frogmen and paratroopers, but not for volunteers of Civil Protection, trained and certified in extinguishing forest fires by the Fire Service,

ii. Provision of fuel to the Armed Forces and Police by the Fire Service, but not to the volunteer groups that assist in extinguishing forest fires.
iii. Purely Armed Forces patrols, not trained in what to do in the event of a forest fire.
iv. Missions of European firefighters to assist the Fire Service, including Norwegians and Finns.
v. Prohibition of traffic in forests and thickets and with a hazard index of 3, when the presence of people prevents malicious actions.
vi. Holding 3 meetings per Regional Unit and per Municipality in April and on the 1st 15th of May, when they must be attended by the Director of Civil Protection of the Decentralized Administration and in the Decentralized Administration of Macedonia - Thrace and in the Decentralized Administration of Peloponnese - Western Greece and the Ionian Islands there are in each of them, 12 Regional Units with their 12 Capitals, so 12X3 +12X3 = 72 meetings in 10 working days on the 1st 15 days of April, 9 on the 2nd and 9 on the 1st of May, since the Easter holidays also intervene and May Day. 72 meetings in 28 days....!
vii. Passage of Law 4871/21 (article 60) and the new penalties for Arson are mentioned.
viii. Passage of Law 4824/21 and transfer of Forestry Services to the Ministry of Environment and Energy
ix. Passage of Law 4685/20 and establishment of the Natural Environment and Climate Change Agency (OFYPEKA) in Athens (Article 27) and the abolition of the Forest Management Agencies and integration of the abolished Agencies into the new Organization by Ministerial Decisions (Government Gazette 6191/t.B΄/23-12-2021).
x. Passage of Law 4916/21 (article 91) on the use of fire to extinguish the fire (backfire), but only by EMODE (KYA 167/20-6-2022)

There are positive and negative points in all the above decisions, where the negative cancels the positive effort towards the objective.
In addition, the following points remained in the same status:

i. The unorthodox allocation of credits to the Municipalities and Associations of Municipalities
ii. Regional Civil Protection Coordinators: not needed
iii. Not using loggers, who know better than anyone how to put out a forest fire.
iv. Non-activation of the provisions of Law 4662/20, concerning the use of Municipal vehicles and machinery by volunteers (Article 70).
v. Zero appropriations of the Ministry of Environment and Energy for fire protection. With €1,700,000, all the Forestry Services of the country were financed in total for fire protection.
vi. The institutional list of participants in the meetings of the Municipal Coordinating Bodies is without the presidents of the communities, although they are institutionally involved in planning and dealing with fires, according to Law 4555/18 (art 63 and 84)
vii. There is no uniform frequency of communication between the parties involved in a forest fire, as a result of which proper coordination is not done.

The above comments are made based on the legislation and my experience in achieving the joint effort to reduce forest fires and their adverse effects.

AEOLIAN: A NEW CROWDSOURCING SOLUTION TO ENHANCE PREPAREDNESS AND RESPONSE TO NATURAL AND ANTHROPOGENIC HAZARDS

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ABSTRACT

Recent climate change projections indicate that the frequency of extreme climatic events will substantially increase in the European continent. This is expected to put under significant stress ageing infrastructure, substantially increase disaster risk and bring significant challenges to societies. This work aims to present AEOLIAN tool which is a new Augmented Reality (AR) mobile application for natural and anthropogenic hazard assessment. AEOLIAN aims to enhance prevention, preparedness and response to evolving risks and occurring disasters. The main functionalities of the proposed solution are presented which provides a useful tool to support the preparedness of citizens and civil protection authorities with features supporting training and citizens awareness raising for evolving hazards coupled by timely notification and effective communication. The main functionalities of AEOLIAN during the response phase are also presented aiming to enhance bilateral communication with end-users, via the exchange of media files and by disseminating safety collection points, as well as communication among end-users via photos and/or text exchanges.

Keywords: Disaster, risk management, augmented reality, preparedness, response, climatic risks, hazards, environment, civil protection, safety, resilience, immersive technology.

1. INTRODUCTION

Climatic risks are considered as main challenges on a global scale. These issues are expected to amplify as recent climate change projections indicate that the frequency of shifting weather events will substantially increase [1, 2]. For example, severe flooding incidents are anticipated to double in Europe by 2050 [3], posing a significant threat to the resilience of critical assets over watercourses [2]. Modern climatic conditions are therefore expected to significantly affect the integrity of ageing critical assets and societal functions due to the high potential of extreme drought and flood events [4]. The increasing trend of extreme weather events and natural hazards emphasises the urgency of adapting to current and future climatic events. Emerging technologies can support preparedness and response to disasters; however, there is limited understanding on how to implement them effectively and in the majority of the cases they do not provide timely and advanced information in case of natural hazards to both citizens and protection authorities.

This work presents AEOLIAN AR mobile application which aims to enhancing the preparedness and response actions undertaken by citizens and citizen protection authorities (CPAs) focusing on bridging the Risk Perception Action Gap (RPAG). The RPAG refers to the lack of active engagement of citizens to the preparedness and response phases of crisis situations of evolving risks which are usually focused on one-way and top-down risk communication that is most of the times initiated by CPAs [5]. AEOLIAN AR mobile app is a new crowdsourcing solution which is following a co-creation design process, through various development iteration phases. The solution places at the centre both relevant authorities and vulnerable citizens, in an effort to deliver functionalities customised to their needs, enhancing knowledge generation and exchange among end users. The tool is built to directly disseminate early warnings, to offer real-time interaction between experts and vulnerable communities through targeted campaigns, to communicate effectively climatic risks to citizens, and finally, increase their disaster preparedness. It is coupled by Augmented Reality (AR) technology, which seamlessly blends real environments and virtual objects, that enriches the knowledge of citizens by disaster tales narratives, in a user friendly and easy-to-digest format. The proposed solution empowers participation, enhances learning through virtual education material focused on climatic and anthropogenic related risks (e.g., flood related hazards, forest fires), and effectively communicates warnings and crowdsourcing information to relevant authorities allowing for precautionary actions to be employed in areas of concern. The developed solution has the potential to lead to improved understanding and communication of climatic risks between CPAs and citizens, enabling to improve the anticipation of natural hazards towards building climate resilient societies.

2. MAIN FUNCTIONALITIES OF AR MOBILE APP

The AEOLIAN system comprises of backend and frontend components as presented in Figure 1. The different modules encapsulate the functionalities of the system which are focused on the following modules: AR technology to provide an immersive experience to the user, the CPA communication module which will enable direct communication between main end users to enhance the dissemination of critical information to interested parties. The media capture functionality aims to centre citizens at the forefront of reporting critical data in locations where such information is considered to be scarce. The hazards reaction module will assist in providing advanced guidelines to end users in case of evolving hazards in adjacent areas while the mapping and navigation module will assist to direct them to safety locations. The gamification feature aims to engage citizens further in the preparedness phase through structured levelled training activities. The AEOLIAN AR mobile app will also be able to exchange information with 3rd party tools (e.g. existing infrastructure of CPAs) while the backend module will be used to store and deliver the required information to specific target groups of citizens.

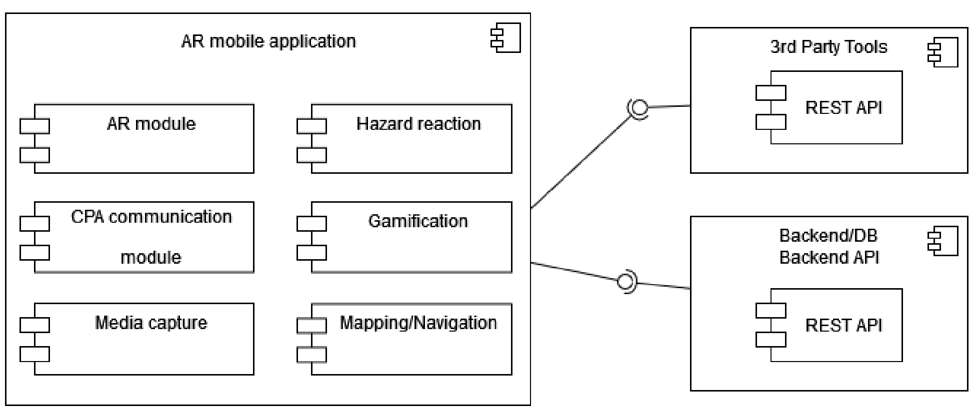

Figure 1. Logical Architecture Diagram of AEOLIAN AR Mobile App.

3. AEOLIAN FUNCTIONALITIES IN DIFFERENT DISASTER RISK PHASES

3.1 PREPAREDNESS PHASE

The preparedness phase aims to enhance hazard assessment, prevention, preparedness and response to evolving risks. In terms of prevention, AEOLIAN app aims to support training and citizens awareness raising for an upcoming hazard. Besides the traditional way of face-to-face training, through the app users can be educated about threats, risks, expected damage and means to mitigate the risk in a gamified structured levels form. Another feature will also be used to verify acquired knowledge of the user of the application through the use of tests and quizzes.. The AR feature may also be used for training and education through disaster tales and providing historical information of past hazards. This will enhance users learning about historical hazards that have occurred nearby (e.g. accessible through a map view in the mobile app) and at the same time receive useful preparedness material.

3.2 RESPONSE PHASE

During the response phase of a disaster management cycle, AEOLIAN solution aims to enhance bilateral communication between citizens and CPA end-users and consequently resulting to timely alerting of the general public about imminent situations. As presented in sequence diagram of Figure 2, users that first identify a possible hazard may use the mobile app to communicate with the relevant authorities and report about evolving risks. Upon validating this evidence, the CPA may create an alert to warn all the users of the AEOLIAN app about the hazard. The alert is coupled with extra information like targeted guidelines about the ongoing situation and general navigation instructions to the safety areas where specialized support can be provided by the relevant authorities. Based on these functionalities, the users are encouraged to proceed to safety locations outside the danger zones. This process is assisted by the proposed solution with the events map function in which all ongoing risks are presented alongside with relevant info (e.g. danger zone, safety areas etc).

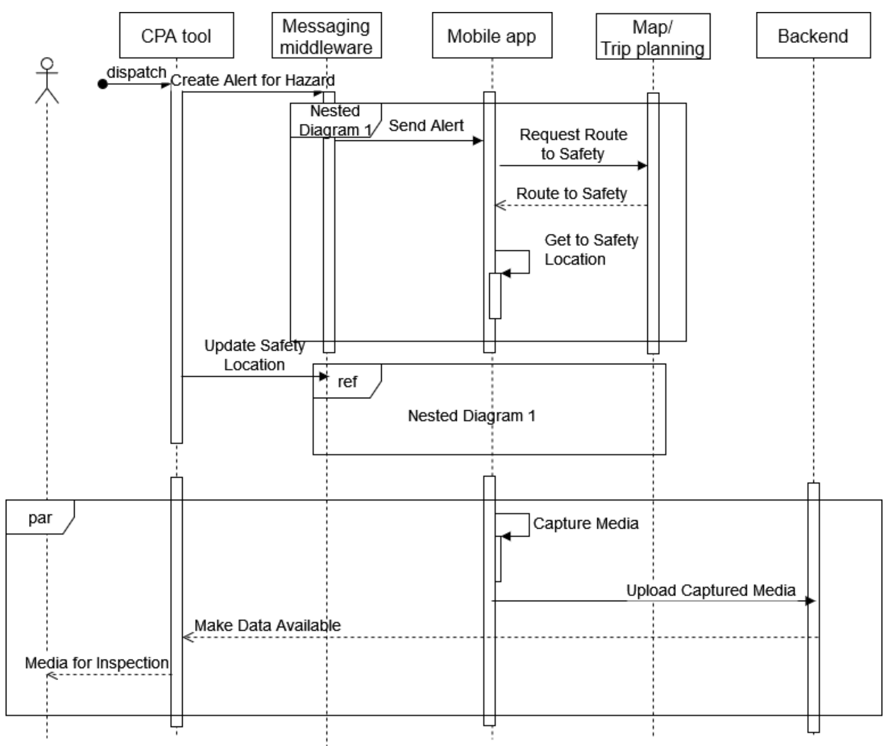

Figure 2. Sequence diagram for AEOLIAN mobile app.

3.2 MAIN RESULTS AND NEXT STEPS

The proposed AEOLIAN AR mobile app has the potential to significantly support end users to effectively prepare and respond to natural and anthropogenic hazards. The functionalities of the solution have been defined through a co-creation approach with end users that enabled an interaction between participants, case study owners and technical partners and provided new, compelling ideas. The co-creation approach also facilitated the enhancement and adaptation of the technological solutions for bridging the RPAG. Training material is currently under the design and preparation stage and will be implemented by the operational authorities focusing on providing information about potential risks for each area and advance the preparedness of citizens. The first round of workshops in the RiskPACC case study regions enabled the further conceptual development of the AEOLIAN crowdsourcing solutions at TRL 2. The next steps involve additional iterations with end users, towards the further development of the technological tools and their testing and validation in a representative environment (TRL 5).

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SIMULATION OF A SMALL WAREHOUSE FIRE USING THE B-RISK SOFTWARE

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ABSTRACT

Fires in warehouses are a special case of residential building fires, which tend to be more intensive and spread more easily compared to other categories of fires in buildings. This study aims to examine the effects of two fire scenarios for a small warehouse used by its owner as a storage room for pellet wood chips, and a small 5lt fuel tank filled with gasoline. According to the methodology used in this work, two case studies were considered: in the first scenario, the warehouse is equipped with an operational fire suppression system being activated 132 seconds after the fire break out, while in the second scenario the same fire suppression system in the same warehouse did not operate. The results extracted through the fire growth simulation analysis carried out with the use of the B-RISK simulation software, include the development of the heat release rate, visibility, heat release rate, and the CO concentrations in the warehouse towards time since the fire's outbreak. According to the results of this study, the significance of installing a fire suppression system and ensuring its functionality through proper maintenance is considered of extreme importance, since in the case of the first scenario, there is a considerable reduction in all of the aforementioned estimated values.

Keywords: fire safety engineering, structural fires, fire dynamics, computational fire modelling, B-RISK.

1. INTRODUCTION - OBJECTIVE

Warehouse fire safety has always been one of the most significant concerns, both for owners and firefighters, as well. Warehouse fires can risk the lifes of occupants and first responders, result in a significant financial, and negatively impact the environment [1]. İn the United States of America, for example, there were a total of 1210 reported warehouse fires between 2009 - 2013, resulting in 3 civilian deaths, 19 civilian injuries, and 155 million $ in property loss [2]. Common causes of warehouse fires include those intentionally started, also referred to as "arson fires", malfunctions with electricity and lighting systems, fires caused by heating equipment used in a warehouse during winter months, smoking materials (cigarettes, lighters), and exposures, which apply to warehouses containing large amounts of materials which could catch fire when exposed to a flame or a heat source.

The use of fire suppression systems such as sprinklers combined with smoke detectors is one of the most helpful solutions towards reducing the effects of a structural fire, thus protecting the property and life of occupants. To this purpose, it is extremely important that these systems are to be carefully checked periodically in order to ensure that they will respond in the even of a fire. There are, however, cases where sprinklers did not operate as expected in residential fires. According to statistics, between 2015 and 2019 in a total average of approximately 51000 structure fires per year in the USA, sprinkler systems operated and were effective in 88% of the fires considered large enough to activate them.

The main reasons of a sprinkler not operating in case of a fire is the system being shut off at some point before the fire event [3]. In this study, two case study scenarios of a fire in a small warehouse are being evaluated. In the first scenario, the fire sprinkler system installed in the warehouse is fully operational, while in the second scenario the same system failed to activate. Reasons of such systems being non-operational may include a malfunction of the electrical system’s components, scaling deposits in the water supply system due to improper maintenance, or an unintentional de-activation of the system. The effects of fire in both cases will be assessed, and the differences in values of the visibility, Heat Release Rate (HRR), and the upper / lower layer CO concentrations in the warehouse towards time since the fire’s outbreak will be presented.

2. METHODOLOGY AND DATA

The warehouse of this case study has a length of 6m, a width of 5m, and a height of 4m. Apart from the main door, it also has a 1m x 0,5m glass window on the rear wall. Its surrounding walls are made of bricks with a surface mat of lightweight concrete, while its ceiling and floor materials are made of reinforced concrete. Inside the warehouse, its owner has stored four pallets of wood chip pellets, and a small 5lt fuel tank filled with gasoline. The warehouse is also equipped with a heat detector activated at a temperature of 57°C, a smoke detector with a 0.097 1/m optical density at alarm, and two sprinklers each installed at a distance of 0,025m below ceiling, with a water spray density of 4.2 mm/min, and a radial distance of 3,25 m. A floor plan of the warehouse is presented at the Figure 1 below. The interior temperature in the warehouse is 24°C, while the exterior temperature is 28°C, and inside the room the relative humidity is 52%.

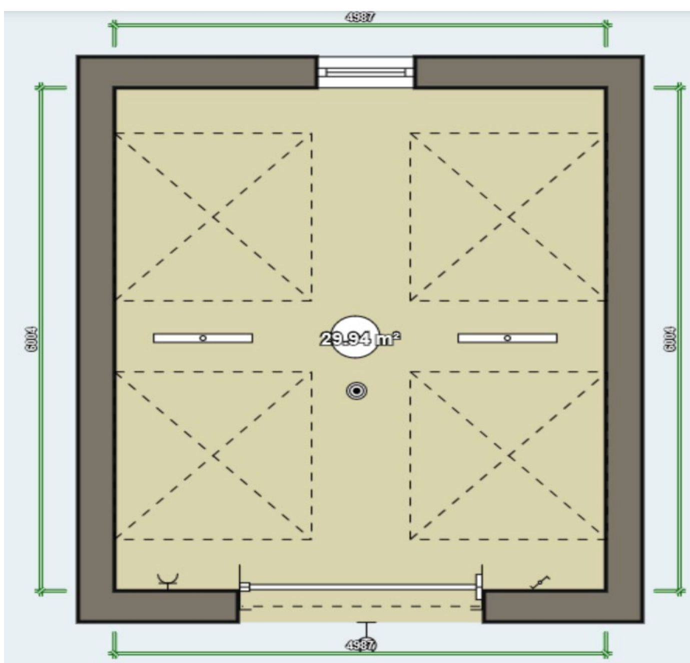

Figure 1. Floor plan of the warehouse used in this study

In order to evaluate the dynamics of fire development in the warehouse under assessment, the B-RISK Version 2019.03 fire modelling software was used. It is a user-friendly fire simulation program which has been developed by BRANZ and the University of Canterbury in New Zealand, based on its precursor zone modelling software, the BRANZFIRE [4], having been used in building fire simulations [5]. By providing a variety of inputs such as a room's dimensions (length-width-height) and flammable materials, wall, vents, floor and ceiling construction materials, fire safety systems, such as sprinklers, heat and smoke detector characteristics, its user can run simulations and get results about a variety of parameters like, for example, the HRR, visibility, gas concentrations in the room's upper and lower layers, and wall surface temperatures. The importance of a functional fire suppression system in a warehouse will be evaluated under two different case studies about the same warehouse: in the first scenario, the fire sprinkler system installed in the warehouse is fully operational, while in the second scenario the same system failed to activate. In both cases, the cause of fire was assumed to be an exposure of the 5lt gasoline tank to a heat source (cigarette), being left inside the warehouse unintentionally.

3. RESULTS

In the following paragraphs the results from the simulations which have been carried out with the use of the B-RISK software are presented for both case scenarios, including the development of HRR, visibility, as well as the upper/lower layer CO concentration over time. In the first case, the smoke detector activated at 32 seconds, the sprinkler system in the warehouse responded 132 seconds after the beginning of the fire, while the glass of the window fractured at 62 seconds in both cases. In the Figure 2 below, the HRR distribution over the first 25 minutes is presented for both scenarios. As for the visibility inside the warehouse, expressed in m per 2m distance, the simulation results for both fire scenarios are presented in Figure 3 below., and the results of CO concentration in the warehouse upper and lower layers are presented in Figure 4.

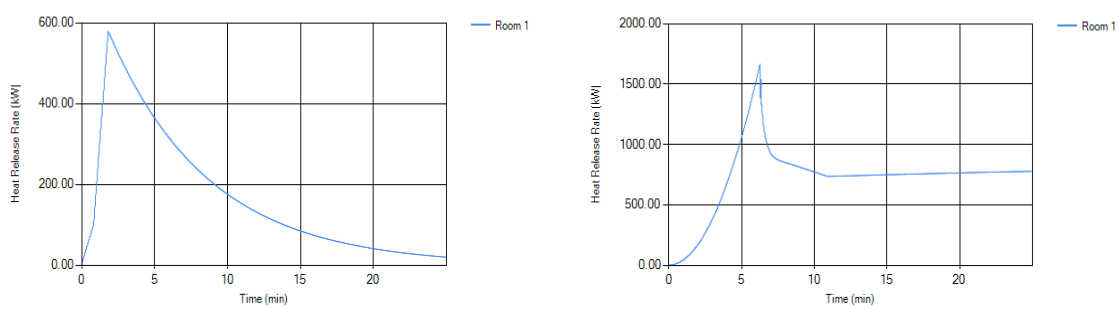

Figure 2. HRR development over time for the 1st scenario (left) and 2nd scenario (right)

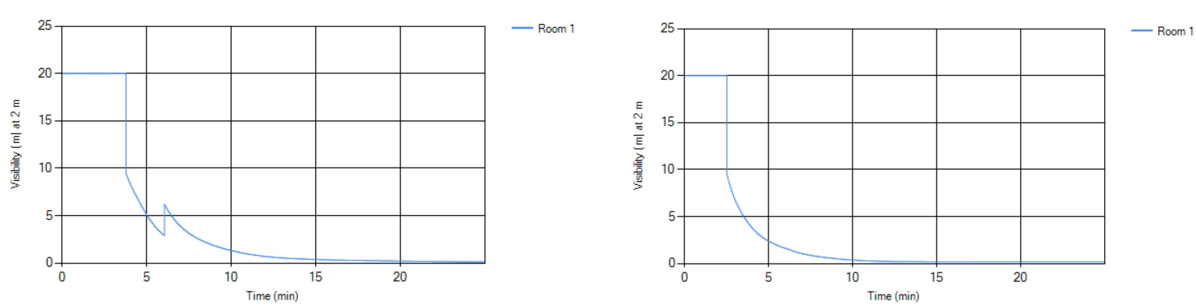

Figure 3. Visibility development over time for the 1st scenario (left) and 2nd scenario (right)

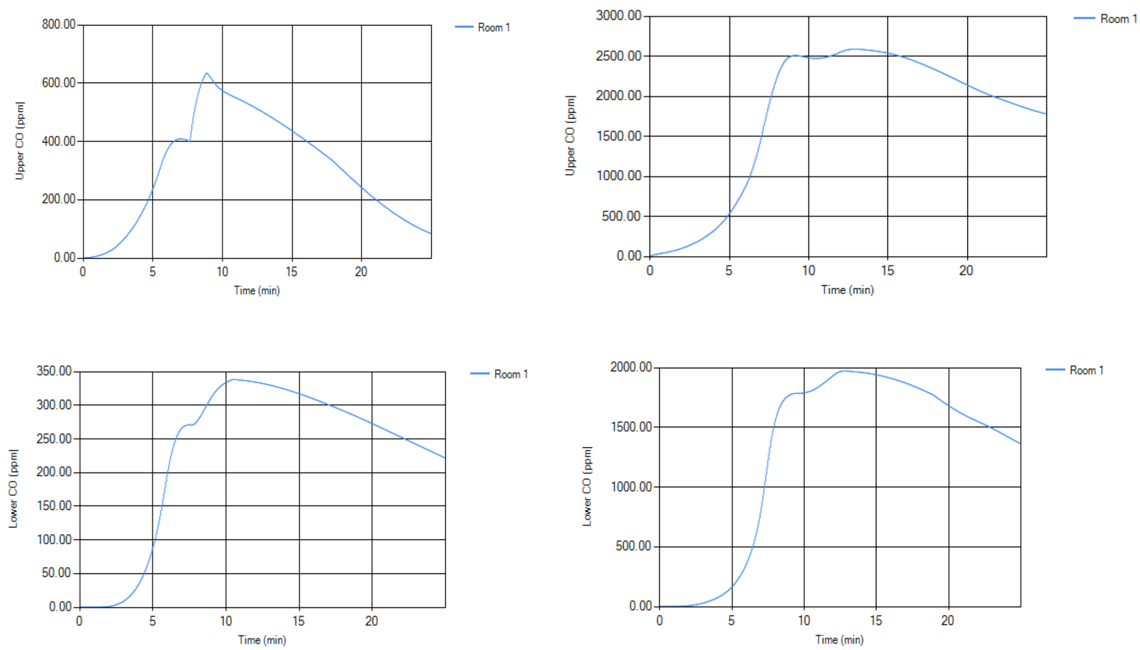

Figure 4. Upper/Lower level CO (ppm) over time for the 1st scenario (left) and 2nd scenario (right)

4. CONCLUSIONS

As can be seen from the B-RISK simulation results, in the first scenario the HRR in the warehouse under fire is being controlled to a reduced level by the sprinkler system activation, being kept below 600 kW after the first two minutes of the fire outbreak, following a constantly declining rate afterwards. In the second scenario of a non-functional sprinkler system, a flashover occurs at 6,5 minutes after the fire started, reaching a maximum HRR of approximately 1600 kW, while after the flashover it drops at 760 kW, which is still a value significally higher than the highest HRR level reached in the first scenario, and a very important parameter to consider for the safety of firefighters, as well as for the property loss of the warehouse owner. As for the visibility, even though the results converge after 15 minutes from the beginning of fire in both cases, where there is a dramatic drop in the clear visual distance inside the warehouse, there is, however, a noticeable improvement in the results of the first scenario during the first 10 minutes. Finally, there is also a significant difference between the simulated values for CO concentration in the warehouse upper/lower layers over time, in the case of a functional and a non-operating sprinkler system, while in both cases the CO levels in the lower level of the warehouse are much lower than these of the upper layer, which is an important factor to consider for firefighters when trying to enter a room under fire, such as in the case of the warehouse in this case study.

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PRESCRIBED BURNING IN GREECE: PILOT APPLICATION IN CHIOS ISLAND

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ABSTRACT
A 2-year pilot project on prescribed burning (PB) has been running on the island of Chios, Greece since 2021. A core team of researchers and practitioners from WWF Greece, the Institute of Mediterranean Forest Ecosystems of ELGO "DIMITRA", the Forest Directorate of Chios Island, and the Voluntary Action Team “OMIKRON”, is conducting planned field PB experiments, matching fire behaviour with the fire impact on soil properties, the effects on trees and the plant biodiversity. Fire Service of Chios Island and Municipality of Chios support the pilot project by supplying water trucks and personnel during the burns. The Project is sponsored by Procter and Gamble corporation.
The project aims to introduce the use of fire in wildfire prevention in the country, namely PB as an accurate and effective tool for forest fuel management, to increase social– ecological resilience to wildfire and to contribute to a climate – resilient future.
It is expected to a) contribute, through applied research, to the standards and procedures development for the use of the prescribed fire in Greece, b) strengthen the role of the forest service in fuel management, c) build the capacity of the volunteer firefighters’ teams on issues related to the wildfire prevention and fuel management, d) increase knowledge and improve experience on the fire behaviour, e) further strengthen, improve and expand local alliances in Chios Island and f) improve landscape resilience and prevent forest fires.

Keywords: Prescribed burning, Controlled burn, Fuel management, Fire prevention, Landscape resilience, Greece.

1. INTRODUCTION
Prescribed burning (PB) is both science and technique and it can be a very accurate management tool. It improves fire resilience over a particular landscape, reduces the probability of fire ignition, affects fire behaviour, making firefighting easier and safer, mitigates fire severity and reduces fire damages.
There is practically no PB in many parts of Europe and progress in adopting the method across the continent remains relatively limited even though increased PB is needed to provide a diversity of public benefits, including wildfire hazard reduction, improved forest resilience, and biodiversity conservation [1]. Only in Portugal, Spain, and south France, PB is practiced quite often, mainly for fuel reduction.
A shift to ‘knowledge’ [2] with improved reporting practices to invigorate PB science and suggest minimum reporting standards for future PB experiments, will facilitate future research syntheses, and foster actionable science [3].
In Greece there is no PB application for fuel management and wildfire prevention. The first efforts to introduce and utilize the PB in Greece began in the 1970s, when members of the forest scientific community and the Forest Service applied PB experimentally, analysed data and drew some preliminary conclusions. Although they made some steps to document the use of fire and study its impacts before

introducing PB as a tool to prevent forest fires [4, 5, 6], those sporadic attempts did not tie bonds with the forest and fire management community and the endeavour was soon abandoned mainly due to lack of constant funding, legal support, logistics, continuous scientific guidance and clear objectives. Almost half a century later, fire is still not used in fuel management and fire prevention and there is no institutional framework for the implementation of PB. The pilot project aims to introduce PB as a tool for forest fuel management and increase resilience to wildfire. The General Directorate for Forests and Forest Environment of Ministry of Environment and Energy provided all necessary permits for the implementation of pilot application of PB in Chios.

2. METHODS

A series of parameters are monitored, measured, and recorded before, during and after the implementation of PB in some of the 16 carefully chosen plots (Figure 1, 2 & 4, Table 1), namely:

i. soil infiltration (mm),
ii. soil temperature (°C) in various depths,
iii. erodibility,
iv. soil texture, nutrients and carbon in the soil,
v. soil respiration,
vi. organic matter decomposition,
vii. soil enzyme and microbial activity,
viii. plant biodiversity,
ix. sap flow ($cm \cdot h^{-1}$) (Figure 3),
x. water potential (MPa),
xi. fireline construction rate ($m \cdot h^{-1}$) along the plot perimeter, by mowing and using various hand tools,
xii. surface fuel loading ($kg \cdot m^{-2}$), cover (dimensionless), height (cm) and fuel moisture content (%) through destructive sampling, to describe the fuel situations and complexes before the burn,
xiii. meteorological conditions,
xiv. fire behaviour that is rate of fire spread (ROS, $m \cdot min^{-1}$) and flame lengths (FL, m) through ground and aerial photography.

Figure 1. Conducting a planned field PB experiment in phryganic vegetation

Table 1. 16 plots for the PB application in Chios island.

Protected Area	Forest type	Area (m²)	Ownership / Notes
No	Maquis, phrygana	3,099	Municipal
No	Maquis	1,528	National
No	Maquis	2,167	National
No	Grass, pine litter	5,741	National
SPA	Phrygana, pines' regeneration	2,750	Municipal / Fire break maintainance
Wildlife Refuge	Phrygana	2,900	National / Shaded fuel break maintainance
Wildlife Refuge	Phrygana, grass	6,812	Glebe / Shaded fuel break
Wildlife Refuge	Phrygana, grass	4,578	Glebe / Shaded fuel break
No	Pine litter	10,641	National Public
SCI SPA	Phrygana, grass	9,573	Municipal / Fire break maintainance
SCI SPA Wildlife Refuge	Phrygana	1,172	National Public
SCI SPA Wildlife Refuge	Phrygana	294	National Public
SCI SPA Wildlife Refuge	Phrygana	388	National Public
SCI SPA Wildlife Refuge	Phrygana	1,491	National Public
SCI SPA Wildlife Refuge	Phrygana	1,584	National Public
SCI SPA Wildlife Refuge	Broadleaf litter (oak)	1,031	Private
Total area		**55,749**	

Figure 2. Implementation of PB

(**a**) (**b**)

Figure 3. Preparing the necessary equipment (a, b) before the implementation of PB (Figure 4) to monitor, measure, and record sap flow (cm·h^{-1})

Figure 4. Conducting a planned field PB experiment in pine litter

3. DISCUSSION - CONCLUSIONS

This pilot project is expected to be the starting point for the application of PB in Greece, using specific standards. Thus, through this effort we expect, in the long run, PB to be institutionalized in Greece, and assimilated by competent services and local communities, as a tool for fuel management and consequently forest fire prevention through documented policy and law proposals that will be based on the results of this pilot implementation.

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FIRE RISK ASSESSMENT AND MANAGEMENT PLANNING AT A BUILDING BLOCK LEVEL: THE CASE OF KAKI THALLASA, ATTICA REGION, GREECE.

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ABSTRACT

Forest fires are quite destructive events as they induce damage to the environment, properties and infrastructure as well as fatalities. This work illustrates a state-of-the-art methodology for high-detail fire risk assessment and management planning in peri-urban areas that are susceptible to forest fires. The methodology fuses fire AI/ML hazard modelling, vulnerability and exposure estimation accompanied by in-situ observations. The fire hazard simulations refer to spatiotemporal scenarios of fire spread. The vulnerability layer was generated by blending population (density and age) and infrastructure characteristics based on census data. The exposure layer considers the land value (€/m^2) and acts as a qualitative indicator of possible economic effects on the study site. Throughout the field campaign, significant and high-risk areas (e.g., flammable buildings) were recorded and incorporated into the mitigation suggestions and management planning.

Keywords: fire, modelling, vulnerability, exposure, mitigation.

1. INTRODUCTION

Forest fires have negative consequences on the environment, animal species, infrastructure and properties. This scenery is further escalated by the impact of climate change due to the increase in the intensity and frequency of summer droughts [1]. Thenceforth, it stands to reason that fire risk assessments and mitigation plans should be a crucial priority to encounter impending challenges and support decision-making processes (e.g., emergency evacuation strategies and prevention measures). In this light, a cornucopia of fire risk assessment methods has been developed over the last decades that support operational actions before, during and after the occurrence of a fire event [2-5]. As far as this work is concerned, the presented methodological approach is an alloy of geoinformatics, machine learning techniques and field observations that aim to assess fire risk and assist management planning in peri-urban/urban areas that are susceptible to forest fires at a city block level.

2. METHODS

The methodology demonstrates an integrated approach (Figure 1) for fire risk assessment and management planning [6] that is applied in two settlements of the Attica region, namely Keratea and Kaki Thalassa. In particular, it combines i) Fire Hazard Simulations, ii) Vulnerability estimation (based on population age and density along with the infrastructure material information), iii) Exposure (land zone value) assessment and iv) extensive field work which supports the evacuation and mitigation planning and highlights the high-risk points and areas of the study site. The aforementioned approach is circular and refers to office-to-field and field-to-office procedures. The outcomes (risk maps, management plans, etc.) of this operational-research project feed a web platform that is designed to reinforce civil protection stakeholders as a support tool against forest-fire outbreaks in high-risk peri-urban and urban areas of the Attika region.

Figure 1. Flowchart of the integrated methodological approach.

To begin with, the fire hazard spatiotemporal simulations refer to fire spread scenarios that initiate from the most probable ignition points for plausible fire outbreaks. The determination of the ignition points was based on the study site's wind characteristics (direction and velocity) and BEYOND's daily fire risk forecasting machine learning model [7-9]. Thereafter, the enhanced FlamMap (https://www.firelab.org/project/flammap) model which requires various parameters, such as topographic and fuel, was utilized to generate the fire hazard simulations.

Thereafter, the vulnerability layer was formed by combining population (density and age) and infrastructure characteristics based on 2011 census data (supplied by the Hellenic Statistical Authority). More precisely, the population density and age layers refer to two factors that are being commonly used as facets of social vulnerability [10], indicators of a fire breakout, components of fire evacuation simulations etc. In addition, the infrastructure characteristics are of vital importance to detect susceptible to fire areas by considering their materials (e.g., wood and stones) as they strongly affect the flammability of the buildings and thus the fire spread.

The next step concerned the exposure layer which considers the land zone value(€/m^2) and works as a proxy for the qualitative evaluation of the plausible economic effects in the area in case of a fire event.

As far as the risk assessment is concerned, it is based on the combination of all the aforementioned layers (hazard, total vulnerability and exposure).

Latly, the high-risk areas identified in the fire risk map were visited in situ to validate and update the maps. In parallel, throughout the field campaign, essential and high-risk areas (flammable buildings, traffic congestion areas, population concentration areas etc.) were detected, recorded and added to the mitigation suggestions and management planning.

3. RESULTS & DISCUSSION

The following figures (Figure 2 and Figure 3) represent examples of the final risks maps and proposed evacuation plans. More specifically, the risk map (Figure 2) demonstrates the assessed fire risk (from very low: green to very high: red) along with the existing infrastructure and services of the area, while the evacuation plans (Figure 3) illustrate the evacuation routes and order, refuge areas, traffic congestion points etc. It is worth mentioning that Kaki Thalassa was identified and highlighted as a high-risk settlement, as it is characterized by various dead-ends, poorly constructed roads, several houses surrounded by dense vegetation etc.

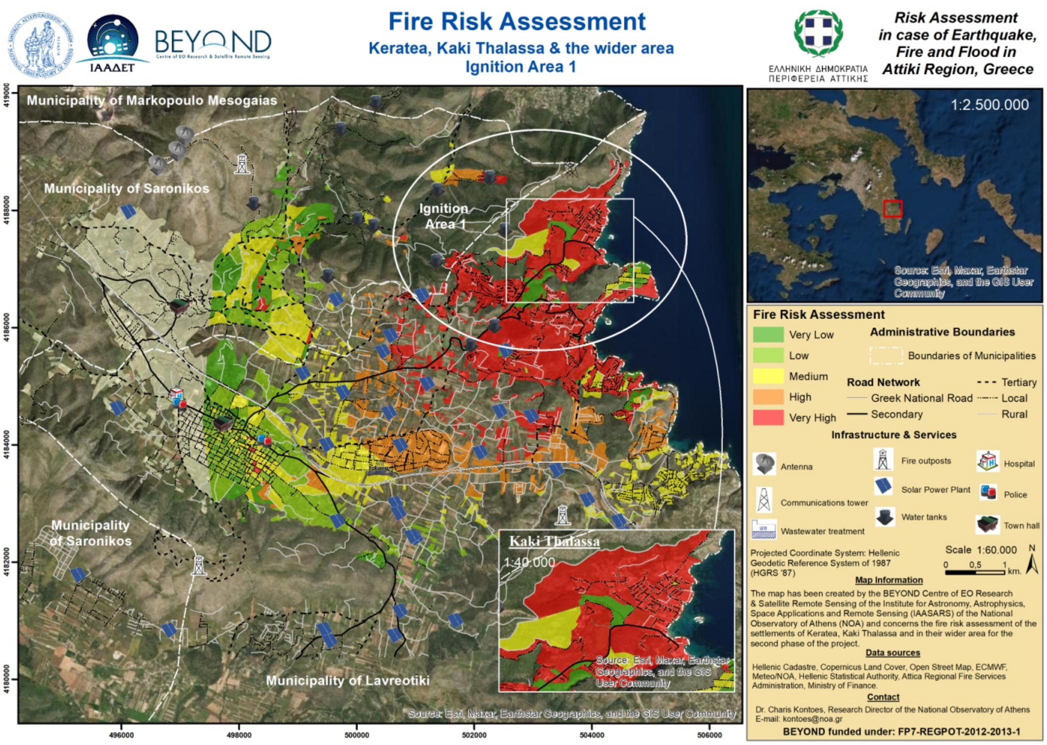
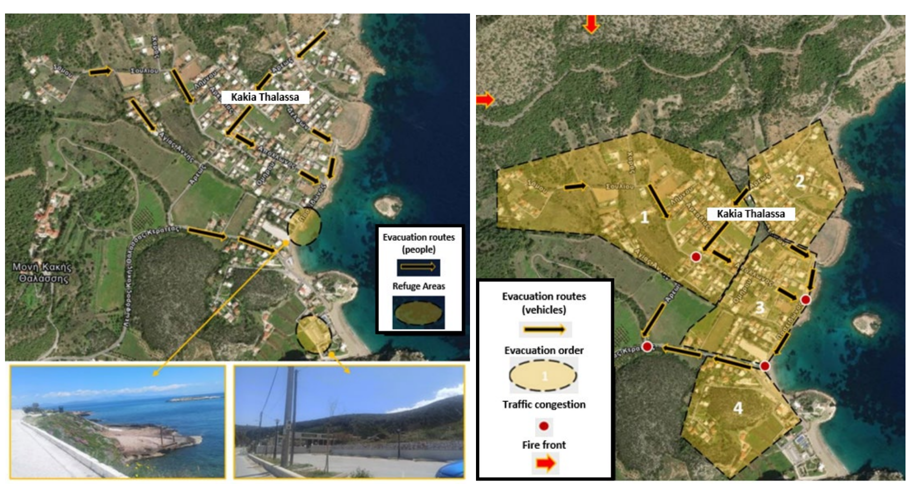


Figure 2. Fire risk estimation for an example ignition area - Infrastructure and Services.



(a) **(b)**

Figure 3. Evacuation routes **(a)** on foot and **(b)** for vehicles along with **(a)** refuge areas.

4. CONCLUSION

The utilized methodology of this work consists of state-of-the-art techniques that spotlight a fire risk assessment and management planning at a high analysis level (building block level). In addition, it is characterized by considerable added value as it supports public actors and stakeholders in decision-making via the means of risk maps, evacuation routes, a web platform etc. It is noteworthy that during the following steps, updated census data (data for 2021 instead of 2011) will be utilized to reduce the time inconsistency. Lastly, yet importantly, the mitigation planning will be further enhanced by the implementation of the Network Analyst routing extension in GIS software.

ACKNOWLEDGMENTS

This research has been supported by using data and resources from the project “Seismic, Fire & Flood Risk Assessment in Attica Region, Greece” funded by Attica Region and led and coordinated by the Centre of EO Research Satellite Remote Sensing – BEYOND, of the National Observatory of Athens (NOA).

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FIRESAT- PORTABLE ATMOSPHERIC MEASUREMENT SYSTEM FOR PRE – AND POST – WILDFIRE MONITORING.

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ABSTRACT

Extensive wildfires create large fire plumes that move over nearby areas and dramatically increase air pollution factors. In this study, we created a portable atmospheric measurement system called *FireSat*, to collect data from the atmosphere, which would initially indicate the risk of wildfire ignition and spreading. On a second level, in the case of a fire breaking out, the system can monitor in real time the immediate effects, while observing the fire's consequences in the surrounding areas. The FireSat Team participated in two CanSat competitions, one national and one European, garnering useful awards for its mission of protecting human life and preserving the environment.

Keywords : wildfire, plume trajectory, air pollution, ESA CanSats in Europe.

1. INTRODUCTION

On August 1st2021, a wildfire ignited in the area of Kalamonas Rhodes and burned about 1,000 hectares of coniferous forests and shrublands. Several days before the Kalamonas fire, multiple wildfires occurred in the west coast of Turkey [1]. These fires produced a hot veil of toxic gases that were transferred within the wildfire plume, covering the island of Rhodes and leading to a dramatically increased air pollution, which in turn, increased the average atmospheric temperature with a parallel reduction of relative humidity [2,3]. The purpose of this project was to create a portable atmospheric measurement system, as a CanSat, that will detect the critical factors that increase the risk of wildfire blowup and spreading, but also to identify their immediate effects, as per air pollution, whilst they phenomenon is taking place, observing the consequences it could have in the surrounding areas. Finally, this project was created as we participated to the National Competition "*CanSat in Greece"* where we won the 1st place [4] and in the European competition "*CanSats in Europe"*, an initiative of the European Space Agency (ESA) [5], where we won the "Highest Technical Achievement Award".

2. MATERIAL AND METHODS

2.1. Team organization and roles

The *FireSat* project team consists of seven students of the 3rd General High School of Rhodes at the age of 15 (2nd grade), their supervisor professor and the scientific responsible of the project's mission (figure 1).

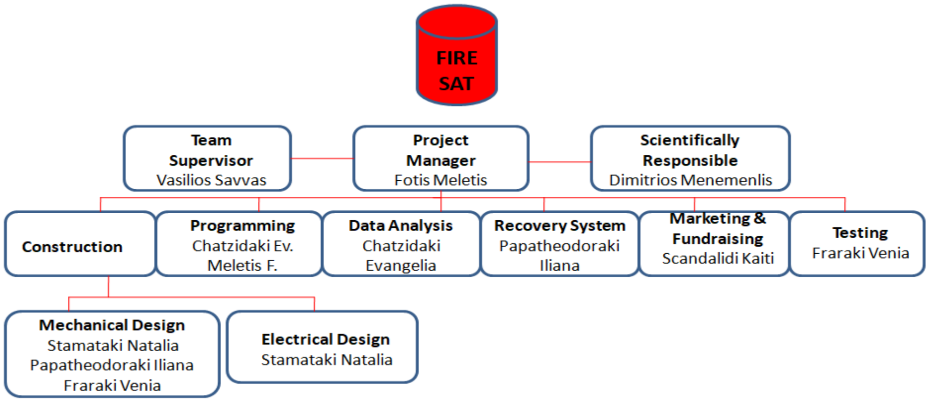

Figure 1. Chart of responsibilities of program members

2.2. Mission Objectives

The idea of the creation of our CanSat originated from the wildfire that broke out in summer 2021,on the island of Rhodes, leaving 1,000 hectares burnt [1]. After seeing the A.S.A.T.'s solar UAV, Copernicus and NASA's Moderate Resolution Imaging Spectroradiometer (MODIS) satellite, we decided to focus our research with the prevention and monitoring of wildfires, locally [6]. The usage of our portable atmospheric measurement system, before and during a wildfire is twofold. On the one hand, before the ignition of a wildfire, it is able to fly in specific areas - where they are not quite covered by the stable weather stations - and conduct measurements like temperature and relative humidity, especially on high risk days, in order to achieve a safe estimation of the risk of an ignition and spread of a wildfire in a particular area. On the other hand, during a large wildfire, *FireSat* flights can be implemented to measure two critical and vital factors both for the environment and humans. The primal is the burdening of the surrounding areas due to the wildfire's plume, indicating temperature, relative humidity, carbon monoxide and dioxide, mainly factors that greatly increase the risk of a new fire starting and spreading in the areas affected. On subsequent level are measurements which are taken under the plume of the wildfire, its course of direction as well as burdening indicators - toxic to human health like formaldehyde and the floating particles (PM 2.5). These measurements are extremely useful for the people living in those areas as well as for those attempting to extinguish the wildfires, e.g. firefighters, volunteers, service workers and citizens.

2.3. *FireSat* Description

A CanSat has been designed and built, so that it can be deployed by the competition's rocket [4,5]. For this reason, the shell and the shelves inside it have been built to withstand all the forces during the rocket launch. When the CanSat is separated from the rocket it will transmit back to the ground station the data collected by the sensors, such as CO, CO2, HCHO, PM2.5, geographic coordinates, atmospheric pressure, relative humidity and temperature and it will simultaneously save that data in the microSD card. A camera also has been installed in place to provide us live footage of the area below and save it to its own micro SD card. At the same time, in order to have the *CanSat* descent from the altitude of about 1000 metres, we designed and created a cross air parachute which ensures that our satellite does not exceed the velocity of 5 m/s. After its landing, the collected data will be imputed into an automated Excel file. Apart from the creation of graphs (height-time, CO-height, humidity-height, CO2-height, C^o-height, CH_2O (H−CHO)-height, PM 2.5-height), a map of probability of fire spreading is created, depending on the coefficient we made, which is based on the circumstances that we identified as creating the conditions for wildfire ignition or a dangerousness map of existing fire indicators for human health.

2.4.Mechanical - Structural Design

The outer casing and the shelves in the interior of our CanSat were printed with a 3D printer using ASA for the final printing of our satellite. The interior consists of three levels which are defined by a total of 3 shelves, (figure 2). On the lower shelf and in vertical position to the base surface of the CanSat, the circuit board, the SEN0233 and MQ7 sensor, the batteries with their voltage converter, the camera with its transmitter, the buzzer and the switches were placed. On the middle shelf is the MicroSD card module, positioned as well as the BMP 280 and CCS 811 sensors whereas on the GPS is set on the shelf above. Finally, on the top shelf the microcontroller Arduino Nano 33 BLE is located over the Adafruit RFM95W LoRa with its lengthwise positioned antenna. The use of insulating material between them is necessary in order to prevent the risk of any short circuit.

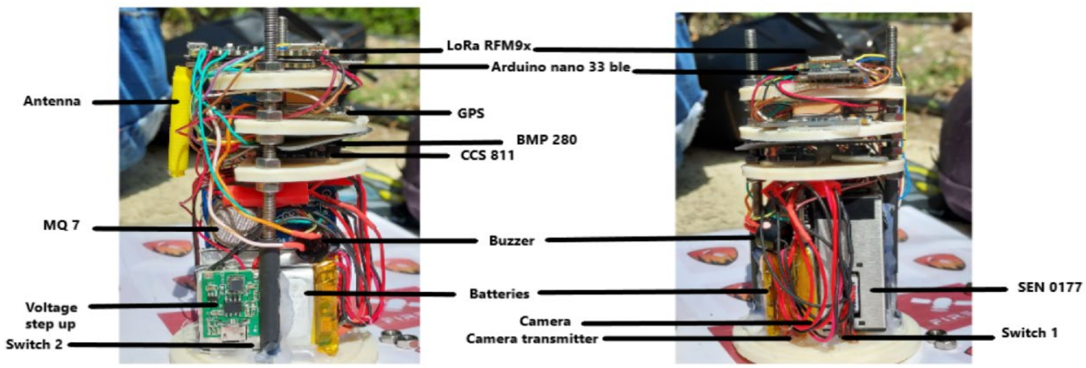

Figure 2. Structural design of the *FireSat*

2.5. Software Design

The "Arduino" programming language was used to create the code *Arduino IDE 1.8.19.* [7]. We chose this specific language because it is fast, easy-to-use and extremely popular on the internet so we can easily refer to it. The estimated data size is 138.784 bytes. Local data storage is carried out on a 32GB micro SD card in our CanSat. The data was sent via lora RFM9x transmitter to the ground station. The codes along with the libraries from all the sensors that we used have been taken from their wiki pages, as they all are open source. Our camera module does not require coding, as it's already programmed with a microcontroller on its own. The *FireSat* telemetry will send all the values from the sensor and the GPS data as well.

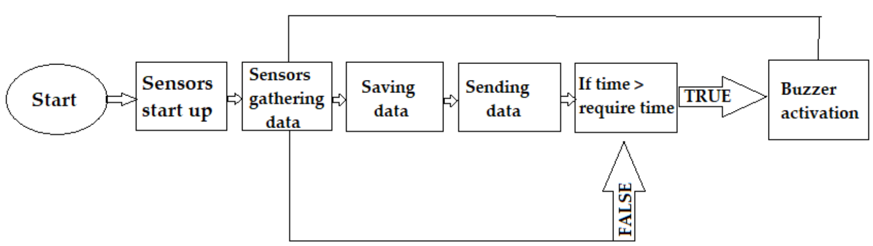

Figure 3. Software Design of the *FireSat*

3. RESULTS AND DISCUSSION

3.1 Air pollution and plume trajectory measurements

The data collected have shown that large-scale wildfires, negatively affect the air quality above wider areas and the latitudinal and longitudinal transportation of wildfires plumes and their aerosols, demonstrating high aerosol concentrations that caused air quality reduction over nearby areas. The behaviour of wildfires depends, among other factors, on the forest fuel moisture content [8,9] We designed and created *Firesat*, a custom-made portable measurement station which enables us to collect data as it can fly under the plume of a large wildfire and measure two things. On the one hand, the pollution of the atmosphere with hot gases from the path of the plume so there is a high risk of a new fire ignition and on the other hand, the pollution of the atmosphere with burdening indicators - toxic to human health especially for those attempting to extinguish the wildfires, e.g. firefighters, volunteers, service workers and citizens.

3.2 Lessons learnt from the National and European Competition

We acquired key skills such as teamwork, scientific research, data analysis & planning. In addition, we gained new knowledge and most importantly we achieved our goal through a unique life experience, after winning the 1st place in the National Competition CanSat in Greece and the "Highest Technical Achievement Award" in the European competition CanSats in Europe, an initiative of the European Space Agency (ESA).

Figure 4. Winning the "Highest Technical Achievement Award" in the European competition CanSats in Europe

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COMPARATIVE ANALYSIS OF TWO EXTREME WILDFIRE INCIDENTS: N.VOUTZAS/MATI-GREECE-2018 & ARAKAPAS-CYPRUS-2021

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ABSTRACT
Comparative Analysis of extreme wildfire behavior in incidents involving settlements and built areas aims to identify the similarities in conditions that defined the growth and impact of the fire. The analysis is based on data concerning two wildfires in Southern EU (Greece and Cyprus), which were gathered from local reports, publications of European Union organizations, media output, and testimonies of people involved in the incidents in the second place. The outcome of the analysis can be epitomized by the Rate of Spread (RoS), that is, the speed of fire propagation, being this the most critical driver of the impact of the fire. The RoS, combined with the form, status, and availability of the fuel to burn, contributes greatly to the extreme behavior of the fire and determines the type and scale of its consequences since it determines the time available for reaction by both firefighters and citizens. For the needs of the impact analysis, the RoS was reproduced using video animations, indicating the locations of the fire front at specific time intervals. The reference incidents used in this work are the Neos Voutzas/Mati (Greece, 2018) and Arakapas (Cyprus, 2021), the most catastrophic wildfire incidents in the history of the two countries. A critical fact that was identified in both cases is that the fire front split very early into two distinct fire branches challenging the response mechanism due to the doubling of the fire perimeter and the need to prioritize between the two active fronts. The results lead to the conclusion that in such a case, prioritization needs to consider the potential impact the RoS may have on the fire growth in the next hours. Prioritizing the less-important (in terms of mid-term RoS potential) fire branch may allow the fire to develop rapidly and massively as soon as it enters areas where the topography (e.g., canyons) contributes to the sudden and extreme increase of RoS due to changes in the fuel load (e.g., high forest) and the influence of fire-induced winds.

Keywords: Extreme Wildfire, Firestorm, Conflagration, Rate of Spread, Public Safety, Fuel mapping

1. INTRODUCTION
Extreme wildfire incidents are increasing fast nowadays, with a severe impact on public safety, the protection of human properties, and the resilience of critical infrastructures. At the same time, they consume natural resources and disrupt businesses. It is expected that the climate destabilization we have experienced over the last decades will contribute decisively to the further increase in frequency and severity of such incidents in the following years. The incidents that are considered here are related to peculiar fire behavior, which led to conflagration due to the induced firestorm conditions, i.e., local winds developed by the high intensity of the fire. Analysis of this category of wildfire incidents is critical for the identification of proactive and reactive protective measures to be taken at the state and community level towards reducing the probability of severe impact and improved coordination of response. Formal public reporting of the specific characteristics of the incident and the extreme fire behavior related to these incidents is missing at the EU level. The official reporting is limited to the figure declaring the burned area. No formal information on the fire start (time and location), initial attack, control, and extinguishment of the fire is publicly published. Furthermore, no official reporting of fire behavior characteristics (range and location of maximum values) such as Rate of Spread (RoS), Fireline intensity (FLI), debriefing on good practices, damages/fatalities, and challenges to be improved exist. This practice is exploited only in case a criminal process is applied, or a debate concerning the incident is

politically escalated. However, this type of information would be valuable to be collected and analyzed for all fires since it could greatly contribute to improvements both in the response mechanism as well as in the citizens' awareness and involvement in wildfire management. There is a standardization and uniformity lack in the way wildfires are reported and analyzed at the EU level. This would be necessary to create opportunities for European cooperation in analyzing the wildfire management situation in the EU member states and would allow cross-border sharing of information between stakeholders from countries with similar wildlife risk profiles (e.g., the Mediterranean zone).

2. REFERENCE INCIDENTS

2.1. The N.Voutzas/Mati fire incident

The fire ignited due to human activity (escape from debris burning) in a lot inside the Ntaou settlement, southward of the monastery of Ntaou in Penteli mountain, at around 04:40 pm [1]. Due to very strong winds blowing that day from the west, which isn't the usual case, the flames burn initially between the open spaces of the Ntaou settlement. The presence of the built area split the firefront into two parts (fingers), embracing the Ntaou settlement. The south finger of the firefront, driven mainly by the topography, was directed to the settlement of Kallitechnoupoli. The north finger of the fire-driven mostly by the wind, moved around the monastery of Ntaou, and from there, it entered a gully west-east direction, which led to another gully crossing the western boundary of the N.Voutzas settlement. Both fingers progressed, at the initial stage, with moderate RoS due to the scarce presence of fuels, comprising dispersed young pines, regeneration from past fire, and low shrubs. The RoS changed greatly when the north part of the fire (finger) entered the gully located in the boundary of N.Voutzas. The west slope of the gully was occupied by dense shrubs, while the east slope was covered by dense mature pine trees. The total blackened area was 1,280 hectares, and it was burnt in less than 100 minutes. The N.Voutzas-Mati wildfire claimed 103 lives due to burns, suffocation, and drowning, the more fatal wildfire incident in the history of Greece during a rather mild fire season and in a fire event of medium size [2].

2.2. The Arakapas fire incident

The fire started due to human activity (burning of agriculture residues) at 01:10 pm in a location west of Arakapas village in central Cyprus. Due to strong west winds, the fire front developed rapidly east, towards the Arakapas village. The fire front was split into two parts (fingers) as soon as it reached the structures in the western boundaries of the village. The south finger advanced along the nearby creek towards Kelaki village, driven mainly by wind and topography. The north branch moved along a cliff on the north boundary of the Arakapas village. The RoS increased massively as soon as the north branch entered the gully located at the north edge of Arakapas village to the direction of Melini village, an area covered by dense mature pine trees, while the wind direction had been favorable on its development compared to the gully's centerline direction. Four persons were declared missing. The final burnt area was 6,400 hectares, in a fire that lasted approximately 5 hours. The Arakapas fire is the worst wildfire-related disaster ever recorded in Cyprus, both for the number of fatalities and the burnt area in a single fire.

3. DATA COLLECTION

The primary sources of information that were used for reproducing the incidents' progress, the pattern of the fire growth, and the delineation of the fire scars are video footage, broadcasted live by bystanders on social media and footage disclosed either live or at a later stage by media outlets (TV & News websites). This material was geo-referenced on satellite imagery, available on Google Earth, which corresponded to the period before and after the fire in the affected areas (August-October 2018). In addition, the data references were evaluated and confirmed by on-site visits and autopsies. Scientific reports concerning the two fires [3,4] provided also significant information to support the assessment of the fire behavior. Furthermore, repeated visits and inspections in the affected area, focusing on specific sites and spots of interest, have enriched the knowledge regarding the way fire was propagated and grew across the area. Information concerning the reaction of the fire and local authorities, as well as the response of the local communities, was also collected via testimonies and interviews with people present in the disaster field during the fire.

4. INICIDENTS PROGRESS RECONSTRUCTION

4.1 Fuel Distribution Mapping

The spatial distribution of the forest fuel types, based on the vegetation types and form as well as their density, was mapped using and processing information from satellite imagery of Google Earth corresponding to the period prior to the respective fire incident. The vegetation forms in the area included low bushes, young reforestation trees, mature natural vegetation/trees, natural vegetation along creeks, hard logged cultivation, cereals cultivation & greenhouses. The information gathered from the images was used to classify the types of fuel into the typology of Prometheus [5].

4.2 Fire Scar and Fire Fronts Spread Patterns Reconstruction

The reconstruction of the N.Voutzas/Mati case was based on satellite images, available on Google Earth, taken in July & August 2018, while for mapping the scar of the Arakapas fire, satellite images dated 04/07/2021 and accessible via the Copernicus Emergency Mapping platform were used. The detailed reconstruction of fire scars, in combination with the forest fuel distribution maps, allows for identifying control points [6] and assessing the main fire spread paths along the areas that the firefront crossed violently or in moderate intensity during the timeline of the incident.

The main fire propagation control points for the two fires of N.Voutzas/Mati and Arakapas are shown in Figure 1. A simplified table of the values related to the propagation control points is presented in Table 1.

Figure 1: Timeline and path of the firefront in the fires of: (left) N.Voutzas/Mati & (right) Arakapas

Table 1: Fire Rate of Spread summary data for: (left) N.Voutzas/Mati & (right) Arakapas

No.	START	END	DURATION	DUR MIN	DISTANCE	ROS (km/hr)
1	16:41	17:39	0:58	58	2,42	2,5
2	17:39	18:10	0:31	31	3,26	6,3
3	18:10	18:30	0:20	20	1,4	4,2

No.	START	END	DURATION	DUR MIN	DISTANCE	ROS (km/hr)
1	13:18	14:30	1:12	72	1,64	1,4
2	14:30	15:30	1:00	60	3,59	3,6
5	15:30	16:40	1:10	70	4,84	4,1
7	16:40	18:00	1:20	80	2,64	2,0

5. IDENTIFIED COMMON CHARACTERISTICS OF THE INCIDENTS

- High and burst rate of spread: In both cases (N.Voutzas/Mati and Arakapas fires), the RoS calculated had been high. In the N.Voutzas/Mati case, given that the distance (straight line) between the eruption site and the coast is roughly 5.2 km, the mean ROS was 2.6 km/hr.[1]. Such ROS is not very rare, but the erratic fire behavior with bursts of ROS that according to the fire control points, reached maximum propagation rates of 6.3 km/hr., which explains the difficulty of the situation. In the Arakapas case, the maximum RoS reached the value of 9.6 km/hr.
- Multi-phased firefront built-up: The pattern of the firefront spread was in both incidents very similar, given that there has been an initial phase with fire propagating at moderate speed, which was followed by an abrupt increase of the RoS due to the change of the environmental conditions, i.e., entry of the flames into

areas with mature high and dense pine trees, and relief with gullies arranged along the direction of the blowing wind. The irregular development of the fire front due to spotting and the presence of constructions was combined with inadequate situational awareness [7] due to the rapid development of the fire and the segmentation of jurisdiction among services and authorities (Neos Voutzas settlement belongs to two Municipalities, and the burned area in Arakapas shared in two Provinces).

- Firefront split at the initial stage: One of the weirdest and most determinant factors in both fires was that the firefront at the beginning of its development was split into two early sub-fronts that propagated almost in parallel and were united at a very later stage of the fire incident.
- Fatalities: Among the similarities between the two incidents are the deadly results claiming the lives of 104 persons in N.Voutzas/Mati and 4 persons in the Arakapas fire. Fatalities in both cases have been directly related to the existence of linear obstacles in the evacuation of persons in danger.

6. CONCLUSIONS

A common characteristic in both fires was that the risk had not been adequately evaluated, and the communities weren't prepared to respond and react in the context of the rapid and uncontrolled spread of fire fronts across a relatively wide geographic area. The main reasons behind the risk's misleading evaluation had been the lack of risk awareness that emerged due to local communities' confidence that wildfire incidents will not affect their settlements. This perception is based on the fact that numerous past large wildfires did not threaten the core of these communities. In addition, local communities are familiarized with the presence of smoke in the wider area without almost any reaction. The apathy observed is due to the fact that citizens nowadays assume firefighting as the main practice for protecting the forest against fire. Furthermore, they consider the state being responsible for firefighting. Thus, they do not consider any responsibility for them as regards the prevention and mitigation of wildfires.

ACKNOWLEDGMENT

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PARAMETERIZATION AND RELIABILITY MODELIZATION OF A SUPPORT OPERATION BY EARTHMOVING MACHINERY DURING A FOREST WILDFIRE

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ABSTRACT
This dissertation belongs thematically to the field of Reliability Operations (Mission Reliability) and is a quantification of the qualitative characteristics of an Earthmoving Machinery Operations during a forest fire (or wildfire) under the Theory of Reliability (Risk Theory).

The purpose of this research is to create a model that will assess the reliability (ie the probability of success) of an earthmoving machine during forest fires. The above research problem will be attempted to be answered through a process of parameterization and quantification of the individual factors of this operation.

Keywords: Machinery, forest wildfires, Operation Reliability, Fire zones construction

1. INTRODUCTION
In general, my project is a combination of two concepts: The management of natural disasters and in particular the use of machinery during a forest wildfire, with fire extinguishing operations which are implemented mainly by the fire zones construction and the operations reliability theory, i.e. a analysis based on the theory of probability where the calculation of the estimated outcome of a operation is a documented probability.

2. MODEL FACTORS PARAMETERIZATION
The operation's Reliability Model consists of the following factors [Figure 1]:

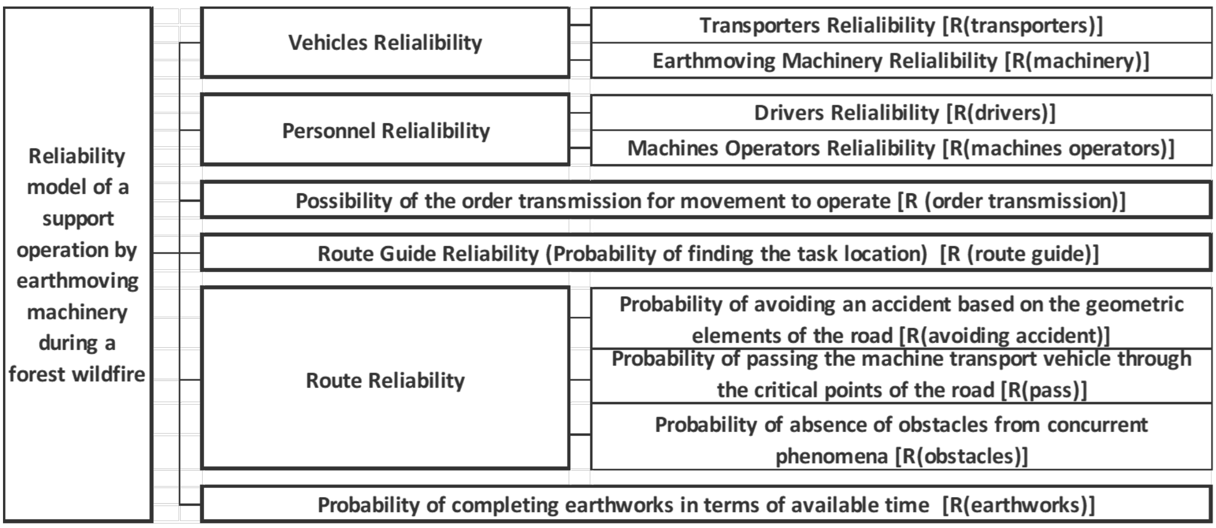

Figure 1:Model Factors Parameterization

The selection of the factors related to the vehicle movement was done after evaluating mainly the factors included in the simulation theories of transportation systems, such as JiangfengWang et al (2017) [1]. The other factors were selected based on other relevant research related to operations (eg military) [2],[3],[4] or from research related to road transportation issues [5].

3. MODEL GENERATION (CONNECTING FACTORS)
For our model we develop two reliability models in terms of how actions are connected, [2]:

- Model with serial connection of individual factors [Figure 2]:

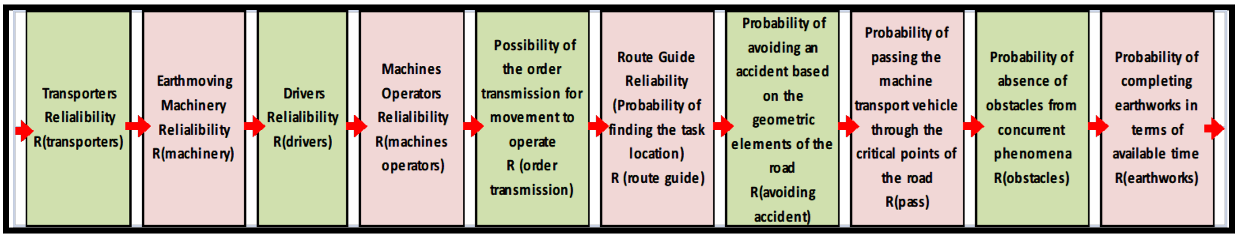

Figure 2: Model with serial connection of individual factors

The general mathematical formula of this serial model is:

R = R(transporters) x R(machinery) x R(drivers) x R(machines operators) x R(order transmission) x R (route guide) x R(avoiding accident) x R(pass) x R(obstacles) x R(earthworks)

- Mixed Model with parallel connection of driver/vehicle and operator/machine factors [Figure 3]:

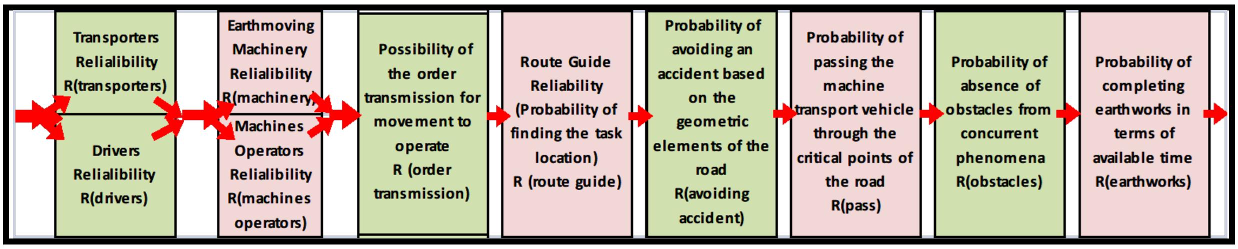

Figure 3: Mixed Model with parallel connection

The general mathematical formula of this mixed model is:

R = [1 - (1 - R(transporters)) x (1 - R(drivers))] x [1 - (1 - R(machinery)) x (1 - R(machines operators))] x R(order transmission) x R (route guide) x R(avoiding accident) x R(pass) x R(obstacles) x R(earthworks)

Evaluating the above models, we come to the conclusion that neither of them is completely correct because in both we can have deviations depending on the type of vehicle-machine damage and the degree of experience of each driver-operator to manage it. For the above reason, we conclude that our model should consist of two limits: An Upper Limit: Mixed Model with parallel connection of certain factors and a Lower Limit: Model with serial connection of individual factors

4. MODEL QUANTIFICATION

For the quantification we used the following assumptions: For the sake of simplifying the formulas in the model, we assumed throughout that all failure rates remain constant and that the systems are only subject to chance failures. The way of connecting the sub-factors is based on the literature references but also on the conclusions of operation of this kind.

- R transporters $=\sum_{i=K_\alpha}^{N_\alpha}\binom{N_\alpha}{i}e^{-i\lambda_\alpha t_\alpha}(1-e^{-\lambda_\alpha t_\alpha})^{N_\alpha-i}$, [3]

  with t_α =T Duration That The Vehicle Has Already Worked Before The Operation + T Duration Operation
  λ_α=Rate of occurrence of failures during the use of the vehicles
  N_α= the number of available vehicles and
  K_α= the number of vehicles required.

- R machinery $=\sum_{i=K_m}^{N_m}\binom{N_m}{i}e^{-i\lambda_m t_m}(1-e^{-\lambda_m t_m})^{N_m-i}$, [3]

  with t_m =T Duration That The Vehicle Has Already Worked Before The Operation + T Duration Operation
  λ_m= Rate of occurrence of failures during the use of the machines
  N_m= the number of available machines and
  K_m= the number of machines required

- R drivers $=\sum_{i=K_O}^{N_O}\binom{N_O}{i}e^{-i\lambda_O t_O}(1-e^{-\lambda_O t_O})^{N_O-i}$, [4]

with t_O = $T_{\text{Duration Operation}}$,
λ_O= the rate at which human error occurs when driving
N_O= the number of available drivers and
K_O= the number of drivers required

- **R** machines operators =$\sum_{i=K_b}^{N_b}\binom{N_b}{i}e^{-i\lambda_b t_b}(1-e^{-\lambda_b t_b})^{N_b-i}$, , [4]
  with t_b=$T_{\text{Duration Operation}}$,
  λ_b = the rate at which human error occurs when operating machinery
  N_b= the number of available machines operators and
  K_b= the number of machines operators required

- **R**(order transmission) = $\prod_{n=1}^{N}(R_{(1)\,\text{order}}) = \prod_{n=1}^{N}\{[1-\prod_{n=1}^{N_t}(1-(0,5*erfc([\frac{d-V}{\sigma}])/\sqrt{2}))*e^{-\lambda_n^{(transmitter.)}t_{transmitter}}*e^{-\lambda_n^{(transmitter.operator)}t_{transmitter.operator}})]*[1-\prod_{n=1}^{N_\Delta}(1-e^{-\lambda_n^{(receiver)}t_{receiver}}*e^{-\lambda_n^{(receiver.operator)}t_{receiver.operator.}})]\}$
  with N_t= the number of available transmitters
  d= transmitter - receiver distance
  V= Average Transmitter Range
  σ= Standard deviation of Transmitter range
  λ_Π= The failure rate when using the transmitter
  $t_{transmitter}$ =$T_{\text{DURATION WHICH THE TRANSMITTER HAS ALREADY WORKED PRIOR TO OPERATION}}$ + $T_{\text{DURATION OF OPERATION}}$,
  $\lambda_{transmitter.operator}$= The rate of occurrence of human errors when using the transmitter
  $t_{transmitter.operator}$ = $T_{\text{DURATION WHICH OPERATOR WATCHES FOR INFORMATION PROPAGATION}}$
  λ_Δ= The failure rate when using the receiver
  $t_{receiver}$ =$T_{\text{DURATION WHICH THE RECEIVER HAS ALREADY WORKED FOR THE BUSINESS}}$ + $T_{\text{DURATION OF OPERATION}}$,
  $\lambda_{receiver.operator}$= The rate of occurrence of human errors when using the receiver
  $t_{receiver.operator}$ = $T_{\text{DURATION WHICH OPERATOR IS ON DUTY TO RECEIVE INFORMATION}}$

- **R** route guide =$1-\left(1-e^{-\lambda^{(\text{guide .})}t_{\text{guide}}}\right)*\{1-[1-\prod_{n=1}^{N_{navigator.}}(1-e^{-\lambda(navigator)t_{navigator.}}*e^{-\lambda^{(navigator\ operator..)}t_{navigator\ operator}})]\}$.
  με t_{guide} = $T_{\text{DURATION OF OPERATION}}$,
  λ_{guide} = The rate of occurrence of human errors on the part of the route guide
  $N_{navigator}$= The number of available navigators
  $\lambda_{(navigator)}$= The speed of occurrence of failures/errors during the operation of the navigator (equipment or personnel)
  $t_{navigator}$ =$T_{\text{DURATION THE NAVIGATOR HAS ALREADY WORKED FOR THE OPERATION}}$ + $T_{\text{DURATION OF OPERATION}}$ (for equipment) or $T_{\text{DURATION OF OPERATION}}$ (for personnel),
  $\lambda_{navigator\ operator}$= The speed of occurrence of human errors when using the navigator (for equipment)
  $t_{navigator\ operator}$ = $T_{\text{DURATION OF THIS TASK OF OPERATION / TRANSPORTER MOVEMENT ENERGY}}$, (in case of equipment)

- **R** avoiding accident **= 1-[(AccR / 10^6) X ApA X MΔ]**

  With AccR/10^6= The rate of accidents, which we get from the nomogram [Figure 4]
  Number of Cars= The total number of cars that we estimate will pass through the route during the business period
  Route Length = Length, in kilometers or miles, of dual carriageway of the route

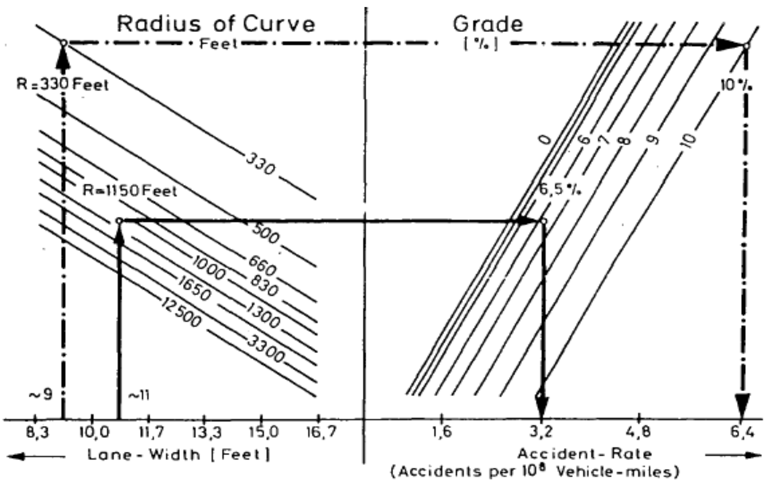

Figure 4:Accident calculation rate (AccR) nomogram [5]

- $\boldsymbol{R}_{\textbf{pass}} = \prod_{\boldsymbol{n=1}}^{\boldsymbol{C_{crucial\,points}}} (\prod_{\boldsymbol{n=1}}^{\boldsymbol{N_{transporters}}} (\boldsymbol{R_{crucial\,point}}))$

  with R ; Either $R_{\boldsymbol{crucial\,point}} = R_{route}$ turn= $= \int_{-\infty}^{W} \frac{1}{\sigma\sqrt{2\pi}} e^{-(w-M)^2/2\sigma^2}\, dw$

  $= 1 - 0{,}5 * erfc([\frac{w-M}{\sigma}])/\sqrt{2}\,)$

  with w= The width of the road

  M= The average width that the carrier vehicle needs to turn

  σ= The standard deviation (usually 0.20m – 0.40m.)

  Either $R_{\boldsymbol{crucial\,point}} = R = \begin{cases} 0; & if\ the\ requirement\ does\ not\ apply \\ 1; & if\ the\ requirement\ applies \end{cases}$

- $\boldsymbol{R}_{\textbf{obstacles}}\,(\boldsymbol{t}) = \boldsymbol{e}^{-\boldsymbol{\lambda}_{\textbf{obstacles}}\boldsymbol{t}_{\textbf{obstacles}}}$

  with: $\boldsymbol{\lambda}_{\textbf{obstacles}}$ = The rate of occurrence of obstacles on the route

  $\boldsymbol{t}_{\textbf{obstacles}}$= The time interval since the last appearance of an obstacle

- $\boldsymbol{R}_{\textbf{earthworks}} = \prod_{\boldsymbol{n=1}}^{\boldsymbol{N}_{\textbf{machinery groups}}} (\boldsymbol{P}_{\textbf{earthworks to finish}})$

  With $P_{\textbf{earthworks}}(T_{\textbf{earthworks to finish}} \leq T_{\text{available}\,time}) =$

  $P\left(\frac{T_{E\textbf{arthworks to finish}} - \mu_{\textbf{earthworks}}}{\sigma_{\textbf{earthworks}}} \leq \frac{T_{\text{available}\,time} - \mu_{\textbf{earthworks}}}{\sigma_{\textbf{earthworks}}}\right)$ = It is Solved with the PERT Method [6]

  With $\boldsymbol{\mu}_{\textbf{earthworks}}$=The Average time to finish the earthwork with the PERT Method

  $\sigma_{\textbf{earthworks}}$= Standard deviation of time to finish the earthwork with the PERT Method

5. CONCLUSIONS

The main advantage of this model is the quantification of the operation factors, resulting in easy planning and simplification of the decision-making process, as well as its future inclusion in a simulation game program for firefighting operations. On the contrary, the main disadvantage is the necessary works to be carried out before a fire occurs (e.g. route mapping).

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FIREFIGHTING VEHICLES MODIFICATION PROJECT: SELF-PROTECTION AND FIRE PROTECTION

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ABSTRACT

The target of this paper is to highlight a serious issue in the safety of fire trucks, when operating in incidents with a strong heat load, especially in forest fires.
The modern fire truck in Greece is not lacking in self-protection systems with those of other European countries. However, the more difficult working conditions of fire trucks in recent years show that existing fire protection systems cannot fully protect vehicles, equipment, and crew.
After new methods of self-protection of firefighting vehicles from abroad are presented and analyzed, some modifications to fire trucks will be proposed by adopting some of them.
Finally, the presented proposal could become the subject of discussions and new studies regarding the upgrading of firefighting vehicles, at the lowest cost, as well as a proposal for the amendment of the European Standard EN 1846 – part 2 "On the construction of firefighting and rescue vehicles".
This paper includes a part of the undergraduate thesis of Lazaros Papadopoulos at the Fireman School of the Hellenic Fire Academy for the year 2022 [1].

Keywords: fire trucks, modification of fire trucks, self-protection systems of fire trucks, fire protection of personnel

1. INTRODUCTION

The role of a fire truck consists of the safe transport of firefighters in an incident, the equipment required by firefighters, as well as providing water with which they will put out the fire [2]. Therefore, we are talking not only about aquifers, but also about auxiliary vehicles for the transport of personnel.
According to Charles Young in Fires, fire engines and fire brigades [3] and Daniel Patrascu in Fire Truck History [4], fire trucks are evolving according to the data and needs of the time. We see this development in every new vehicle. Automated functions with electropneumatic valves so that all processes are done correctly without giving any margin of human error, water spraying in the entire vehicle, provision for a water tank which will be used with an independent electric pump for the self-protection of the vehicle. can it cope or not? Is it not time to improve the self-protection of vehicles together and the fire protection of personnel?

2. FIRES AND FIRE TRUCKS

In the last 15 years, we have been observing fires, mainly forest fires in the summer, whose intensity and duration are constantly increasing and along with these factors the difficulty in dealing with them is growing. Staff are forced to work closer and closer to the fire and move through it if necessary. Many times, the staff has been surrounded by the flames, were most of the time there are victims such as the 3 dead forest firefighters in Rethymno, Creta in 2007 [5].

2.1. The fire truck

A firefighting truck is a vehicle whose cabin chassis comes from common European heavy-duty vehicles, placing on it the superstructure that gives it the firefighting character.
To date, its self-protection from fires is water sprinkler systems mainly on the wheels but also in the most modern sprinkler systems on the windows and in the passenger cabin for their protection and in a few cases in the superstructure.

2.2. The problem

The problem that the Fire Brigade must face in Greece, is the diversity of today's forest fires mainly with these fires of the past twenty years. Many referred to climate change, but few believed them. Of course, the reason for the megafires. *According to National Geographic "Once a rare occurrence, megafires are now becoming more prevalent throughout the world, in large part due to climate change"* [6].
Therefore, we must understand that it has come that we must evolve or upgrade the fire trucks, mainly in the fire protection they offer to the crew and their fire safety, according to the data and needs of the time.

2.3 The example of other countries

According to Lazaros Papadopoulos, targeted modifications to vehicles participating in forest fires [1] have been carried out in various areas of the world where they face megafires, after chronic studies and tests in the field.
The aim is to acquire the vehicle some key features such as: The system needed to be:

a. Sufficiently robust to withstand day-to-day off-road operations in heavily forested environments and open grassland plains.
b. Able to remain operable for a minimum of five minutes (the accepted benchmark burn-over duration) when subject to radiant heat loading of at least 5000 kW/m2 and full flame immersion with temperatures approaching 1000 ^{0}C.
c. Passively operable following initial simple discretionary activation protocols [7].

3. SUGGESTIONS FOR IMPROVING SELF-PROTECTION AND FIRE PROTECTION

According to Lazaros Papadopoulos [1], research out of the Country Fire Authority (CFA) in Victoria of Australia, is leading the change in Fire-Fighting Vehicles (FFVs) for crew protection systems from burn-over (Fig. 1). Developmental work commenced in the early 2000's in collaboration with the Australian research organisation CSIRO (Commonwealth Scientific and Industrial Research Organisation) [7].
In USA, the beginnings of the development of an ideal vehicle that will target on the safety and protection of the crew both during the march and during the emergency departure from the incident safely are in Los Angeles after the October of 1996 [1].
In Russia, the Central Command of the Moscow State Fire Service has formed a common standard of fire protection systems for the entire fleet of vehicles, the GOST standard [8].
In all three cases there are similar interventions on the vehicles. The main ones are:

- Shielding and thermal insulation of the cabin
- Reinforced glazing in thickness
- Cabin ventilation system
- Breathable air from a breathing apparatus
- Radiant Heat shields with their rapid growth within 5 sec
- Sprinkler piping system with foaming material.
- Increase the amount of water tank
- Plastic brake and fuel lines are lagged/sleeved, shielded or replaced with high temperature flame resistant equivalents to ensure the vehicle remains mobile and critical firefighting functions operable.
- Radiant heat shield paneling is placed around body critical elements such as batteries, pump, and plumbing systems.
- Vulnerable cabin exterior plastic panels are replaced with metal, or non-flammable equivalents, to minimize the possibility of radiant heat/flame intrusion into the cabin interior.
- Replacing the engine air filter with a Flame Retardant Air Filter technology by RYCO Filters [9] or a Fire-Resistant Air Filter technology by WIX Filters [10].

Figure 1 Vehicle fire protection test, Australia
Source: https://www.iawfonline.org/article/engineering-a-safer-crew-

4. RESULTS AND DISCUSSION

Looking for a suggested solution, an article was found on the AMN page (www.aftermarketnews.com) which refers to the replacement of engine air filters in fire engines in the USA [10]. We contacted with the WIX Air Filters in the USA asking them to give us filter replacement codes in Fire-Resistant Air Filter technology. The answer was negative, namely that there are no replacement filters for these codes.
The first proposal we submit is the supply and replacement engine's air filter with Fire-Resistant Air Filter technology as well as a proposal for the amendment of the European Standard EN 1846 – part 2.
Putting human life as the main concern, it should begin as soon as possible the study of the modification of forest firefighting vehicles. There are examples from other countries that we can adapt them to our own circumstances.

Certainly, the main issue is the economic one. Converting an old vehicle can cost a lot compared to applying it to new vehicles in the first place. However, until the above proposals for improvement are implemented, we will have to upgrade the existing vehicles. So, the topics of discussion should be:

- Which vehicles will we upgrade?
- Which of the proposed improvements are feasible to make to existing vehicles?
- How much will they cost
- Who will do the upgrade studies?

Because human life is the supreme good.

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ANALYSIS OF GEOHAZARDS USING LOW-COST INNOVATIVE METHODS

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ABSTRACT

Challenges in current geomorphological processes demand fast response and monitoring, achieved by low cost and highly accurate methods. The rapid development of remote sensing techniques in synergy with classical geomorphological surveys, like field data collection and geological mapping, can provide the necessary precision that modern hazard studies require. However, the use of various resolution photogrammetric products can lead to fragmentary knowledge due to incorporated errors of each product. As an alternative, multidisciplinary data, acquired om different periods secures the accuracy of the derived results. Our methodology is based on the combine using of multitemporal and multi-sourced data and field geology, mainly applicated in areas inflicted by mass wasting events. The use of this type of methodology, enhanced by the low-cost technology of UAVs' and the Terrestrial Laser Scanning (TLS) surveys, which allows the fast mapping and detection of geohazard areas. Furthermore, this methodology provides data from millimetric- to meter-scale processes on the degrading slope.

Keywords: geomorphological changes, remote sensing techniques, field geology, geohazard mitigation.

1. INTRODUCTION AND OBJECTIVE

The planet transmits vital signs for its survival, highlighting the importance of using new technologies for achieving effective management of the recorded changes. These technologies are considered crucial for predicting and mitigating changes in Earth Systems based on the collection, analysis, and use of the collected data. Especially this type of data is becoming important if geomorphological changes lead to natural hazards in urban or near-urban areas with a complex landscape. These changes involve many earth disciplines such as active tectonics, geomorphic indices measurement methodology, sedimentology, hydrology etc. Commonly areas of interest are hills under landslide processes. Every year thousands of people worldwide are being affected by instability phenomena (landslides, rockfalls, mudflows or creep), while in the upcoming years this problem is expected to deteriorate due to the warming temperatures and weather extremes [1]. Remote sensing has proven to be an effective tool for investigating instability phenomena, contributing to the detection, classification, monitoring and prediction of its future evolution [2].

Modern earth observation techniques use innovative remote sensing sensors and novel processing methodologies. In particular, the development of Unmanned Aerial Vehicles (UAVs) gave a new impetus to the field of risks and hazards, providing information to the international research community on disaster risk reduction and management [3]. Another innovative remote sensing sensor, widely used into numerous geotechnical surveys and stability investigations, is Light Detection and Ranging (LiDAR) scanner [4]. Airborne LiDARs have proven their effectiveness in the identification and mapping of various types of mass movements as well as in the assessment of their kinematics [5]. However, the execution of repeatable surveys using airborne LiDARs is a particularly costly procedure. In contrast terrestrial Laser Scanning (TLS) is able to provide data with high temporal and spatial resolution at a more affordable cost. The utilization of TLS data for the characterization of rock falls, the estimation of

rock fragments as well as the monitoring of the slopes has already been fully analyzed in numerous studies [6].
This paper aims to highlight a methodology based on multiple sensors data integration applied in Geographic Information Systems that can improve our knowledge of monitoring the geomorphological evolution of an area at landslide risk.

2. EXPERIMENTAL METHODS

Traditionally, studies for monitoring and mitigation of geomorphological processes like landslides were relied on qualitative methodologies based mainly on field surveys, while quantitative approaches are less preferred. Quantitative methods include boreholes and geotechnical testing. However, these traditional methods are either of high cost or their application is time consuming and related with environmental restrictions. Thus commonly the period just after the landslide is difficult to be monitored due to accessibility or other technical problems. On the other hand the increasing frequency of the natural hazard expression led to the seeking of new methods in deriving quantitative data from the inflicted area at low-cost and immediately after the landslide event.
At the present study we use the Unmanned Aerial Vehicles (UAVs) and Terrestrial Laser Scanning (TLS) in an area of a relatively small complex landslide characterized by dense vegetation. Our methodology is used immediately after the occurrence of the landslide, providing quantitative results and a data base for the future monitoring of the area. Both of these two techniques gave a new impetus to the field analysis of risks and hazards. Also these two methodologies provide useful information to the international research community on disaster risk reduction and management (Figures 1-4).

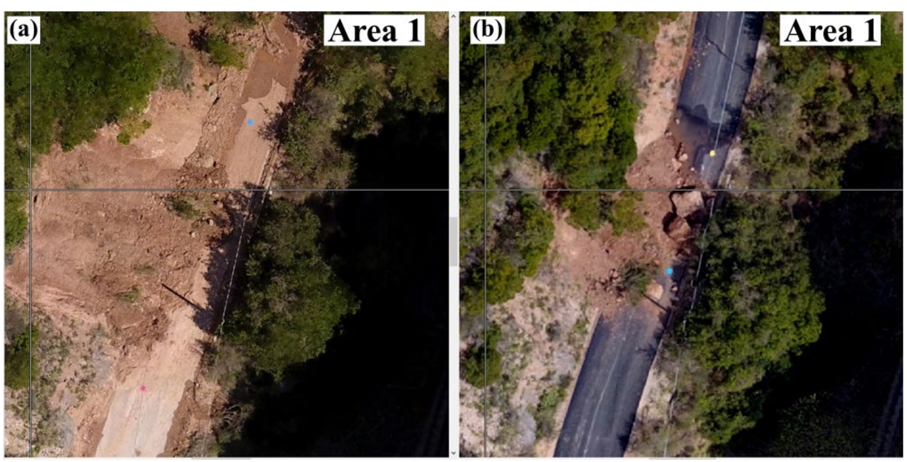

Figure 1. Orthophotos: (a) Area 1 on April 4th,2020, (b) Area 1 on April 21st, 2019.

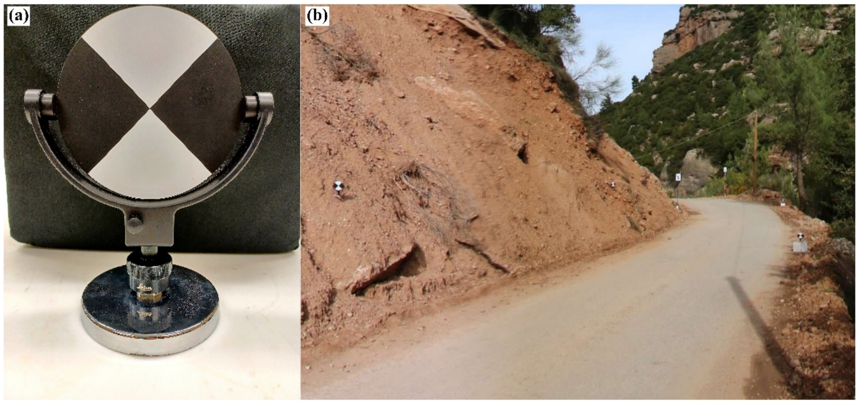

Figure 2. (a) 4.5" black and white target for TLS methodology of data aquizition. (b) Distribution of ground control points within the area of interest.

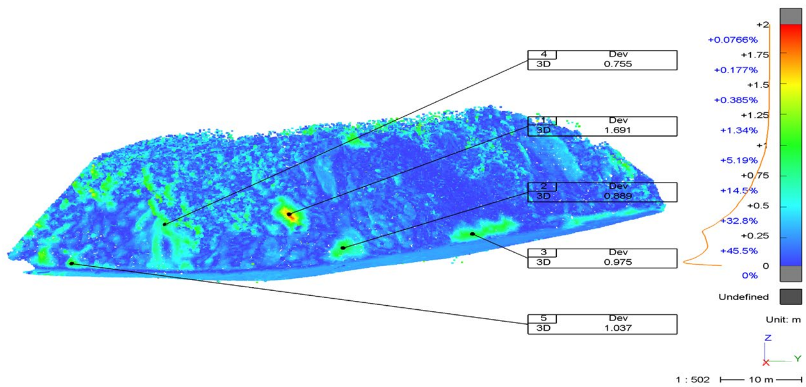

Figure 3. Cloud to cloud comparison between the UAV point clouds, acquired on June 10th,2020 and September 25th, 2020.

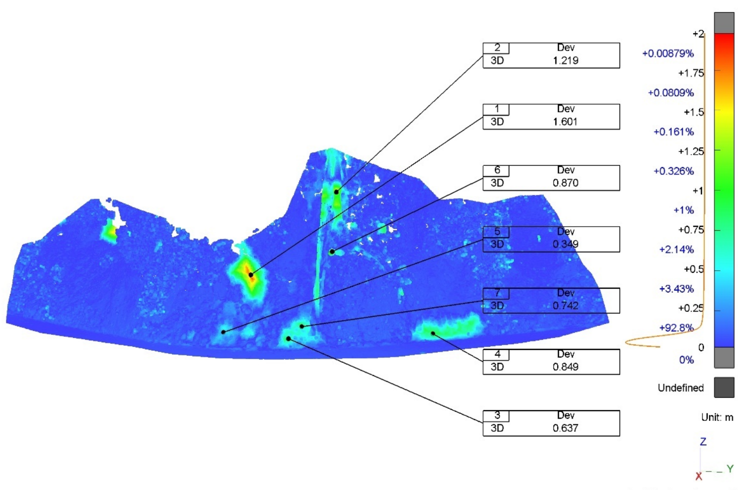

Figure 4. Cloud to cloud comparison between the TLS point clouds, acquired on June 10th,2020 and September 25th, 2020.

3. RESULTS AND DISCUSSION

Concerning the monitoring of the instabilities using UAV's, the main advantage is the capability of producing multitemporal point clouds, and Cloud-to-Cloud comparisons between the various evolution

periods. The results of this comparison, related to either manmade activities or natural processes are presented in Figure (3). In particular, UAV point clouds detect relief variations varying from 1.5 m to 1.7 m and were highlighted in reddish to magenta colours. Smaller scattered surface variations were detected throughout the sliding area relatively not significantly affected by the dense vegetation.
The detection of mass wasting with the TLS survey, was again performed through Cloud-to-Cloud comparisons of the acquired point clouds (Figure 4). TLS sensors are able to identify surface differences in a clearer and more accurate way. Thus the largest surface variation associated with the stabilization measures were calculated at about 1.60 m and they are similar but more accurate with those measured from the UAV point clouds (Figures 3 and 4). On the other hand, scattered relief changes related to erosion processes were noticed in larger areas on cliff under erosion.

4. CONCLUSIONS

The systematic observations, at a reduced cost as well as the ability to investigate inaccessible areas or widespread phenomena are some of the advantages of the aforementioned technique.
This reliable technique for collecting data that concern geomorphological changes were develloped over the last decade and are based on collecting and managing dense point cloud data, which is the main advantage compared to classical methods.
Although, the technique can encounter all types of geomorphological changes, the mass wasting field appears as most prominent as it concerns many areas of different climate and different grades of human interaction. This synergistic approach based on multitemporal and multisourced data appears to monitor successfuly the evolution of ongoing geohazards encrypted in a landslide manifestation.

5. REFERENCES

Resources that have been presented inside [ ] in the text with numbers should be listed according to their order in the text. References must be numbered in order of appearance in the text (including citations in tables and legends) and listed individually at the end of the manuscript. Two or more references at a time may be put in one set of brackets [3, 4]. References that have been presented in the references list should be prepared in a format according to the reference style shown below (**10 font size Calibri**):

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FLOOD RISK ASSESSMENT IN THE REGION OF ATTICA

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ABSTRACT
Flood risk assessment in selected and vulnerable areas is crucial for the analysis and design of civil protection measures and the implementation of studies with proper interventions towards mitigating flood risk. This is even more crucial in the region of Attica, which is the most densely populated region of Greece, with critical infrastructures and important social economic activities. Under the Programming Agreement with the Prefecture of Attica, the Operational Unit BEYOND Centre of EO Research & Satellite Remote Sensing of the Institute of Astronomy, Astrophysics, Space Applications & Remote Sensing (IAASARS) of the National Observatory of Athens (NOA), in cooperation with the Research Group ITIA of the Department of Water Resources and Environmental Engineering of the School of Civil Engineering of the National Technical University of Athens (NTUA) study five flood-stricken river basins in the region of Attica, which affect 23 Municipalities. Detailed field visits and flood risk assessments in every area of interest are conducted, high-risk critical points are identified, and mitigation measures are proposed, both structural and non-structural, in order to achieve effective crisis management for the protection of the population, the properties and the infrastuctures. In addition, a web GIS platform has been developped by the BEYOND Centre to store and make available all the collected and produced data, the flood hazard, vulnerability and risk maps, as well as the identified critical points, the refuge areas and escape routes. Detailed presentations are organised for all the relevant stakeholders and the competent authorities who are directly or indirectly involved in civil protection, and the studies' general outcomes are also disseminated to the public to raise awareness.

Keywords: flood, risk assessment, mitigation measures, escape routes, civil protection.

1. INTRODUCTION
The Prefecture of Attica constitutes a region with special features, such as long coastline, large inland area, various geoenvironmental units, high population density (3.792.469 residents, 36,4% of the country's population according to the Hellenic Statistical Authority [1], crucial infrastructures and social economic activities. In March 2021, a Programming Agreement was signed between the Prefecture of Attica and the NOA – Part A – to conduct the study entitled «Earthquake, fire and flood risk assessment in the region of Attica» funded by the Prefecture of Attica [2]. Flood risk is assessed in five river basins (Pikrodafni, Giorgis, Sourres and Agia Aikaterini streams and Sarantapotamos and Kifisos rivers), which affect 23 Municipalities.

2. METHOD AND DATA

2.1. Method

At first all necessary data and the relevant studies are gathered from the competent services, quality control and corrections are performed, and additional data are collected from photo interpretation and field visits (such as dimensions of bridges and culverts, obstacles in the riverbed, feedback by residents). For the three return periods of the EU Flood Directive [3] (50, 100 and 1000 years) and a selected rainfall duration, rainfall hydrographs for each subbasin as well as for the total river basin are derived from ombrian curves which are constructed and adapted to each specific study area following a new advanced methodology [4]. Then, using HEC-HMS rainfall-runoff model, a schematic diagram of multiple sub-basins is developed, and the suitable methods for runoff estimation (estimation of losses, transformation into unit hydrograph) are selected. The three abovementioned scenarios are executed considering medium antecedent soil moisture conditions (CN II) [5]. The flood hydrographs alongside with other input data, are entered in the hydraulic model LISFLOOD. The scenarios are executed using sensitivity analysis of input parameters, and the results are evaluated in order to calibrate the hydraulic model HEC-RAS. A 2D hydraulic model is developed for the river basin using rain-on-grid method, a uniform spatially distributed rainfall method, and rainfall hydrographs. Water depth and velocity maps are produced subsequently for each scenario for the flood hazard assessment.
Vulnerability is considered as a weighted estimation of population density, population age, and building characteristics (construction materials and the presence of pilotis). Specific points of interest are delignated using photo interpretation methods, while exposure is based on the land value. Finally, the hazard, the total vulnerability and the exposure are mathematically combined to estimate the flood risk. Additionally, information about historical flood events and critical points indicated by the authorities is combined with the calls to the fire brigade for help in flooded areas in order to create a flood record and validate the risk assessment. All in all, according to flood risk assessment and in-situ observations, critical points are identified, classified based on their risk level and accompanied by a detailed technical report. Mitigation measures (refuge areas and escape routes) are proposed for the worst-case scenario.

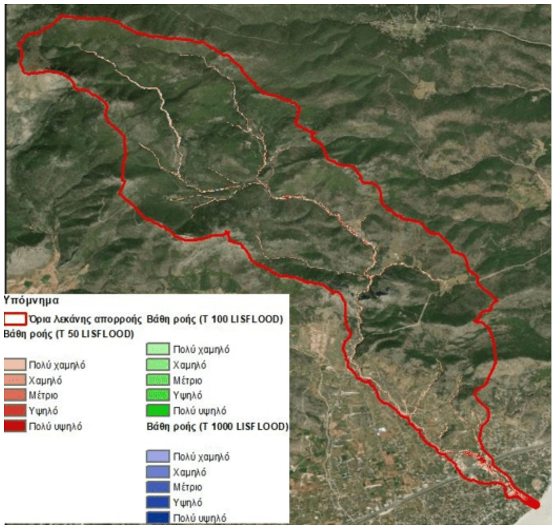
2.2. Data

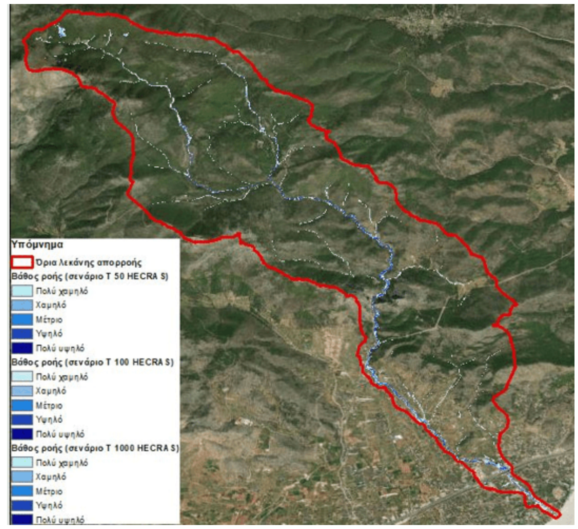
A 2m spatial resolution Digital Elevation Model (DEM) from the Hellenic Cadastre is used as terrain. Land cover polygons are created using the European Urban Atlas geodatabase of the Copernicus Land Monitoring Service [6] and burnt scar mapping from 1958-2021, provided by the FireHub Service of the BEYOND Centre of IAASARS/NOA [7]. Each class is matched to the corresponding Manning's roughness coefficient [8]. Curve Number polygons for medium antecedent soil moisture conditions (CN II) are provided as well [9]. Technical works such as drainage networks, river bed diversions and arrangements are derived by the relevant studies and available data from the Flood Risk Management Plan of the Attica Water Department (EL 06) [10]. Climatic data (rainfall time series) are gathered from the respective meteorological stations of the Hellenic National Meteorological Service, the National Observatory of Athens and the Ministry of Environment and Climate Change for the 1860-2020 period. Population data (age and total number) and buildings characteristics (number of floors, construction material and year, etc) are provided for each building block by the latest Population-Housing Census of the Hellenic Statistical Authority [1] and the land values are defined by the Ministry of Finance.

3. RESULTS

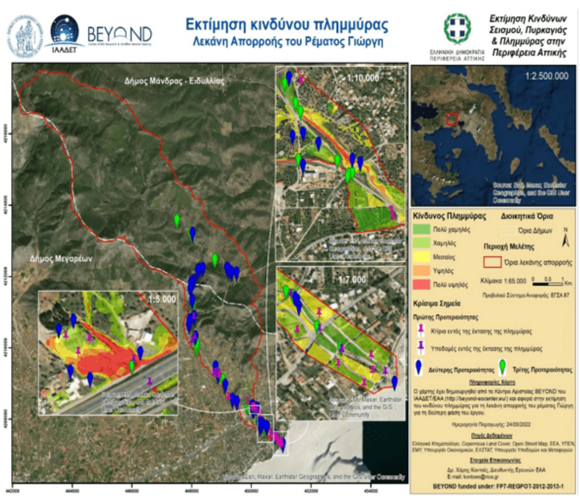
The geospatial data, modelling results, critical points from the field visits, and the proposed mitigation measures are delivered to the Prefecture of Attica and to the flood-stricken Municipalities both in hard copy and in digital format through a dedicated web GIS platform designed for the needs of the specific project by the BEYOND Centre of IAASARS/NOA. For each study area the following maps are produced:

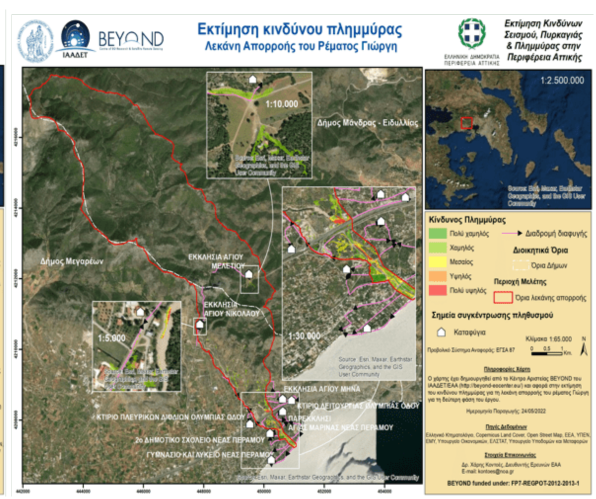
the simulated maximum water depth and flood extent using LISFLOOD and HEC-RAS models (Images 1 and 2), the 1st priority critical points for flood risk (Image 3), and the proposed refuge areas and escape routes during the crisis (Image 4).





Example of the river basin of Giorgis stream: **Image 1.** Flood map for the following scenarios of 50, 100 and 1000 years return period, using LISFLOOD model. **Image 2.** Flood map for the following scenarios of 50, 100 and 1000 years return period and 12 h rainfall duration, using HEC-RAS model.





Example of the river basin of Giorgis stream: **Image 3.** 1st priority critical points for flood risk. **Image 4.** Proposed refuge areas and escape routes during the crisis.

4. DISCUSSION

Many high-risk points were identified in residential areas, road network and other critical infrastructures. Therefore, the proposed mitigations measures are of crucial importance towards increasing the flood resilience. These include flood protection works, such as delimitation of streams/rivers, river bed arrangement using up-to-date environmental terms, removal of constructions inside the river beds, construction of drainage network, small mountain hydrodistribution works and non-structural measures, such as special signs at high risk points, review of the building use, especially of the ground and basement floors, cleaning of the river bed, cleaning and maintenance of flood protection works on a regular and ad-hoc basis after each flood event, tree planting, encouragement of rainwater storage at plot level, training and raising awareness of the population, flood management exploiting the output of the projects. Overall, it is very important to apply strategic design in order to mitigate flood risk towards the implementation of the EU Water Framework Directive [11], the EU Flood Directive [3] and the directions of the National Program of Water Resources Management and Protection [12]. Strategic design should be considered as an organized and planned response to the flood risk, with specific actions (prioritized works and measures), shared according to the responsibilities of each competent authority, accompanied by cost analysis and implementation timeline.

5. CONCLUSION

This study analyses and estimates - in the most objective and reliable way secured by science and technology – the vulnerability and the expossure of the selected river basins to flood risk, in conjuction with the actual physical and socioeconomic parameters of each study area and proposes mitigation measures. It is the first time that such a holistic approach for flood risk assessment is implemented on building block level in Greece. The prototype knowledge created through the project supports the Prefecture of Attica in the optimum implementation of the National Civil Protection Plan and the work of Civil Protection Coordination Bodies. This serves the operational needs during the crisis, as well as the preparedness and the strategic decision making towards disaster resilience. All the above-mentioned were confirmed and evaluated positively according to the stakeholders' feedback.

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PERFOMANCE AND INTEROPERABILITY ASSESSMENT OF FLOOD PROTECTION INTERVENTION MEAURES AND ACTION PLAN IN THE STRYMON RIVER BASIN, GREECE

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ABSTRACT
Action plans for flood protection and management are of critical importance, facing the fact that flood events have been increasing in frequency and intensity and will become even more critical because of climate crisis. The Flood Protection project offered the ability of a thorough assessment of the operational applicability of the measures and solutions that can be utilized in the Region of Central Macedonia-water basin of Strymon river, with corresponding interventions to reduce and avoid flood risk by the assessment of the interoperability of structural and non-structural infrastructure in the regional unit of Serres. The Action Plan that was developed, formulated a framework of all the flood intervention measures and may assist to the construction of a specific strategy for the area with a decade time horizon of implementation, in order to shield the area of Serres regional unit from the possible flood events and their consequences in the human and natural environment by specific proposals in the areas mostly endangered and vulnerable.

Keywords: Strymon river basin, flood protection, action plan, interoperability, infrastructure evaluation, measures

1. INTRODUCTION

Flood risk management and protection infrastructure does not comprise an exclusively technical subject. The implementation of flood risk management strategies and their societal integration and acceptance necessitate floods governance [1]. The catchment area of the project, Strymon River basin has suffered numerous flood evets of varying importance the last decades, with consequences on the natural and socioeconomical sector. At the European Union (EU) scale, the gradually employment of the Water Framework Directive (WFD) (EC 2000) since the early 2000s and of the Directive on the Assessment and Management of Flood Risks (EC 2007), commonly known as the Floods Directive (FD), have provided critical legislative framework that led to the development and operational tool such as the Flood Risk Management Plans (FRMPs). The area of Strymon river basin (EL11), belongs to the central Macedonia region with the basin in the administrative boundaries of the regional unit of Serres. The FRMPs for the study area that were approved in 2018, offer protection measures categorized in i)prevention, ii)protection, iii)preparedness and iv)restoration.
The project “Evaluation of the performance and interoperability of flood protection intervention measures in the area of the Strymon river basin” that was implemented under the INTERREG V-A European Territorial Cooperation Program "Greece-Bulgaria 2014-2020 "Flood Protection - Cross Border Planning and Infrastructure Measures for Flood Protection" aimed to combine the FRMPs with a thorough and detailed recording and evaluation of the existing situation in terms of flood protection

infrastructures, to assess the majority of civil works and already applied measures in order to evince the areas prone to flooding and provide an Action Plan where specific located measures are proposed according to an hierarchical evaluation.

2. METHODOLOGICAL APPROCH

The methodological approach was applied in three distinct phases. The first phase of the project delivered a valuation report and an open access Web-GIS platform as the base mechanism for the implementation of an Action Plan in terms of the projects, measures and interventions that are necessary or appropriate to be done for flood protection of the regional units of Serres, whilst the second produced the Flood Protection Action Plan. On the third phase a pilot implementation on local scale for the interoperability of the mobile flood protection barriers was caried out.

2.1. Base-line Valuation Report

The main objective of the report was to investigate, record, evaluate and correlate the existing measures and intervention projects for the flood protection of the entire area of the of Strymon river basin, in order to assess the existing situation and to determine the possibilities and alternatives available in terms of implemented and immediately implementable intervention measures. A detailed recording in the geospatial database and a display and processing platform of all the data were produced. The methodological approach followed was identified, documented and the evaluation of measures and interventions at multiple levels is presented through a Web-GIS open access platform. For the study area 692 structural measures/infrastructures were located and evaluated and correlated. Their interoperability was also examined in terms of:

• their spatial dimension, i.e. the location of all recorded projects/intervention measures and the correlation between them (common or similar projects, proximity of projects to each other, grouping by sub-catchment, etc.)

• their time dimension with categorizations in various categories (implementation time, duration of operation, repeatability of activity/energy, etc.)

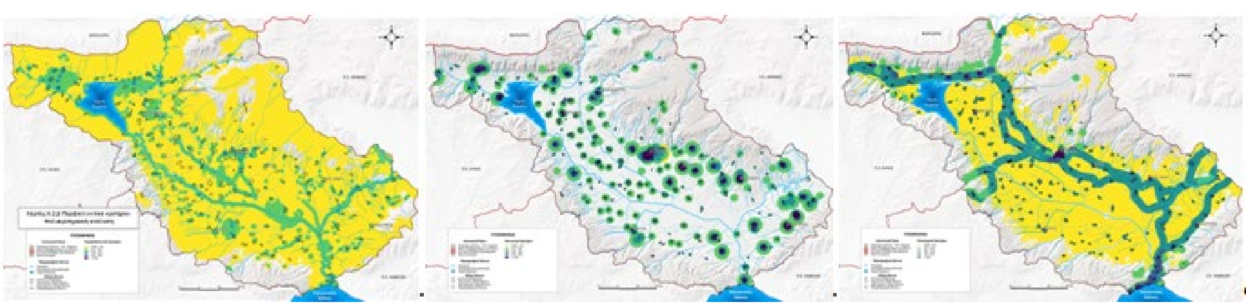
• and their cost dimension in terms of the implementation, operation and maintenance of each intervention measure and project.

Then, a correlation process was carried out with several other important elements. Data evaluated and inserted to the correlation model were related to terrain relief data, hydrographic data (hydrographic network, hydrological basins), infrastructure data (road, railway, irrigation networks, etc.), as well as spatial/urban planning data, land use, data on flood events and their risk as determined in Flood Risk Management Plans, [2],[3] while incorporating the most recent infrastructure data by fieldwork on the occurrence of flood events and their performance. Finally, the existing legal framework in terms of zones of environmental interest and protection status was recorded.

The overall result of the 1st phase was the dynamic analysis of all the infrastructures/protection measures at: i)the level of their performance evaluation, with an overall assessment of the prevailing state of the infrastructure, ii)the way the flood protection infrastructure is managed and iii)the performance of the implementation of the flood risk management plans so far, in order to subsequently identify the needs and the possibility of their readjustment, as well as the implementation of the new actions/projects and bundles of measures for the subsequent creation of the Action Plan.

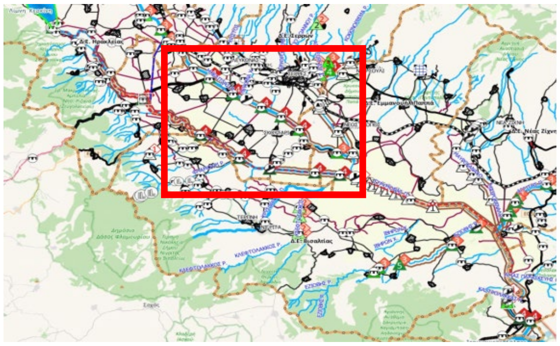
2.2. Action Plan

The Action Plan formulated a framework of all the flood intervention measures (the existing and especially the new ones proposed) and may assist to the construction of a specific strategy for the area with a decade time horizon of implementation, in order to shield the area of Serres regional unit from the possible flood events. The action plan was delivered by the following axes:
•Determination of the operational parameters of all intervention/protection measures
•Determination of their levels of interaction
•Determination of the degrees of freedom of each level of interaction
• Evaluation of the interoperability of the interventions in the main catchment areas by sub-basin
•Scenarios of functional inter-operability of intervention/protection measures
•Determination of the acceptable cost-benefit limits of each measure.
The Action Plan aimed to rationalize the potential risk of flooding due to the development of the area and mainly to propose measures and interventions of permanent structural and non-structural character. Through the Action Plan, based on the detailed record of the current situation, the problems faced in the region and the detailed analysis of its parameters, the priorities on the projects and intervention measures emerged.
The Action Plan was delivered through multi-tasking applications, such as SWOT analysis, multi-criteria analysis, Analytical Hierarchy Process, that formed a Spatial Decision Support tool [4], which provided the Action Plan on the optimal selection and adaptation of intervention measures per potential flood event and per location. Priority axes of Hierarchical Analysis were the following:
Axis 1: Protection/shielding of urban areas and infrastructure projects
Axis 2: Protection/shielding of activities within flood zones and reinforcement of flood protection infrastructure
Axis 3: Protection/shielding of tourism, agricultural and industrial uses
Axis 4: Protection/shielding of zones of environmental importance
Axis 5: Protection/shielding of environmental management infrastructure
Multi-criteria analytical prioritization was integrated-combined with geospatial information and analysis to specifically identify the locations of structural new projects and intervention measures. This combination determined the levels of importance from each scientific aspect and composed the road map of the hierarchies in relation to the hazard, the importance of the consequences, the environmental, economic and social costs of the potential occurrence of a flood phenomenon and the cost to the infrastructure. The multicriterial AHP process results in the environmental, social and economic sector performed in the Web-GIS platform are shown in figures 1a, b, and c below. All structural measures where then evaluated and assessed (figure 2).



(a) (b) (c)

Figure 1: Multicriterial analysis regarding (a)environmental, (b)social and (c)economic criteria


(a)


(b)

Figure 2: Structural protection measures (a) and their performance and interoperability combined with the multicriterial analysis (b)

3. RESULTS

The Action plan came forward with three different scenarios that consequented on the proposal of the types of measures for flood protection in the regional unit of Serres. The first scenario in the one of Zero mitigation with the evaluation of the existing status flood protection works on the flood protection infrastructure with the revised cost of these over a time horizon of next decade. The second scenario is the one with Mild mitigation/degradation/rehabilitation measures using mobile flood protection systems in combination with the permanently existing flood protection projects and infrastructures and the third scenario is the one of Major mitigation/rehabilitation measures and proposed projects/interventions and modifications in conjunction with the permanently existing flood protection projects and infrastructure.

The Action Plan may empower proposals for axes, priorities and indicators, with the new development programs programming period such as the PEP MS 2021-2027, with the Cross-Border Programs Cooperation not only (which set their own general or specialized interventions) for the Region of Central Macedonia but also for all stakeholders and key players involved in the flood protection and management sector.

ACKNOWLEDGEMENTS

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CROSS-BORDER EMERGENCY MANAGEMENT IN THE BALKANS

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ABSTRACT

The **objective** of the current research is to contribute to the identified gaps regarding Cross-Border Emergency Management by developing a framework to monitor and measure the readiness levels of major components of Emergency Management in Cross-Border situations between countries. The geographical focus and case study for the current research are the countries of the Balkan Peninsula. The developed framework will be tested for its validity in collaboration with the participating countries of the Balkans at the ongoing EU project under DG ECHO with the acronym BALANCE (*Large Scale Earthquake Management at Western Balkans through Joint Cross Border Cooperation Activities*). The DELPHI **method** was conducted among a selection of experts in the field of emergency management from the 10 investigated countries. The questionnaire conducted with the DELPHI method was necessary in order to determine expert professional consensus on key recommendations/dimensions of various aspects of cross-border emergency management elements that are unanimously essential for developing the framework. These recommendations afterwards will serve as the basis for the KPIs development and the comparative country analysis. Preliminary findings show higher consensus levels on the topics of Governance and Leadership, Capacity building & Maintenance (Education, Training & Simulation exercise) and in Workforce Capacity. The research is still ongoing, and the final rounds of the DELPHI study will be concluded in the upcoming weeks, however, first level consensus has been reached and the preliminary results give us an insightful idea about the needs of the cross-border framework.

Keywords: Cross-Border, Emergency Management, Disasters, DELPHI

1. INTRODUCTION

Despite decades of disaster and emergency management authorities aiming to improve citizens' awareness of hazards, preparedness levels have been found to be generally low amongst populations around the globe. The building blocks of effective disaster management are risk assessment, mitigation, planning, training and exercises for response, and a good plan for recovery ([1]; [2]; [3]). Natural hazards scholars have been studying community risks and vulnerabilities to disaster ([4]; [5]; [6], [7]; [8]; [9]) to determine the causes, characteristics and consequences of probable future catastrophic events, which may be natural, accidental or intentional. Addressing crisis management aspects at European level requires not only the consideration of different legal and governance frameworks and languages, but also the consideration of strategic, operational, and technical specificities that differ between countries. Nevertheless and in line with the increasing need to address respective aspects, civil protection activities are increasing at the European level.

Respective procedures and practices are well established in many member states within the European Union and are facilitated—among others—by guidelines developed by the European Commission, on assessing risk [10] or risk management capability [11]. Activities in managing risk are usually structured around four phases— prevention, preparedness, response, and recovery—with main actors being involved in response activities encompassing first responder organizations such as firefighters or health services. They ensure the provision of emergency services and public assistance during or immediately after a disaster in order to save lives, reduce health impacts, ensure public safety and meet the basic subsistence needs of the people affected.

Clarity and conceptualization of the system's goals are critical. To deal with the crucial issue of guaranteeing preparedness and building resilient systems, this work will develop a framework which identifies the essential elements of Cross-Border Emergency Management. The framework for Emergency Readiness Response thus conceptualizes the essential elements to consider in the development of a quality assurance framework for successful cooperation in cross-border emergencies and the created indicators will be aligned with the framework to advance performance measurement for local/regional emergency management agencies.

2. METHOD

Based on the literature review, 128 recommendations for Cross-Border Emergency Management were identified, adapted or newly developed spanning in 36 themes were extracted and classified in 10 CBERR framework elements. These framework elements are the most important and interconnected elements that exist in an emergency management regime with some additional elements identified and added that play an important role not only in emergency management in general but also to Cross-Border contexts more specifically. The core elements of the framework are:

1. Governance and leadership
2. Command & Control
3. Technology & Information Security
4. Capacity building & maintenance (Education, training & simulation exercise)
5. Risk analysis
6. Workforce capacity
7. Cross Border networks
8. Community engagement
9. Resources
10. Health care

For this specific part of the research a questionnaire based on the DELPHI method was conducted and issued among a selection of experts in the field of emergency management from the investigated countries. The questionnaire conducted with the Delphi method was necessary in order to determine expert professional consensus on key recommendations/dimensions of various aspects of cross-border emergency management elements that are unanimously essential for developing the framework. These recommendations afterwards will serve as the basis for the KPIs development and the comparative country analysis.

Countries that took part in Round 1 from the Balkan area are : Greece, Albania, Republic of North Macedonia, Bulgaria, Kosovo, Montenegro, Croatia, Serbia, Slovenia, Romania.

Experts that took part were: Senior experts and Head officers from Civil Protection agencies and ministries, Emergency management experts (Head officers and operationals) from 1st responders from

Fire brigade, Police, Emergency medical personnel ambulance, Humanitarian aid operationals (e.g., Red Cross) and experts from civil protection departments from all the aforementioned countries.

Through the questionnaire's rounds based on the Delphi method the goal is to reach expert consensus on the most important elements that need to exist in a cross-border emergency readiness response framework. Afterwards based on the elements of the framework along with the KPIs developed, the framework will be tested in a real-time simulation exercise among the participating countries of the Balkans. The final step of testing the framework will give valid results in order to have a measurable quality assurance procedure for the framework and allow professionals of the EM field to evaluate their overall situation on cross-border emergency issues. The end result will be:

1. A cross-border emergency readiness response framework that will be available to any stakeholder in the field of emergency management.
2. Key Performance Indicators for all the major elements of the framework to have a measurable model.
3.Comparative country analysis.

3. RESULTS AND DISCUSSION

Until now, there is no overview of recommendations for robust readiness for response planning at operational level in cross-border level to support countries in response planning at both the regional and the inter-regional level. The aim of the questionnaire rounds procedure is to seek consensus from regional/national-level experts from the cross-border participating countries of this research on identification of core principles of emergency management topics on readiness aspects for emergency response. KPIs for core elements will be developed. The findings could be potentially used in a systematic and integrated approach to cross-border emergency preparedness and response planning.

From the total number of 129 statements in the Delphi questionnaire across 10 thematic categories in round 1, 36 statements reached unanimously consensus. Therefore, the statements that reached consensus in the first round will not be used for the second round. The Likert scale of agreement was a 5-point Likert scale ('1 – Not At All Important' to '5 – Very Important').

Table 1. Round 1 Consensus levels of the framework's statements in each category.

Thematic Category	Total Number of statements	No. of statements that reached consensus
Governance and Leadership	46	20
Command & Control	10	3
Technology & Information Security	16	1
Capacity building & Maintenance (Education, Training & Simulation exercise)	14	6
Risk Analysis	12	1
Workforce Capacity	7	3
Cross Border Networks	5	1
Community Engagement	6	0
Resources	7	0
Health care	6	1
Total	**129**	**36**

Preliminary findings show higher consensus levels on the topics of Governance and Leadership, Capacity building & Maintenance (Education, Training & Simulation exercise) and in Workforce Capacity each of which have various sub-statements for their category. The research is still ongoing, and the final rounds of the DELPHI study will be concluded in the upcoming weeks, however, first level consensus has been reached and the preliminary results give us an insightful idea about the needs of the cross-border framework.

4. CONCLUSION

Evidence of informed measurement of cross-border emergency preparedness is lacking. The data collected through this research and the framework developed have the potential to be used to enhance the research on the field of cross-border disaster management by providing a foundation to improve the readiness levels of bordering countries regarding cross-border disasters. By developing this framework, the solution space of a problem which in our case is how to achieve effective and efficient cross-border emergency management concerning a cross-border disaster would be substantially optimised. On an operational level the findings of this study will directly benefit stakeholders in the field of EM and the developed CBERR framework will have the potential to improve readiness levels by providing a quality assurance monitoring and measuring scheme of the major EM elements that are about to be unfolded in a CB disaster and need immediate attention.

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THE CONTRIBUTION OF CYBER SECURITY TO IMPROVED CIVIL PROTECTION. EUROPEAN VIEWPOINT

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ABSTRACT
When it comes to civil protection, particularly when it comes to the attempts to safeguard the population of a state from all types of calamities, cybersecurity is becoming an increasingly crucial aspect. The purpose of this research was to investigate the part that cyber security plays in improving civil protection from a European point of view. Cybersecurity may have a significant influence on the principles of emergency operations: prevention, mitigation, preparation, response, or emergency evacuation and recovery. The potential weaknesses in cybersecurity offer significant dangers to the usefulness and performance of such essential infrastructure, which in turn has an influence on the way in which nations, economies, and society operate. It is essential for organizations in Europe, both public and private, to embrace newly developing technology in the field of cybersecurity in order to contribute to improvements in cyber security and civil protection.

Keywords: Cyber security, Civil Protection, Cybersecurity technologies

1. INTRODUCTION
1.1 Background

According to Fekete and Rhyner (2020), inadequate cybersecurity might possibly have a significant negative influence on society, even to the point of eroding the public's faith in digital services. Given how closely these services are tied to our everyday lives, any effective cybersecurity plan must take into account the social and, more broadly, human components. Cybersecurity is crucial for ensuring that digital services operate safely and securely while also preserving citizens' privacy and data protection since data flows and information is the lifeblood of today's digital society (Gercke, 2012). For its vital infrastructure, Greece has expertise creating and implementing cyber-resilience. Greece has created thorough cybersecurity rules and regulations over the last three decades, strengthened its institutions, and established the necessary expertise to guard against and stop cyberattacks on the nation's vital infrastructure (Kalogiannidis et al., 2022). This research will concentrate on existing methods and difficulties in boosting civil protection through enhancing cybersecurity skills, resilience of crucial cybersecurity infrastructure, and developing confidence in the digital society.

1.2 Objectives of the study

The primary objective of this research was to analyze the part that cyber security plays in improving civil protection, with the European viewpoint serving as the primary base. In addition, the research was predicated on a number of distinct goals, which might be summarized as follows:

1. To determine the impact that cyber security technologies have on the protection of civil infrastructure
2. To investigate the impact that cyber risk mitigation strategies have on the provision of civil protection
3. To investigate the connection between the role of the government in cyber security and the protection of civil rights.
4. To determine the various cyber dangers or natural catastrophes that are related with inadequate civil protection in various industries (such as power, communications, and so on)
5. In order to create the operational models and existing methods for addressing cyber threats in critical infrastructure.

1.2 Significance of the study

This study essentially provides multidimensional insights into the growth of cybersecurity over the past years, identifying weaknesses in the current European digital evolution and their impacts on the European perspective of civil protection. This study will also set out the elements that potentially can be used to shape a brighter and more secure future for Europe's digital society as well as civil protection, taking into account the new cybersecurity challenges.

2. LITERATURE REVIEW

A look at cybercrime and how to stay safe online

Many studies have shown that getting the right cyber-security skills is one of the most important things you can do to stop the growing number of attacks on private or institutional information (Ekaterina, 2008; Klimnurg, 2012; UNISDR, 2017). When information isn't managed well and people don't understand cyber security, hackers have a chance to get into other people's or organizations' information and use it wrongly.

Adriana et al. (2016) say that most cybersecurity attacks are caused by mistakes made by less-skilled or less-qualified IT staff. These mistakes give hackers a chance to mess with network systems. It's important to keep in mind that most attackers or hackers try to take advantage of human weaknesses. This is why cybercrime is so common in businesses with underqualified staff. Improving cyber security also requires a deep understanding of how people work. Most human functions are used to make security tools and rules more effective by taking into account history, behavior, and design. Buckland et al. (2015) say that companies should choose a multi-criteria policy framework that combines risk assessment and then prioritizes countermeasures by using user-friendly technology in most difficult situations.

Civil Protection

OECD (2021) says that preparing for and responding to disasters requires knowing the risks, working well as a team, and using a variety of skills. People in Europe and all over the world agree that the EU's civil protection strategy is one of the best ways to show that it cares about people who have been hurt by any kind of disaster. As a result, more and more European Services are working together to strengthen the links between the different policies for disaster risk reduction (DRR) and disaster risk management (DRM) (Pursiainen & Francke, 2008). Through the Union Civil Protection Knowledge Network, the EU is creating a new place for experts in civil protection and disaster management to share their knowledge, best practices, and lessons learned. The EU hopes to improve its European Disaster Risk Management by using the Knowledge Network (Fekete & Rhyner, 2020; Winkler, 2022).

Table 1: Showing strategic steps to avoid cyber crimes

Monitoring and alerts	It's crucial to have robust system monitoring in place to prevent malicious attackers from accessing and storing sensitive data on a peripheral device. This includes network monitoring and alerting settings to spot unusual behaviour.
Risk management decision-making	They may decide how assets and a constrained budget should be used by doing a risk assessment. The element in question will access technical hardware, software, and assign monetary risk value if it is degraded or infected by a virus.
Up-to-date technology	The effective use of security technology and the required tools. Due to old computer firmware, shoddy security methods, and antiquated safety technologies, the corporation will continue to be exposed to hackers.
Security team	Sensitive and confidential information should be immediately protected by a well-trained professional personnel; the IT department should be watchful to know about frequent risks.
Knowledge is power	Maintaining thorough awareness of prospective risks and assaults is essential to preventing cybercrimes.

3. CONCLUSION

The study found that cybersecurity is an important part of making a country safer for its citizens. Due to how quickly technology changes and how hard it is to do things online, hackers and other cybercriminals have gotten better at using technology. In this case, both private and public organizations around the world have had their security put at risk because they use all kinds of technology to change the most sensitive data. This shows how important it is to have a strategic plan to help different countries or organizations fight cybercrime. The best ways to stop cybercrime and improve cybersecurity focus on getting rid of human mistakes. These include a thorough risk assessment, constant monitoring of the organization's network or information systems, and making the right decisions. Setting up national or international frameworks for cyber security policy is another important step in stopping cybercrimes. Such policies are necessary for economic and social growth and, by extension, for protecting societies that depend on the internet from all kinds of risks and threats. As technology keeps getting better, cybersecurity threats are becoming a bigger worry. Cybercriminals are always coming up with new ways to attack systems and the companies that run them.

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EPIDEMIOLOGICAL SURVEILLANCE REPORTS ON COVID-19 IN GREECE. SENTIMENT ANALYSIS AND PUBLIC PERCEPTION BASED ON MACHINE LEARNING AND ARTIFICIAL NEURAL NETWORK

AWARDED

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ABSTRACT

The present research deals with sentiment analysis performed with Azure Machine Learning Excel Add-in to classify Facebook comments on the Greek National Public Health Organization (EODY) from November 2021 to January 2022. The 300 reviews were categorized, into Positive, negative and neutral sentiments. This approach involved analyzing the keywords appearing in the comments and exploring the sentiments related to daily surveillance reports of COVID-19 published on the EODY Facebook page. Moreover, an Artificial Neural Network (ANN) model was implemented to predict the classification of sentiments. Machine learning and ANN approaches can provide critical information combating public health hazards and enrich communication strategies and channels in public health issues during the COVID-19 pandemic.

Keywords: sentiment analysis, ANN, COVID-19, Facebook, public health.

1. INTRODUCTION

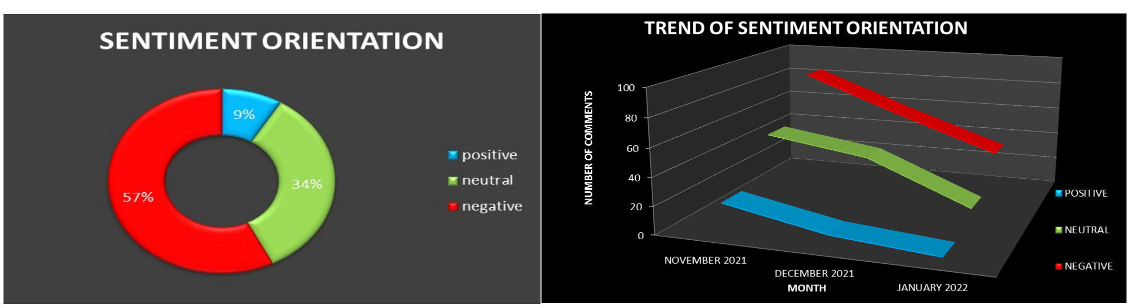
National Public Health Organization (EODY) in Greece supervise all the public health services related to communicable and chronic diseases and implement all the necessary actions for epidemiological surveillance, risk assessment, scientific consultation, dissemination and communication strategies to inform the population about health issues, like COVID-19 surveillance reports and data [1].
Sentiment analysis can decipher people's opinions, emotions and sentiments. Political sciences, marketing and sales use sentiment analysis to improve products and services following customer reviews. In the medical field, sentiment analysis is used to spot and extract opinions and sentiments on social media, on issues regarding mental health, epidemiology, new medical treatments, drugs and supplements, patient forums, and pharmacovigilance [2].

2. EXPERIMENTAL METHODS

Natural language processing (NLP) is a subfield of computational science and refers to a software's capability to automatically manipulate natural language, like text and speech [3]. Sentiment analysis was based on a Natural Language Processing algorithm, a subset of Artificial Intelligence (AI). A machine learning technique was performed with the Azure Excel Add-in to classify Facebook data (comments) from the official page of EODY. In particular, daily reports publicized from November 2021 to January 2022 were collected. Moreover, Positive, Negative and Neutral sentiments were recorded fter processing 300 comments. This approach involved analyzing the comments of the people discussing the daily EODY reports on Facebook, which included, among others, the number of deaths, number of patients in critical condition/intensive care, patient gender, and number of confirmed cases of COVID-19 based on rapid and molecular tests [4,5].
In the next phase, all neutral comments were omitted, and the remained comments were corrected manually to leverage the machine learning performance, especially in the case of sarcasm and irony of Greek phrases. Finally, only the positive and negative comments were selected to create an ANN model, namely 199 comments. Subsequently, an ANN model was developed to classify public sentiments, positive or negative, using the number of deaths, the number of confirmed cases of COVID-19 based on rapid and molecular tests, the number of patients in critical condition/intensive care, the number of male in critical condition/intensive care, the number of female in critical condition/intensive care, summation of notifications and reactions of each surveillance report on EODY's official Facebook page and the respective sum of comments. Furthermore, an engagement rate of the daily reports of EODYY was built and considered as the summation of the number of comments, replies and notifications divided by the number of followers of EODY's Facebook account, namely 191.000 followers. In this analysis, 70% of the dataset was used to train the model and 30% for testing purposes. The architecture was set to select the numbers of the hidden layer's units automatically (one hidden layer). Batch type of training and scale conjugate gradient was selected to optimize the algorithm [6]. Statistical analysis was performed by SPSS v.21 statistical software (SPSS Inc., USA) and Microsoft Excel.

3. RESULTS AND DISCUSSION

The text analysis revealed positive, negative and neutral sentiments expressed on EODY's Facebook page in three months period, from November 2021 to January 2022 (Figures 1a,b). The vast majority of the sentiments have a negative orientation, with the respective percentage rising to 57%. On the contrary, 34% neutral and 9% positive comments were also documented (Figure 1a-b). A declined trend of negative and neutral sentiments at the end of the winter, in January 2022, is highlighted in Figure 1b.



(a) **(b)**

Figure 1. (a) Percentage of sentiments based on comments; (b) Trend of comment's sentiment orientation

Figure 2 illustrates the words with the best frequency rate in the public comments, reflecting opinions and debating issues. Additionally, their frequency determines word size. Overall, 60 words are depicted. The public discussed topics related to lack of communication and guidance to people infected with COVID-19, especially on the first day after the positive result of a rapid or molecular test. The communication strategy of EODY and social media activity on Facebook are also criticized, while transparency issues emerged [7].

Figure 2. Word cloud based on their frequency (60 words)

The model performance had an overall accuracy of 86,9%. Regarding sentiment classification, sensitivity analysis revealed a high score for negative comments (100%), which was subsequently set to zero for the category of positive comments. As emphasized in Table 1, the model performed with a high level of credibility for negative sentiment orientation, yet for positive sentiments, the developed ANN model was not efficient enough. The following table presents the outcome of the model and the incorrect predictions for the training and the testing dataset (Table 1).

Table 1. Model statistics and classification summary.

		Classification			
Sample	**Observed**	**Predicted**			
		NEGATIVE	POSITIVE	Percent Correct	Accuraccy=86,9% (TRUE POSITIVE+TRUE NEGATIVE /TOTAL NUMBER)*100
Training 14,9% incorrect predictions	NEGATIVE	120	0	100,0%	
	POSITIVE	21	0	0,0%	Sensitivity (POSITIVE) =0% TP/(TP+FP)*100
	Overall Percent	100,0%	0,0%	85,1%	
Testing 8,6% incorrect predictions	NEGATIVE	53	0	100,0%	Sensitivity(NEGATIVE) =100% TN/(TN+FN)*100
	POSITIVE	5	0	0,0%	
	Overall Percent	100,0%	0,0%	91,4%	

Dependent Variable: SENTIMENT(POSITIVE OR NEGATIVE).

4. The combination of the number of comments on EODY's Facebook page, the number of female in critical condition/intensive care and the engagement rate contribute the most in terms of importance to the ANN model. Likewise, the number of patients in intensive care and the number of confirmed COVID-19 cases partially regulate sentiment orientation and public discussion. The same effect (12%) has the number of COVIV-19 deaths, while the number of notifications and reactions to the surveillance reports has a minor influence on the overall prediction capacity of the model (Figure 2).

5. CONCLUSION

This research analyzed the public perception and sentiment orientation regarding the daily surveillance reports of EODY. The respective sentiments were classified into three main comment categories: positive, neutral, and negative. Moreover, this study implemented an ANN model to predict public positive or negative sentiment orientation concerning Facebook and COVID-19 data from daily surveillance reports. Based on the results, sentiment analysis and ANN models can provide critical supplementary information about the expression of sentiments during the COVID-19 pandemic. Overall, further research is required to advance algorithms and predicting models for sentiment and opinions to help monitor public health services and decision-making processes during the pandemic.

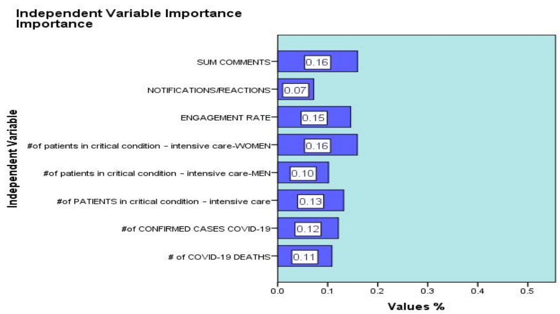


Figure 3. Independent variable importance according to the ANN model

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EDUCATION & TOOLS TO SUPPORT PUBLIC RESPONSE IN EARTHQUAKE EMERGENCIES: THE REDACT EDUCATIONAL HUB

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ABSTRACT

Earthquake imposed crises, invoke the entire community including all of its structural components: the operational capacity of services, their response efficiency and the response of the population. Especially the latter is strongly related to the level of communication, of comprehending the risks and of being trained to respond.
An effort to capitalize on the wealth of educational material published by competent authorities at National level and to constructively contribute towards enhancing the response capacity of the public over providing education and targeted situational awareness during emergencies, is presented. This effort is represented by a set of tutorials and tools comprising the REDACt project Educational Hub. In a sequence, it focuses on helping the public comprehend the risks, on providing simple guidelines regarding Preventive, Preparedness and Response measures inside and outside the house, it promotes volunteering at "neighbourhood level" and it also provides during emergencies, solutions for establishing situational awareness which responds to the main concerns people have immediately after an event, as are the condition and whereabouts of loved ones and owned assets. The latter is based on communication over data, existing technologies and free services and is provided as brief step-by-step tutorials. Navigation-able maps of state-defined safe (refuge) locations can also be accessed over the EDU-hub to support both planning Prevention and Response actions. To disseminate information, the Edu-Hub is complemented by a smartphone app and is designed as part of a Rapid Earthquake Damage Assessment (REDA) System, which also includes a REDA platform to provide both scenario based and near Real-Time Earthquake Damage to authorities and support decisions during Prevention and Response stages.

Keywords: earthquake disaster mitigation, Decision Support System, REDACt, earthquake resiliense.

1. INTRODUCTION

Earthquake imposed crises, invoke the entire community including all of its structural components: the operational capacity of services, their response efficiency and the response of the population.
A "crisis" or "critical situation" is strongly related to the viewpoint of the one who is undergoing it [1], which means that different people may have a different perspective on the same "critical situation". On the other hand, even though decisions are binary, under critical conditions they have to be aligned among all involved parties, to minimize the threat. What is actually important and at large defines the

public response and “social vulnerability” [2], is what concerns the public during those critical moments; and that, includes a set of parameters related to a person’s initial well being; self-protection; livelihood and resilience; social protection and; the social and political networks and institutions [3]. In a cue based on the personal interest of any individual, those subjects include: (i) Individual (personal, family issues), (ii) Household (owned assets), (iii) administrative community, (iv) cultural community, (v) National, (vi) regional [1]. Since reactions of the public are driven by those interests, the perception of people and their feelings, values and beliefs during emergencies, should be the indicators followed when studying the vulnerability of modern societies [4]. As is therefore evident, the public needs: (i) capabilities to comprehend and evaluate the risk, (ii) situational awareness at different levels including those related to the event itself as well as those regarding “the persons of interest” and owned assets and (iii) the capacity to react. Subjects (i) and (iii) can be enhanced by providing targeted education in a popularized way, whereas situational awareness can be provided in real-time by using a set of tools, facilitating communication over data. As communication over data requires and consumes a very limited bandwidth as compared to voice communication, it is more likely that it will still be available even when voice communication is blocked due to overloading. The REDACt EDU-Hub is designed as a part of a Decision Support System [5] which attempts to support Earthquake mitigation by aiming at two targets: (i) to enhance the Operational Capacity of decision making authorities by providing Earthquake Damage both in case of scenarios-thus supporting Preventive actions- and by providing event related information (Earthquake damage) in near Real-Time thus providing situational awareness; and also, to enhance the population capacity to respond responsibly and effectively, in line with the State emergency plans by providing them (i) education to enhance their competencies and (ii) the means to establish situational awareness during emergencies by verifying the safety conditions and location of the their “persons of interest” and owned assets. Over the hub, principles and software tools facilitating real-time, on-demand text and “live” location sharing are provided in a popularized way. This information is expected to help the public build their own response capacity and thus to prevent them of unnecessarily exposing themselves to risks while at the same time, they follow, their own emergency plans, in line with the State guidelines.

2. THE REDACt PROJECT EDUCATIONAL HUB

The EDU-Hub is a part of the project’s Web Site (https://www.redact-project.eu/). Visitors can browse to find it within the REDACt project Web Site or be directly linked to it over the REDACt smartphone app, which is also going to provide event related data and receive feedback (“I felt it”) which will be evaluated at a later stage in comparison to the Rapid Earthquake Damage Assessment platform outputs. Visitors to the hub are first introduced to the earthquake disaster mitigation competent Organizations at National level for all project participant countries (Greece, Turkey, Romania, Moldova). The public is directed to those Organizations for more information regarding Earthquake Prevention, Preparedness and Response guidelines, tutorials and other Educational Material published.

2.1. Tools and methods to support capacity building

To help the public better comprehend the earthquake risks, the EDU-Hub presents a multi-level structure which starts with a table aiming at helping the public comprehend the Risks and link them to Preventive and Response actions. Each table field is linked to the respective image published by the competent Organizations at National level with a reference made to the publication and the Organization. At the second level, all stages of risk mitigation, classified as plans and actions taken inside and outside of the house/building are presented and explained and step-by-step popularized guidelines are provided (Figure 1a). At the same time, mutual support through volunteering is promoted in order to build resilience for the community as a whole.

2.2. Improving Situational Awareness during emergencies

The third level focuses on building capacity for ensuring situational awareness. It is based on the principles presented in previous paragraphs and includes short tutorials on how to share short text messages and Real-Time continuously-updated (live) location using freely availably services (as Google Maps, Whatsapp and Viber). As costs for “live location” sharing paid services, may be discouraging and prevent the public of using them, freely provided services have been selected instead of paid ones.
Care has been taken so that the tutorials are easily comprehensible (Figure 1 b&c). In any case they are complemented with short, bulleted texts and videos.

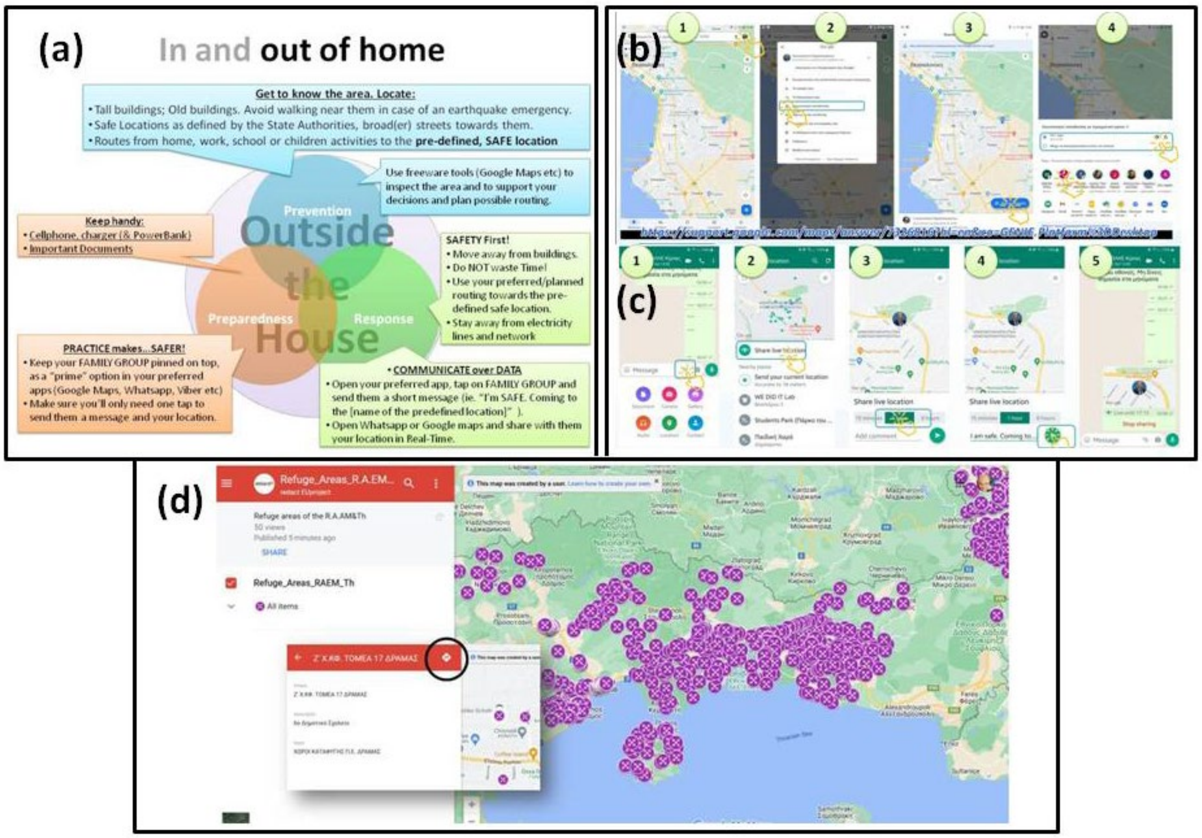

Figure 1. (a) actions to be taken inside and outside the building, classified as per mitigation stage. Four “taps” to share “live” location with (b) Google Maps© and (c) Whatsapp©. (d) Safe locations (refuge areas etc) as defined by the Regional Administration of Anatoliki Makedonia & Thraki. Upon selection, information about the safe location is provided to the user (inset image) and navigation is made possible over the small arrow (inside the black circle).

2.3. Navigation towards safety

The public can select any “safe” location in the proximity of their usual whereabouts but knowing the organized by State authorities “safe” areas can be very useful information both at the stage of planning for their own emergency plan (prevention) and during the response phase. Moreover, the location of safe areas is necessary to visitors, who may have problems to decide where to go during an emergency.

For those reasons, the EDU-Hub provides a navigation-able map (Fig. 1d) containing all of the safe (refuge) areas as defined by the competent Regional and State authorities. Users can have direct access to the map using their cell phone or any computer, over the REDACt EDU-Hub and the REDACt smartphone app. They can use this information to plan during the prevention stage and to navigate towards them, in case of an emergency. Navigation towards safe locations can be a useful capability during emergencies, especially for people who do not know the area very well (tourists, visitors etc).

3. CONCLUSIONS

The REDACt project Educational-Hub can be accessed over the REDACt project web site (https://www.redact-project.eu/). It has been designed as part of a Decision Support System aiming at providing support to authorities for enhancing their Prevention and Response capacity and to the public as well, by providing education, methods and tools to support them during emergencies.

Over the REDACt EDU-hub, principles, software tools and services provided for free, facilitating real-time, on-demand text and "live" location sharing, are provided in a "popularized" way. The hub additionally provides information regarding the location of safe/refuge areas and facilitates navigation towards them, a capability especially useful to visitors (tourists etc).

All of this information is expected to enhance the public ability for planning for emergencies and for on-demand, real-time communication during emergencies, which can help them make informed decisions, act responsibly and thus to prevent them of unnecassarily exposing themselves to risks and to improve their capacity to respond efficiently during emergencies in line with State emergency plans.

As the EDU-Hub outputs follow a set of principles identified by respective research regarding the psychological response during emergencies, it is expected to positively contribute towards improving the public safety and the community resilience overall. In any case, the feedback provided from the end-users will be very important to further refine and/or calibrate the REDACt Educational-Hub content.

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EXPLORING HOW CITIZENS COMMUNICATE ABOUT NATECH RISK THROUGH A COMPARATIVE STUDY AND A SERIOUS GAME

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ABSTRACT

Disclosing information about natural-hazard-triggered technological accidents that involve the release of hazardous materials (Natech) empowers all involved stakeholders to make comprehensive and risk-informed decisions. This study ventured to explore how citizens communicate concerning Natech risk information disclosure and propose an approach to enhance community awareness. We surveyed households in Japan and S. Korea to examine how they perceived and communicated about Natech risk using the interpretative framework of the Situational Theory of Problem Solving. In addition, we explored the potential of serious gaming for Natech risk communication by proposing and developing EGNARIA: a novel, educational, role-playing board game considering earthquake and tsunami scenarios potentially causing subsequent chemical accidents. Our survey findings suggest that Natech accident risk is perceived as a concerning issue in both countries. However, even though households from both countries acknowledge the Natech risk information deficiency as a serious issue, Japanese are significantly more constrained in resolving it through communicating. In comparison, S. Korean respondents seemed to be more communicatively active about it, and more confident in responding to potential Natech accidents. Regarding the proposed serious game, EGNARIA received overall positive scores from players as an engaging, educational tool useful for introducing communities to and discussing about Natech accident risk. Participants noted that the game raised their awareness about Natech accidents, highlighted the importance of community participation and chemical information disclosure, and positively affected their intentions to actively search for and share information about Natech risk.

Keywords: Community Participation, Disaster Risk Management, Natech, Risk Communication, Serious Gaming.

1. INTRODUCTION

Active community engagement plays a central role in effective disaster risk reduction. Despite its wide recognition and numerous approaches, community involvement in disaster risk management processes still seems to be easier claimed than actually realised in most cases[1, 2]. In this regard, the contribution of effective risk communication is considered *sine qua non*. Promoting transparency throughout the decision-making process and disseminating risk information empowers all involved stakeholders to make risk-informed decisions[2]. Considering the emphasis placed by current risk communication approaches on relationship-building among stakeholders, such practices seem to create favourable conditions for participatory disaster risk management, since they encourage community involvement and trust-building[2]. Furthermore, recent approaches involving serious gaming—i.e., games that have purposes other than only entertainment—have gained considerable credit within the disaster risk management discourse as promising risk communication tools to promote public awareness and support participatory decision-making for risk-related issues.

Such risk communication issues have only recently emerged considering large-scale, complex disasters, such as technological accidents triggered by natural hazards, also known as Natech*[3]*. In cases where chemical risk communication is limited, individuals may find themselves in lack of necessary information crucial for their effective preparedness against and appropriate response during a potential accident. In this context, this research aims to contribute to the emerging topic of Natech risk communication by expanding the current knowledge about citizens' communicative behaviour towards chemical risk information disclosure and further by proposing a serious game as a means to raise awareness about Natech accident risk and communicate about its management.

Focusing on the communication problem of lacking Natech risk information, this research initially explores the determinants that shape individuals' situational perceptions and communicative behaviours. Japan and South Korea have been selected for a comparative study in an attempt to identify and understand any potential differences in how individuals from analogous sociocultural backgrounds, but embedded in different chemical risk governance systems, communicate about Natech risk information disclosure. In particular, these two countries share a comparable collectivistic sociocultural structure in view of cultural dimensions, yet they present important institutional differences in terms of chemical and Natech risk communication. S. Korea has recently updated their regulatory framework for the management of technological accidents (see 'Chemical Substances Control Act', 2018) introducing requirements for public disclosure of chemical information, while Japan still has not.

2. METHODOLOGY

This study approached the analysis of the public's communicative behaviour through the interpretative framework of the Situational Theory of Problem Solving (STOPS)[4]. For the purposes of data collection, self-administered, anonymous, household questionnaire surveys were carried out in 2018 (Japan) and 2020 (S. Korea) targeting residential, urban districts near prominent industrial parks in both countries: Higashinada (Kobe) and Sakai-Senboku (Osaka) in Japan, and Yeosu, Suncheon, Gwangyang and Ulsan in S. Korea. Structural Equation Modelling was employed to validate the conceptual model and analyse the results of the two surveys, while the differences between groups were assessed using inferential statistics.

Aligning with the current risk communication paradigm which promotes participatory approaches that extend the disaster risk management discourse to involve the public[2, 5], this research additionally explored the potential of serious gaming for Natech risk communication. This study proposed and developed EGNARIA: a novel, educational, role-playing board game considering earthquake and tsunami scenarios that might cause subsequent chemical accidents. Players try to survive by taking disaster preparedness actions and responding correspondingly to the natural and chemical hazards they face. The game is designed to raise community awareness about Natech accidents, and generate a discussion among stakeholders about risk management strategies, chemical information disclosure and risk-informed decision-making concerning Natech accidents. In order to assess the impact of the game a quasi-experimental design was employed with a questionnaire survey before and after the trial application with Kyoto University affiliates. Following the same conceptual approach, the survey was structured based on STOPS measures to understand the game's impact on how participants communicate about Natech risk.

3. RESULTS AND DISCUSSION

In terms of the Natech accident risk itself, our findings revealed that both our Japanese and Korean sample generally perceived the risk to be quite high, although Japanese seemed to consider such scenarios a little more probable (Table 1). Moreover, Japanese expressed a remarkable level of perceived unpreparedness for such scenarios, comparatively. Considering the Natech risk information deficiency issue, the problem is perceived by both as severe and one that very much affects their lives; however, S. Koreans seem to be statistically significantly less constrained in solving it, they have more expectations about how it should be dealt, and are more motivated to communicate about it. Additionally, Japanese scored consistently lower in the active components of their communicative behaviour, namely in information selecting, forwarding and seeking, thus indicating a comparatively less active communicative attitude overall.

Table 1. Mean Scores and Differences for Perceived Natech Accident Risk and STOPS Measures

Aspect	Japanese	Korean	t-Test
Natech Accident Risk			
Natech Potential	5.92	5.71	.009
Accident Scale	5.70	5.82	.161
Appropriate Response	2.75	4.00	.000
Natech Risk Information Deficiency – STOPS			
Problem Recognition (PR)	5.89	5.74	.053
Involvement Recognition (IR)	5.21	5.31	.294
Constraint Recognition (CR)	4.67	4.12	.000
Referent Criteria (RC)	3.37	4.12	.000
Situational Motivation (SM)	4.43	4.69	.005
Information Forefending (IFrf)	2.66	3.60	.000
Information Permitting (IPrm)	4.83	4.58	.005
Information Forwarding (IFwd)	3.72	4.31	.000
Information Sharing (IShr)	4.02	4.56	.000
Information Seeking (ISek)	3.29	3.89	.000
Information Attending (IAtt)	4.92	4.87	.560

Next, we segmented the public into four categories based on their situational motivation determinants for both survey groups (Figure 1). In both groups more than 8 in 10 people belonged to either aware or active publics, exhibiting thus a high concern and communicative activeness about the Natech information deficiency issue. Also, we found a notably smaller number of S. Koreans, in particular about 10%, who belonged in non- and latent publics compared to almost 19% for Japanese respondents. Along with a comparatively larger aware public (+10%), and a less-than-half activist public, results show an overall less active communicative behaviour of Japanese in solving the Natech risk information deficiency problem.

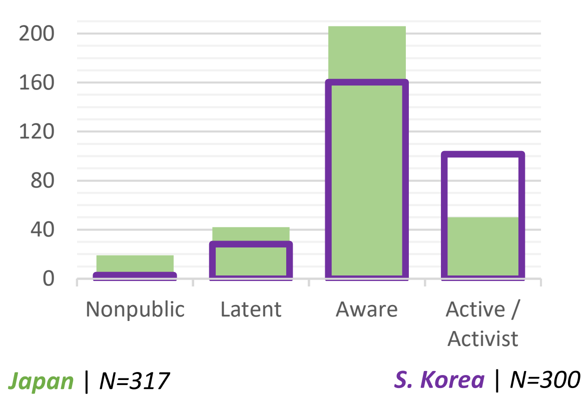

Figure 1. Comparison of Public Segments for Natech Risk Information Deficiency between Japan and S. Korea

Concerning the serious game, our trial findings suggest an overall positive reception of EGNARIA from participants as an engaging, educational tool to introduce communities to Natech accident risk and discuss about its management (Figure 2). Participants noted that the game raised their awareness about Natech accidents, highlighted the importance of community participation and chemical information disclosure, and positively affected their intentions to actively search for and share information about Natech risk.

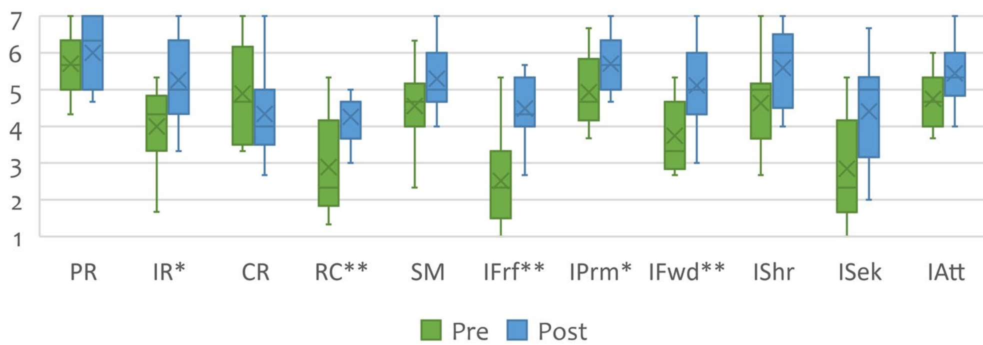

Figure 2. Changes in Communicative Behaviour Pre- and Post-Game. Two stars (**) indicate a difference significant at the .01 level (2-tailed). One star (*) indicates a difference significant at the .05 level (2-tailed).

4. CONCLUSIONS

This study attempted to explore the communicative problem of Natech risk information deficiency and in doing so provide some rudimentary empirical evidence for risk managers to pursue and foster chemical and Natech risk information disclosure. Our research findings suggest that even though both acknowledged the Natech risk information deficiency issue as a serious problem, Japanese were significantly more constrained in handling it. S. Korean respondents seemed to be more communicatively active about it, and more confident in responding to potential Natech accidents, perhaps owing to the recent regulatory framework. Additionally, we developed and tested a novel serious game for Natech risk awareness to aid risk communicators in opening the risk management discourse to communities. Overall, EGNARIA proved to be a fun, informative and stimulating serious game about disaster risk reduction.

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CONVERGENCE OF PUBLIC AND EDUCATIONAL SYSTEMS FOR BETTER CATASTROPHE PREPARATION

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ABSTRACT

As natural disasters and man-made crises continue to pose substantial threats to people and property all over the globe, there has been an increase in the need for knowledge about the most effective approaches to strengthen emergency readiness. This research examined the integration of school and public sector systems for increased preparation for natural disasters, with a particular emphasis on Greece as a case study. For the purpose of the research, a sample of one hundred fifty people who were all influential figures in the education sector in Kozani, Greece, participated in the study. The findings of the study indicate that school systems have a positive influence on disaster preparedness, that the practices of the public sector have a positive influence on disaster preparedness, and that the integration of the public sector and school systems has a positive influence on disaster preparedness. Education about disasters helps to educate individuals and organizations so that they may take safeguards to reduce their vulnerability to the effects of natural disasters. Over the course of the last several decades, a significant amount of attention has been paid to the subject of how persons who have received enough training may be prepared for disasters and respond to them.

Keywords: *Disaster Preparedness, Disaster Risk Reduction (DRR), School Systems, Public sector*

1. INTRODUCTION

1.1 Background

Disasters and emergencies pose great risks to humanity and property across the world and this has raised the need to acquire more knowledge on the best actions to utilize in enhancing disaster preparedness whereby improving on disaster risk reduction(Ghanekar et al., 2021). Numerous examples across the globe show that the general public and children in schools are all vulnerable to disasters(Connelly, 2019; Singh, 2019). However, they may also be powerful and effective communicators when it comes to calamities. Lessons learned at school are often carried over to the home. Children and teachers would gain a better understanding of the immediate environment in which they and their families live if disaster awareness and risk reduction education were introduced to the school curriculum and made available to the general public. This would improve disaster preparedness and lead to the desired Disaster Risk Reduction (DRR) (IFRC, 2011). Many nations have already included DRR into their curricula, are finishing off their integration, or are just beginning. However, the manner of integrating varies often from one country to another based on the policy choice made by the nation's educationists (IFRC, 2011; Meira & Bello, 2020). Disaster recovery, for example, is sometimes taught as a stand-alone course in both public and private educational institutions. Frequently, sections and particular chapters of other courses, such as environmental studies, geography, science, and so forth, are combined with the principles of disaster preparation to teach them (Greece Country Strategy, 2012). Disaster education attempts to provide people with the information they need to act to lessen their susceptibility to catastrophes. The question of how well-trained individuals can be prepared for catastrophes and react has received a lot of attention over the last several decades. According to the findings, disaster education is a practical, useful, and affordable risk management technique. According to some data, it's critical for vulnerably minded individuals to be informed about calamities. There are several approaches of educating the vulnerable, but none of them is superior to others. Schoolchildren or trained individuals are more able to defend both themselves and others. To prepare people for catastrophes, extensive educational programmes must be planned and designed(Sena & Kifle, 2016; UNDRR, 2007).

1.2 Purpose of the study

This study assessed the integration of public sector and School systems for improved disaster preparedness, focusing on Greece perspective. The purpose of this study is also achieved by focusing on the following;

- To assess the influence of the public sector factors that facilitate effective disaster preparedness
- To establish the best strategies to improve knowledge on disaster preparedness in the public domain
- To establish the effect of public sector and school systems integration on disaster preparedness

1.3 Research hypotheses

H1: School systems have a positive influence on disaster preparedness

H2: Public sector practices have a positive influence on disaster preparedness

H3: Public sector and school systems integration positively affects disaster preparedness.

2. LITERATURE REVIEW

This research is inspired by the Hyogo Framework for Action (2005-2015), which outlined performance objectives for reducing disaster risk globally (National Progress Report, 2015). The third function, which focused on information, innovation, and education, prioritized safety and resilience at all levels. HFA says catastrophes are decreased when individuals are educated and motivated to promote disaster prevention and resilience. Gathering and distributing knowledge regarding risks, vulnerabilities, and capacities, particularly for vulnerable populations, must be a primary focus (National Progress Report, 2015). People with restrictions and conditions need specific guidance and care from competent and experienced people. Globally, disaster education programs for kids will boost children and families' preparedness and resilience. A 2005-2015 Hyundai paper details the evidence. Early teachings are never forgotten, according to study. Teaching children risk reduction and catastrophe avoidance is useful (Kalogiannidis et al., 2022). Education is vital for catastrophe planning. Families, schools, and healthcare personnel must understand the value of preparation education for children. Choosing the right demographic for disaster education is the first step (Ferris & Daniel, 2013). Three levels of education, including primary education for families, teachers, and school administrators, should concentrate on children. When a crisis occurs, families and schools help schoolchildren. Families or school personnel may initiate first aid and organise the emergency evacuation of children, depending on the circumstances and time. Educating families and schools is vital to childrearing (Greece Country Strategy, 2012). Include catastrophe risk education in school curriculum at all levels, especially primary schools, and spread the information to the public sector.

3. METHODOLOGY, RESEARCH DESIGN, TARGET POPULATION, SAMPLE SIZE

The study used a quantitative approach and a descriptive research design. Descriptive research is an inquiry in which quantitative data is gathered and evaluated to characterize a particular phenomena in terms of current trends, current occurrences, and current connections between various variables. The descriptive research design was used because it enables the researcher to generalize the findings to a larger population of leaders in the education sector in Kozani, Greece, that provided data about the topic of study.

The study targeted the different leaders in the education sector in Kozani city of Greece. The population ion was based on to establish the most appropriate sample for the study. The study utilized a sample of 150 study participants who were all leaders in the education sector from Kozani, Greece.

4. DISCUSSION

The research found that integrating public and school systems improves catastrophe preparation. The research reveals that school systems, public sector practices, and school-public sector cooperation favorably enhance catastrophe preparation. Governments, companies, communities, and schools may respond and cope with catastrophe aftermath by being proactive. School officials, personnel, professors, and students are all responsible for improving catastrophe readiness. Different measures should be in place to guarantee that schools and the public have disaster preparation information. Emergency preparation knowledge should concentrate on prevention, mitigation, readiness, response, and recovery (Ghanekar et al., 2021; IFRC, 2011).

The research found that adding disaster preparation teachings into the school curriculum would help teachers, students, and the public sector understand the environment in which they and their families live, reducing community risk. Helping people in charge of disaster education and research may boost disaster preparation education. Various training strategies may be used (FAO, 2021; Kanyasan et al., 2018; Weekes & Bello, 2019). Good planning uses a range of exercises and manoeuvres to increase knowledge and skill levels and measure how effectively individuals work in simulated circumstances. Even though these issues have received little attention, vulnerable people require specialized movements and exercises. Disaster education is important at any time, but its impact is greatest during preparation. At this stage, further education is needed.

5. CONCLUSION

This study focused on Greece to show how important it is to connect the public sector and school systems to be better prepared for disasters. The study shows that people can be less affected by natural disasters if they know about them, learn about them, get ready for them, and use prediction and warning systems. It is important to find out which groups in the community and at school are most likely to be affected by a disaster and give them extra training. It's important to remember that the right education can help people avoid or lessen the effects of some disasters. People who have been trained know how to protect themselves and others better. Even though it hasn't gotten as much attention and there isn't a full training program, training may help reduce the human and financial damage caused by disasters, which is seen as a bigger problem for people who are weak.

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STRONG: AN ADVANCED FIRST RESPONDERS TRAINING APPROACH

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ABSTRACT

Responding to disasters is both rewarding and demanding work. Studies indicate that First Responders (FR) are at a much higher risk when executing their duties. To mitigate such a risk, training and education is a proper tool approach for fast and effective integration to teams. With the incorporation of Information and Communication Technologies (ICT) tools the traditional learning methods have undergone an improvement shifting to a more imminent and interactive reality. The use of online courses by higher education institutes is common, but not the case for other groups or institutions such as FR (police, paramedics and firefighters). STRONG project supports online training in the necessary and other (soft) skill by introducing a dual scheme: a Learning Management System (LMS) interoperable with Virtual Reality (VR) capabilities. By utilizing ICT-enabled methods, tools and VR technologies, the LMS will boost the level of training and allow trainees to engage in real-life scenarios while offering trainers insights into trainees' experiences. A European Network of First Responders will ultimately be created through which they can connect; share experiences; best practices and foster cooperation.

Keywords: Training, First Responders, LMS, e-Learning, Virtual Reality, Disaster Management, Soft Skills

1. INTRODUCTION

First responders are amongst the first specialists to arrive during the events of a disaster, timely and accurately evaluate the scene and provide help to affected people and when necessary, enforce law [1]. The rapid increase of disasters and extreme phenomena has led to an increased number of disasters across the globe [2]. Volunteers are always present in first responders' groups helping and working in collaboration with specialists. Though to ensure that volunteers are properly assisting the experts proper training and experience in smaller scale disasters if needed. Emergencies and disasters, in which the number of victims considerably surpasses local resources and skills, are events that, at least temporarily, overwhelm the local system. The response of first responders to these incidents frequently reveals a lack of resources (rescue personnel, medical professionals, facilities, etc.), communication challenges, and organisational interoperability issues, which are especially apparent in cross-border, cross-sector, and cross-hierarchical operations [3]. Despite the fact that the EU has evolved to a strong capacity for joint cooperation and cross-sector cooperation among Member States, studies such as the EU Mandate M/487 to establish EU security standards reveal that the Union is not yet at a stage where responders can interconnect information management systems from different organisations to share situation assessment or automate coordinated response procedures.

2. INTEGRATED LMS APPROACH

First responders are the experts that arrive on site and offer medical services, guide civilians to safety and even enforce law when deemed necessary. In past years the number of disasters has significantly increased in frequency and scale leading to increased demand for first responders. The need to train volunteers efficiently and prepare them to work cooperatively with experts is necessary. STRONG project aims to provide a Learning Management System (LMS) able to offer high quality training material to first responder volunteers and trainees to cope with the ever-increasing demand for ready to act experts. LMS increases learner engagement by providing greater access to learning content. This includes the ability for learners to access their learning materials from any device. Additionally, it incorporates AR/VR tools to offer the trainees close to the real environment and gain experience and a communication platform so they can discuss the courses between them as well as with the developers.

2.1 Domains and approaches

To cope safely, HRT's first responders should have a range of soft and hard skills in Search and Rescue Operations, depending on their specialisation. Based on facts gathered by HRT's Operations Directorate, we concluded that volunteer rescuers need a period to participate effectively in search and rescue operations. This is primarily since they require ongoing training to strengthen their soft skills, which include communication, critical thinking, decision-making, and stress management.

Towards the LMS implementation, one of the most considerable challenges is managing to maintain an equilibrium between the tool's features and the users' needs. Due to this fact, it is essential to identify the different ways through which first responders can benefit from the STRONG LMS platform and accordingly implement the various services and user interfaces. The utilisation of VR technologies has proven quite fruitful and efficient in the field of educational training. A major advantage is their ability to help muscle memory, which is a strong asset for first responder training [4]. VR technologies enable the isolation of trainees from the physical environment, by creating an interactive 3-dimentional- scenery. In this synthetic environment, the trainees will be able to interact via avatars to achieve specific tasks. It is expected that VR can upgrade the learning experience of first responders, since it manages not only to simulate real-world experiences, but also to physically engage the trainees in collaborative mixed reality environments.

The courses will have a practical approach based on real life scenarios and situations, presented via short videos and infographics. In addition, discussions and analysis of Earth Observation (EO) images processed by digital image analysis tools will also take place during the courses in order to engage the interest of trainees and prepare them towards predicting potential weather menaces if required to. Finally, self-evaluation activities will also be included. The collaborative space of the STRONG LMS platform will support first responders with the relevant interest in the domain to meet up, work on projects, share best practices relevant to the topics of the provided courses; towards creating a European Network of First Responders.

2.2 Data Gathering and Content Selection

The two overarching goals of the HRT activities were to investigate first responders' experiences with current training and search and rescue operations on the one hand, and to identify the wishes and needs of HRT rescue volunteers, describing their expectations of an LMS training platform on the other.

To achieve this, a field study was conducted that included interviews and training workshops. More particularly, the emphasis was on the required time to deal confidently and successfully with Search And Rescue (SAR) operations, the needful skills improvement and can incorporate into the training platform, and their acceptance regarding the creation of an LMS. With the affiliation of the trainer or trainee, a total of 30 people from various HRT departments (Mountain Rescue, Water Rescue, USAR) actively participated. Among the primary goals of all HRT recruitment initiatives was to achieve an indicative gender balance.

Based on the STRONG LMS, three online courses for the training of first responders will be designed and developed, focusing on soft skills for first responders; response to weather menaces, health risks and personal risks.

In particular, the online course focused on soft skills of first responders will have a duration of 30 hours of e-learning training, cultivating critical and analytical thinking; decision making skills; teamwork and stress resilience. The training material will include short videos, pictures and infographics relevant to incident response and crisis management, establishing effective communication lines with civil society when implementing safety protocols and finally to the action protocols for vulnerable populations like minors, refugees etc.

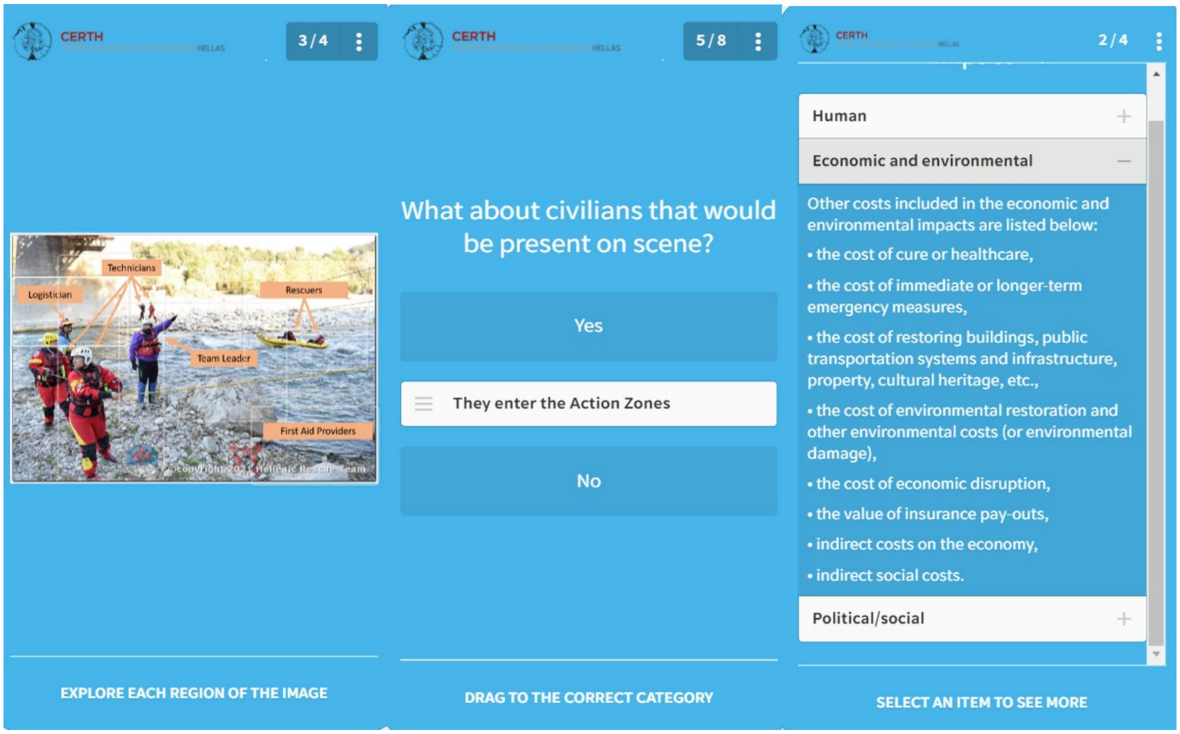
The second online course focused on response to weather menaces will have a duration of 40 hours of e-learning training, providing knowledge on the preparation and control of weather phenomena. More specifically, the training material will be relevant to the operation and management of digital image analysis tools and the preparation of firefighters to act in case of blizzards, heavy snows, ice storms, wildfires, hurricanes and extreme flooding.

Finally, the third course focused on response to health risks and personal risks will have a duration of 30 hours of e-learning training. The training material will raise awareness on topics such as response to health emergencies (involving bacteriological risk, pandemics and other risks to people's health), SAR operations in natural environments. In addition, two more topic of high interest will be elaborated, the education on satellite image analysis and the first responders acting protocols in case of a terrorist attack in urban environment.

Each participant registered on the LMS and enrolled on the courses will be invited to create a profile with information about their relevant experience; topics of interest; expertise; territory of operations etc. In the light of this endeavor first responders from all Europe will be able to connect among them, create collaborative initiatives with other first responders and share their best practices. This network will also help responders to develop other initiatives at European level. The challenges faced by first responders are not circumscribed to their territories, they are global challenges, so the existence of a collaborative space will help them to interact; offer coordinated responses and to share their experiences.

2.3 Presentation of the structure - Examples - Functionalities

Based on design principles that cover learning agility and flexibility, collaborative learning, different mediums to learn through and boosted completion and retention rates, the EdApp (https://www.edapp.com) was considered the most appropriate platform to deploy the LMS. Some of the simplified, interactive or gamified templated that were used are depicted in Figure 1.



(a) (b) (c)

Figure 1. Examples of the templates that are used in STRONG LMS using the edapp: (**a**) Exploration of an image with details; (**b**) Short quizzes in between the lessons; (c) Simple structures to provide condedced information.

2.5 Conclusions

The concept of providing a safe environment for responders is of major importance. This would be addressed by increasing first responders awareness through the provision of an e-learning platform aimed at enhancing the understanding, knowledge and skills of participants in terms of safety and security management at operational and strategic levels, so that they can be better prepared for field operations and act efficiently. The findings indicate that LMS can be more focused on the learner and less on the instructor and also guidelines can be more customized and flexible. In addition, there are side benefits of learning new technologies and technical skills.

ACKNOWLEDGEMENTS

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MED1stMR: AN INTEGRATED TRAINING USING A MIXED REALITY APPROACH FEATURING HAPTIC FEEDBACK FOR ENHANCED REALISM - EUO'S REQUIREMENTS

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ABSTRACT

The European Union's Horizon 2020 project MED1stMR aims to provide solutions to improve modern training practices for medical first responders for mass casualty incidents by developing innovative Mixed Reality applications that will combine existing simulators with a virtual environment to better support, assist, and personalize MFR training. Therefore, MED1stMR will also integrate wearable technologies for monitoring trainees' biosignals to assess the mental stress and adapt the training accordingly. In this paper, we indicate the status and primary findings of the project's analysis phase of the needs for future trainings from the perspective of the end user organizations. To do so, we describe the conduction of workshops and the insights provided by them: First, the state of current training procedures, and second, the management and policy perspective on the MED1stMR project. These results will be used in the next phase for the development of innovative training approaches for effective performance in medical emergencies.

KEYWORDS: Medical First Responders, Mass Casualty Incidents, Mixed Reality, First Aid Training, Smart wearable technology

1. INTRODUCTION

Globally, mass-casualty incidents (MCIs) with injured people caused by human-made or natural disasters are on the rise [1]. In such cases, medical first responders (MFR) must provide basic life support and first aid to victims to stabilize them until additional assistance arrives. Correctly assessing conditions, evaluating, and monitoring vital signs, and deciding on the best treatment strategy are all difficult tasks. However, training capabilities for such scenarios are still restricted according to the literature.

The 3-year MED1stMR project with 19 partners from nine countries (https://www.med1stmr.eu/) intends to create a new generation of MR training providing haptic feedback by incorporating high-fidelity patient simulation manikins into MR. As a consequence, MED1stMR provides a significantly richer sensory experience bringing MR training closer to reality. A feedback loop between physiological signals and trainee behaviour will be integrated for scenario control to improve the effectiveness of MR training. Wearable technology with body sensors will be developed to monitor MFR states and behavior during training.

This paper aims to present relevant information regarding MCI training from the perspective of the project's end users through the preliminary findings during the analysis of their requirements. It describes findings on current MCI training practices, and constraints on MCI simulation training [2]. From this point of view, the paper proceeds to explain the requirements, wants, needs, and expectations of the MED1stMR project's end users regarding the use of Mixed Reality (MR) for MCI simulation training. The End User Organization (EUO) requirements provide immensely helpful insight into the existing training of MCIs as well as their outlook on the future of MR-aided MCI training in the context of the Med1stMR project.

2. METHODOLOGY AND DATA

The following section describes the methodology and data used for the preliminary analysis of end user requirements within the MED1stMR project. To acquire the relevant data, various data sources were used: contextual interviews and training observations of the consortium's EUOs with trainers and trainees, and co-creation workshops and focus groups with trainers, trainees, and management and policy inputs were conducted. The training observations involved a total of n=123 trainees and trainers, the contextual interviews n=30 and the co-creation and focus groups n=41. The data were analyzed through qualitative content analyses [3, 4].

3. DISCUSSION AND FIRST RESULTS

The following are the key requirements of MCI training based on the analysis of the end user activities: Communication, MCI management, safety assessments, and triage procedures are the primary training courses or MCI training in MR (assessment and treatment). There is currently insufficient MCI training due to a lack of (financial, people, and planning) resources [5,6]. End User Organizations, on the other hand, recognize the need for further training in the case of MCI. Key shortcomings in present training have been found in terms of immersion [7] and scenario design. In particular, there is a lack of realism in the presentation of injuries as well as the inability to replicate human interactions [8].

The findings indicate that MCI training is currently restricted in both quantity and quality. It necessitates a large amount of staff resources for planning and implementing the training, and it occurs seldom, at most biannually, and with a small number of participants. As a result, many trainees may go years without participating in an MCI simulation. In terms of quality, the training is also limited in its ability to immerse trainees and in its adaptability for training scenarios. As a corollary, end user organizations have high expectations for MR-aided MCI training, expecting it to reduce MCI training expenses and create safer trainings. Moreover, end users believe that MR training can improve training outcomes by allowing more trainees to train MCI simulations on a regular basis, allowing them to take on different roles in MCI management, improving quality while allowing for debriefing, and introducing more objective measures of successful and effective MCI management. Finally, they anticipate that MR training will improve different aspects of training realism. However, in order to meet these expectations, the technology must be simple to use and adaptable enough to match a wide range of scenarios and training objectives.

However, as the end user organizations within the Med1stMR project vary from volunteers to specialist trained MFR, the result show a variation in the training needs and thus the requirements. More precisely, it depends on the end user organizations themselves which have different amounts of financial resources, different levels of adoption of future and emerging technologies such as MR, different goals as medical organizations, etc. It is worth mentioning that the location of FRs appears to influence the selection of specific realistic scenarios. More accurately, MCIs that are geographically relevant to HRT pertained to earthquakes, as well as fires/floods.

MFRs also had clear objectives for MCI training using MR, including ease of use, long-term cost effectiveness, enhanced training outcomes, safer training, accomplishing the key aims of MCI training, and increasing realism in training.

CONCLUSION

The next phase is for the technology partners to analyze the defined needs and estimate how challenging the individual requirements are to accomplish technically and how long it would take to implement. This will be followed by a decision-making process with technology partners and end users to find a feasible technological solution for the MR system that fits the required MCI training and learning objectives. The project will design an iterative development and testing plan based on the priority of features in the backlog. Finally, end user organizations will assess the MR training system in field tests and more specifically by comparing full-scale MCI training and MCI training in MR.

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FIELD TRIALS OF INFORMATION FUSION, EXPERT REASONING, SOCIAL MEDIA EXPLOITATION AND WORKSITE OPERATIONS IN SAR MISSIONS – INGENIOUS (EU HORIZON 2020)

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ABSTRACT
On September 29th, 2021 a field testing activity for the INGENIOUS project took place at HRTA's training facilities in Afidnes (ATC), Attica region of Greece. The INGENIOUS project is about ensuring a high level of protection and augmented operational capacity for First Responders (FR) working inside the disaster area. The main objectives of these two Small Scale Field Tests included the integration of the specific components of the INGENIOUS Toolkit in real-life conditions, in order to provide testing, assessment, validation and improvements for further development steps. FRs have a significant role as they are the end-users that in future will depend on technologies like these, while robustness, accuracy and reliability of the components are crucial acceptance factors. Hence, this work presents these field tests, their outcomes and the assessment of their results from the FR perspective for real-world Search and Rescue (SAR) operations.

Keywords: Search and Rescue, field tests, crisis managment, security and safety, First responders

1. INTRODUCTION

Search & Rescue (SAR) operations require a high level of training, skills, team capacity and safety procedures. Newly developed tools and technologies can enhance the operational capabilities of First Responders (FRs) in such missions, especially with regard to rapid response in continuously changing environments. The INGENIOUS project (EU Horizon 2020) aims at developing, integrating, testing and validating a next generation SAR toolkit for collaborative team response, providing enhanced protection and augmented operational capabilities.

One of the most crucial factors for the successful development and adoption of novel technologies by FRs in existing SAR operational protocols and guidelines is the active, early involvement of the actual end-users. Instead of providing them with completed prototypes to test and assess for the first time in the field, an iterative collaborative approach is much more effective and risk-preventive in terms of developing tools that are operationally unfit or incompatible with the FR expectancies.

For these reasons, a series of iterative laboratory and field tests have been planned throughout the INGENIOUS project, involving individual tools as well as integration cycles, where FR operators can test, evaluate and comment on the progress of the development from very early on. In this context, Small Scale Field Tests SST#7 and SST#8 were organized and conducted during September 2021 at the Afidnes Training Center (ATC) in Athens, Greece, under the coordination of the Hellenic Rescue Team of Attica (HRTA) as the corresponding end-user in the project consortium.

2. METHODOLOGY – DESCRIPTION OF THE FIELD TRIALS

Four main components were selected from the Next Generation Integrated Toolkit (NGIT) of the INGENIOUS project to be tested and evaluated in this set of field activities:

- **Fusion Engine (FE)**: Data gathering, fusion and combined feeds to other components in NGIT.
- **Expert Reasoning Engine (ERE)**: Information fusion, assessment, mission-critical and safety-critical alerting during the operations.
- **Worksite Operations Application (WOA)**: Integrated coordination platform for mission Command & Control (C&C) at the team level, as well as the Urban Coordination Cell (UCC).
- **Social Media Application (SMA)**: Online monitoring of social media platforms for prompt alerting regarding possible large-scale disaster events are they are evolving.

From the technical partners of the consortium, EXUS and CERTH are the developers of Fusion Engine (FE) & Expert Reasoning Engine (ERE), Worksite Operations App (WOA) (EXUS) and Social Media App (CERTH), while from FRs' side HRTA and ERTZ were present as end-users and field testers. The tested components of the NGIT for Collaborative Response were presented by the technical partners and FRs interacted during the event with a mixed team from Greece and Spain.

The components that were demonstrated/tested during SST#7 included the Fusion Engine (FE), the Expert Reasoning Engine (ERE) and the Worksite Operations App (WOA). The use case that was used involved first response in a single site after a terror attack in public space, as it was defined at previous stages of the project. Similarly, SST#8 focused on the demonstration and field testing of the Social Media App (SMA) component.

2.1. Fusion Engine

The Fusion Engine was tested with incoming data received by the present components (either physically present or remote) and by data generators to replicate the input from components where data were not yet available. Several scenarios and conditions were tested. Functionalities that were tested included interoperability with components, registration of resources, FR Health Status early warning, Danger Zone Rating, among others.

2.2. Expert Reasoning Engine (ERE)

The Expert Reasoning Engine (ERE) was tested in terms of health status warnings and the detection of abnormalities and communication with the Common Operational Picture Platform (COP) through alerts that feature the status the severity or the urgency of an incident. Within the scenario, there was a need to monitor the health status of the First Responders. To tackle this, the Expert Reasoning component receives the measurements of the vitals and processes them for detecting abnormalities. These abnormalities in the measurements can be the results of dehydration, exhaustion and heatstroke. As a result, the component pushes the corresponding alerts to the COP to monitor the health status of the First Responder.

At this stage, the knowledge base of the module was implemented regarding the FR's status. Each person contains entities that are possible to be impacted by the crisis (Figure 1). The result of the impact is visible through the vital signs (body temperature, blood oxygen level, heart rate, etc) that are measured by the other components, and lead to the physiological condition (tiredness, asymmetric waking etc).

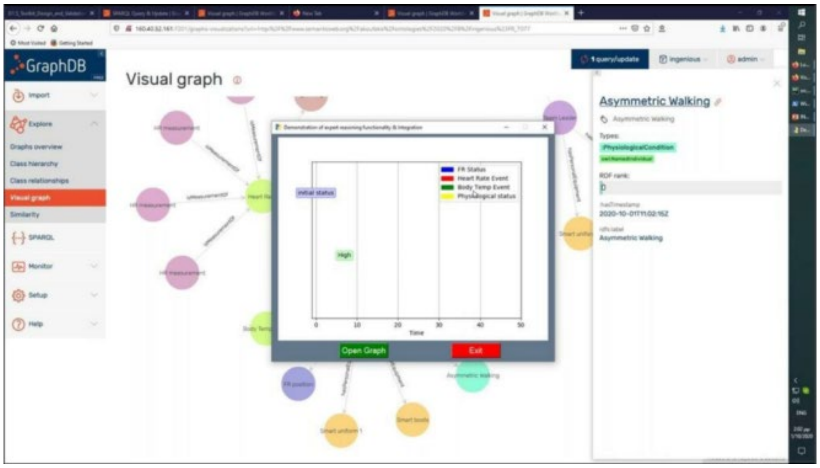

Figure 1. FR status and impact analysis (ERE).

2.3. Worksite Operations Application (WOA)

The Worksite Operations App (WOA) demonstrated functionalities regarding the resource management, decision support and system integration with FE and other online resources. More specifically, the WOA component plays a vital role in coordinating FR teams at the worksite level, monitoring assets and deployment locations, while at the top-level C&C it functions as the workbench for the coordination of multiple teams and guidance from the UCC.

2.4. Social Media Application (SMA)

During large-scale disaster events like in wildfires, people in the affected region used to post on social media to learn and inform about critical information about the fires. In addition, FR teams can use this information to their advantage. As a result, the Social Media App aims to collect the related information and filter out the irrelevant in real-time by detecting events related to a simulated large forest fire near residential areas.

During the SST#8, real tweets were posted, in real-time, on the Twitter platform. As Twitter is a public platform, those tweets were encoded with particular hashtags and codes to avoid false alerts to the platform's users (Figure 2). The new upcoming tweets are stored and processed near-real time by the appropriate services. Then, the event detection method collected and grouped the relevant tweets based on the time posted and the location. In particular, each group of tweets refers to an event detection message. The corresponding events with the post analysis information were sent from FE to COP in order to be monitored in the COP platform.

	A	B	
39		relevant	#THIS_IS_A_TEST #ingenioustest Καίγονται σπίτια σε BR940 και AD967 - Η πυρκαγιά πέρασε το RM543 - Έχει διακοπεί η κυκλοφορία στην ευρύτερη περιοχή - Ενισ
40		relevant	#THIS_IS_A_TEST #ingenioustest Μαίνεται η μεγάλη πυρκαγιά στη BR940. Βίντεο: Κωνσταντίνος Πουλής
41		relevant	#THIS_IS_A_TEST #ingenioustest Μαίνεται η πυρκαγιά στη BR940 – Ειδοποίηση από το 112 – Έκλεισε η εθνική οδός ΕΟ123 δείτε περισσότερα
42		relevant	#THIS_IS_A_TEST #ingenioustest Μαίνεται η πυρκαγιά στη BR940: Ειδοποίηση στους κατοίκους να κλείσουν πόρτες και παράθυρα – Διακοπές στην κυκλοφορία
43		**irrelevant**	**#THIS_IS_A_TEST #ingenioustest Απεριόριστος θαυμασμός, στήριξη και κουράγιο στους ανθρώπους που πλήττονται από τις φονικές πυρκαγιές και στους πυ**
44		relevant	#THIS_IS_A_TEST #ingenioustest Προς την Εθνικό Οδό η πυρκαγιά στη BR940 - Δεν αποκλείει η Τροχαία την απαγόρευση διέλευσης
45	Bunch 2	relevant	#THIS_IS_A_TEST #ingenioustest Πτώση τάσης στο ρεύμα εξαιτίας ζημιάς από την πυρκαγιά στη BR940 - ΔΕΔΔΗΕ: Πού θα σημειωθούν σήμερα διακοπές ρεύματο
46		relevant	#THIS_IS_A_TEST #ingenioustest Πυκνοί καπνοί έχουν καλύψει το λεκανοπέδιο της AT845ς από τη μεγάλη πυρκαγιά της BR940ς. Οι καιρικές συνθήκες δυσχαιρένο
47		relevant	#THIS_IS_A_TEST #ingenioustest Πυρκαγιά BR940: Εκκενώθηκε κατασκήνωση με 80 παιδιά- Κυκλοφοριακές ρυθμίσεις στην Εθνική Οδό
48		relevant	#THIS_IS_A_TEST #ingenioustest Πυρκαγιά στη BR940: Δραματική η κατάσταση – Μήνυμα από το 112 – Χωρίς ρεύμα περιοχές της AT845ς
49		**irrelevant**	**#THIS_IS_A_TEST #ingenioustest Μια από τις συνέπειες της κλιματικής αλλαγής είναι ότι οι πυρκαγιές θα γίνονται όλο και πιο πολλές, όλο και**
50		relevant	#THIS_IS_A_TEST #ingenioustest Πυρκαγιά στην BR940: Πού έχει διακοπεί η κυκλοφορία των οχημάτων
51		relevant	#THIS_IS_A_TEST #ingenioustest Σε εξέλιξη είναι η πυρκαγιά σε δασική έκταση στην BR940, όπου οι ισχυρές πυροσβεστικές δυνάμεις δίνουν μάχη για να περιορίσ
52		relevant	#THIS_IS_A_TEST #ingenioustest Σε εξέλιξη η πυρκαγιά στη BR940 – Κλήση από το 112, διακοπές κυκλοφορίας -
53		relevant	#THIS_IS_A_TEST #ingenioustest Σε εξέλιξη πυρκαγιά στη BR940
54		**irrelevant**	**#THIS_IS_A_TEST #ingenioustest Όποιο αδέσποτο ζωάκι έχει επηρεαστεί από τη πυρκαγιά μπορεί να λάβει τις απαραίτητες πρώτες βοήθειες στο νοσοκομείο**
55		relevant	#THIS_IS_A_TEST #ingenioustest Σε εξέλιξη πυρκαγιά στη BR940 – Επιχειρούν ισχυρές δυνάμεις (Βίντεο & Φωτο)
56		relevant	#THIS_IS_A_TEST #ingenioustest Στην πυρκαγιά στην δασική έκταση στην περιοχή UB345, του δήμου AX560 επιχειρούν 104 πυροσβέστες, με 4 ομάδες πεζοπόρω
57		**irrelevant**	**#THIS_IS_A_TEST #ingenioustest Φραγκοσυκιά: Το φυτό που μπορεί να σταματήσει μια πυρκαγιά**
58		relevant	#THIS_IS_A_TEST #ingenioustest Φωτιά - Επείγον SMS από 112 στην μέγαλη πυρκαγιά που μαίνεται στην BR940 - Στα KF128

Figure 2. Examples used in training the event-detection model (SMA).

3. CONCLUSIONS

SST#7 and SST#8 were the first opportunity for Small Scale Field Tests of the FE, ERE, WOA and SMA components. Although there were several setbacks, e.g. COVID-19 and fires affecting the HRTA location, these field tests were conducted successfully and with overall positive feedback from the end users. The functionalities demonstrated by all three components (FE, ERE, WOA, SMA) satisfied the technical requirements that were established by the technical partners and end users, such as location information of victims, FRs, and incidents, allow FRs to select areas and display information, raise alarms regarding the physical state of FRs among others.

The impression FRs gained is that the overall development of these technologies is on track, although it needs further development and some minor changes in order to be operationally usable. Based on the FR comments, the Fusion Engine & Expert Reasoning, as well as the Social Media App, can be included in the standard FR tools in the field, helping in gathering information and enhancing the situational awareness, as well as protecting them from unseen hazards.

Further information collected through the formal evaluation, but also through the experience of field deployment led to additional improvements of the components. Specifically, the next steps will include:

- Provide to COP info on hover of rated zones (type of gas, concentration, etc).
- WOA to show points of interest in map (such as camp, fuel station, etc)
- Continuous integration with other components of the NGIT

Also, special attention will be given to improving the security of the developed solutions and focusing on the collection and application of real time data.

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SMART TEXTILES AND BIOMETRICS/MOVEMENT DATA FUSION IN DEEP LEARNING FOR SEARCH AND RESCUE OPERATIONS – FASTER EU HORIZON 2020)

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ABSTRACT

First Responders (FR) are at the forefront of every emergency for protecting and helping people. It is very important to protect FR's lives in emergency scenes and to protect the rescue operation as well. The question that arises is "How can we effectively protect first responder's lives?" and the answer is by using effectively technologies for environmental/movement sensing and biometrics. FASTER project aims to protect FRs in Search and Rescue (SAR) missions by developing mechanisms for monitoring their health status. In this work, information fusion techniques and Machine Learning (ML) methods are developed with biometric and movement data from FRs, in order to automatically recognize medical emergencies, using fall detection as such a use case. Experimental results have shown robust training and accuracy of more than 95% in this modality, making it a valuable asset in the FRs' inventory for the safety of the deployed teams for risk mitigation in possibly hazardous situations.

Keywords: Search and Rescue, first responders, smart textiles, information fusion, biometrics, crisis managment

1. INTRODUCTION

Recent research has shown that the use of several sensors along with Machine Learning (ML) algorithms can provide accurate results in various tasks by processing biological/motion data. By monitoring FR's health we can manage the SAR operation more efficiently and mitigate the risk of injuries or medical emergencies. Several mechanisms rely on sensor signals, such as audio, accelerometer, gyroscopes, etc., to detect biological/move events. However, the use of only one sensor may lead to less accurate results, hence it is better to use of more than one and apply fusion techniques to the multimodal data that they provide.

In the FASTER project [1] we aim to develop a mechanism for critical human activity recognition using machine learning-based data fusion. In particular, several hazard alerts and possible medical emergencies are considered under the scope of biometrics and motion sensing regarding a FR working in a SAR operation. The sensing modalities have additional specifications due to the nature of the work, such as being multi-user to a large extent (can be shared), ruggedized as much as possible and for extended use (several hours), as well as non-intrusive nor hindering in combination with other crucial personal gear used by the FR.

To achieve that, we tested multiple ML algorithms for detecting human activities that can be considered as critical and an emergency alert should be sent to the corresponding services. Such activities could be fall, coughing and difficulties in breathing (excluding normal breathing). Using recent research over critical human activities detection, we aim to develop a mechanism that will identify these types of anomalies using data from a smart textile, which can be mounted on a FR along with personal gear.

2. METHODS

In this study we exploit ML-based data fusion techniques, specifically deep Neural Networks, to provide reliable results for the status of FR health. The data used of are biometric (respiratory rate, heart rate, ECG) and motion (3-axial accelerometer). Figure 1 depicts the abstract architecture of Data Fusion from Smart Textile Framework (STF) for cough detection.

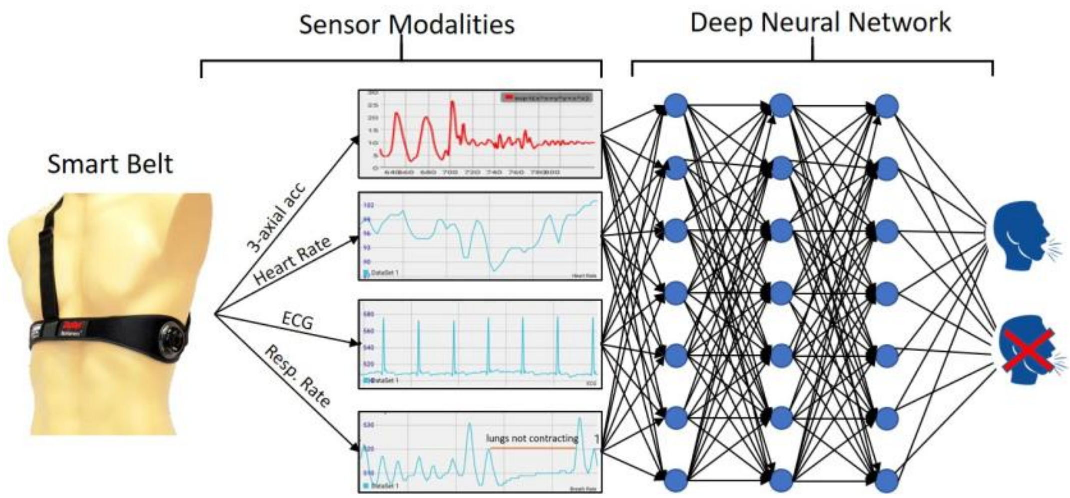

Figure 1. Abstract architecture of Data Fusion model based on a deep Neural Network architecture for cough detection.

2.1. Dataset

For the purposes of this study we created our own dataset on critical human activity recognition and more specifically fall detection, using the Zephyr's smart belt. Also, we developed two different neural network architectures, a Dense Neural Network (DNN) and a Recurrent Neural Network (RNN) for fall detection, with the second one outperforming the first one, and be our final choice for the fall detection mechanism. The reasons for choosing fall detection as the main use case here is that it achieved very high results of accuracy (~95%), while the other choices (i.e., cough detection) performed poorly on a small set of data collected by the smart belt, thus, not yet deemed mature enough to be used in production in the context of SAR operations.

For the creation of the dataset for this task we used the Zephyr BioHarness 3 smart belt, which offers the following data:

- Heart Rate, Breathing Rate, BR Amplitude, ECG Amplitude, Skin Temperature
- Posture, Activity, Peak Acceleration, Accelerometer X, Y, Z Peak, Accelerometer X, Y, Z Minimum

The sensors we used to collect data for training were Heart Rate, Breathing Rate, Accelerometer (X, Y, Z) Peak and Accelerometer (X, Y, Z) Minimum and each one of those has a sampling rate of 1 Hz. Each move lasts 4 seconds (time window) and to record these moves we developed an android application that communicates with the smart belt via Bluetooth and records (stores in CSV format) 4-second moves of fall and nothing (i.e., every move that is not a fall, such as walking, standing etc).

To collect the samples of this dataset, six subjects in total contributed. The samples of four subjects were used for training, one for validation and one for test. The validation set was used to evaluate our models at the stage of training (including hyper-parameter optimization) and the test set was used to evaluate our final model on data that have never seen before. Each subject recorded 100 moves and the analogy of the moves is 30% fall and the remaining 70% is nothing (any other move except fall). So, the total number of samples (fall & nothing) is 600.

2.2. Model design & training

Since RNNs have been proven to be effective in task of human activity recognition [2-4], we chose to train an RNN model with 4-layer architecture. The first is a normalization layer, which makes learning more efficient and helps to avoid overfitting. The second layer is a Long Short-Term Memory (LSTM), which learns time dependencies in time series data. The third is a dropout layer, which helps the model to generalize on new data and reduce overfitting. Finally, the fourth is a dense layer that makes use of a sigmoid function to break the linearity and outputs a binary result (true or false) for fall detection. For this architecture different hyper-parameters have been explored, including dropout value and LSTM layer size, as presented in Table 1.

Additionally, we trained another model architecture consisted of sequential dense layers. We ran several experiments with different numbers of dense layers, number of neurons, and dropout values; however, none of these tries outperformed the RNN architecture. The results of those are presented in the next subsection.

Table 1. Fall detection RNN model hyper-parameters used.

Hyper-parameter	Value
size of LSTM	6-12
dropout rate	0.4, 0.6
max epochs	1000
early stopping	100

3. EXPERIMENTS & RESULTS

In this subsection we present the results of the final version of fall detection mechanism. Accuracy and F1-score metrics were used to evaluate the developed models. Also, we present a comparison table of the three model architectures we tested for fall detection.

Overall, the RNN model outperforms the dense networks by achieving accuracy equal to 95%, while the dense networks achieved accuracy to 80-85%. Another advantage of the RNN model is that it generalizes well without overfitting (see Figure 2a), while both dense networks suffered from high rates of overfitting even after trying methods like dropout and normalization. Table 2 shows the detailed results and comparison of the tested models.

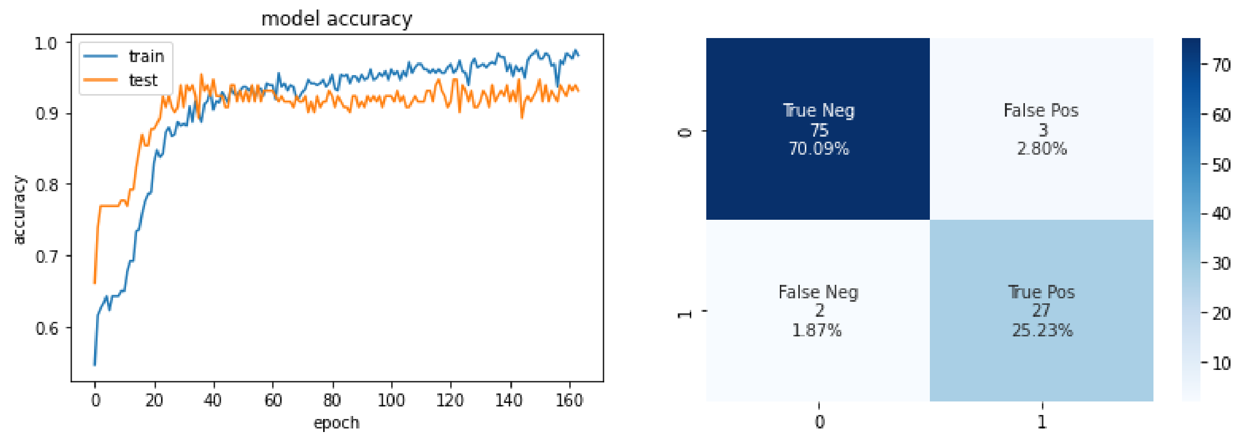

Figure 2. RNN model's train-validation accuracy plot (a) and confusion matrix (b) in the test dataset.

Table 2. Fall Detection RNN Model hyper-parameters.

Model	Accuracy %	F1 Score %
RNN model	95.32%	94.14%
2-layer dense model	81.30%	76.34%
4-layer model	81.30%	76.34%

Figure 2b depicts the confusion matrix of our RNN model, displaying the performance by presenting true negatives (values that correct classified as "nothing"), true positives (values that correct classified as "fall"), false positives (values that incorrect classified as true) and false negatives (values that incorrect classified as false). False positives and negatives of our proposed model both show very low error rates (~4.5%), proving the robustness and validity of the trained RNN.

4. CONCLUSIONS

Using state-of-the-art ML methods, biometric and motion data fusion has been proven as a viable real-world application for FRs in SAR missions, specifically demonstrating automatic fall detection. This application is based on a versatile set of sensors (STF) that can be easily integrated in the standard FR gear and enable crucial monitoring and risk mitigation for personal safety in field operations.

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SEARCH AND RESCUE: EMERGING TECHNOLOGIES FOR THE EARLY LOCATION OF ENTRAPPED VICTIMS UNDER COLLAPSED STRUCTURES AND ADVANCED WEARABLES FOR RISK ASSESSMENT AND FIRST RESPONDER'S SAFETY IN SAR OPERATIONS

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ABSTRACT

A prompt and effective reaction following an earthquake, an industrial chemical release, or the collapse of a building can prevent or greatly minimise the danger of casualties. This is why modern equipment and specialised tools are essential for first responders and rescue teams in order to improve their abilities in terms of accuracy, speedy localization, and a decrease in false alarms. The Search and Rescue (S&R) project is developing, testing, and deploying a highly interoperable open architecture platform for first responders through a number of large-scale pilot scenarios [1]. This platform is including cutting-edge equipment systems and backend applications, improving first responders' decision-making and delivering a dynamic operational picture of the crisis.

Keywords: SAR operation, first responder, crisis management, disaster management, pilots

1. INTRODUCTION & OBJECTIVES

Technology is an essential element for the rescue personnel in a variety of ways during an Search And Rescue (SAR) operation. Finding living people within the wreckage of collapsed infrastructures is a time-sensitive task because the survival of the entrapped individuals is closely related to the parameter of time [2][3]. Since the duration of the several SAR stages (deployment, search, locate, extrication, and on-site medical support) differs, INSARAG has developed a variety of SAR protocols, procedures, and recommendations at the UN level [4][5]. The ultimate objective is to speed up search and rescue operations, however there are still issues to be overcome regarding the operational tool and method interoperability amongst different rescue teams.

With the advancement of technology, specialised instruments that provide more reliable and practical solutions for post-disaster interventions are now accessible. The Search and Rescue (S&R) project is designing, implementing and testing through a series of large-scale pilot scenarios a highly interoperable, modular open architecture platform for first responders' capitalising on expertise and technological infrastructure from the FP7 projects: CONCORDE and IMPRESS.

The two primary components of crisis management—stakeholders and technologies—are the main focus of the S&R project. Reducing risk to emergency responders by providing accurate and timely coherent information pertaining to hazards and dangers would result from the unification of the crisis stages, i.e. preventative and preparedness actions, which will guarantee amore effective and speedier response. At the same time, as supporting cogent contingency planning, S&R will make a significant effort to encourage a systematic approach to harmonise and standardise risk assessments and risk management strategies on a local, regional, and national level in the European Union (EU).

Establishing an effective synchronisation framework for managing data, developed services, and information flow between the many agencies participating in emergency management activities (rescue forces, Police, Fire- department, etc.) is the major goal of the S&R project. A shared, uniform, and widespread platform for gathering, analysing, and sharing real-time data from the sensors, drones, and rescue robots will be made available through ad hoc web portals and enhancements to stakeholders' systems and back offices to assist management decisions. Access to services offered by many stakeholders will be made possible through federated security.

As such, the S&R project is aiming to create a cutting-edge architecture that will incorporate:

1. Advanced sensors, systems and procedures to obtain high level awareness capabilities
2. Secured data gathering and information exchange between the many authorities and entities engaged in managing crises and anomalous events
3. Creation of a Common Situational Picture by fusing data from many sources in order to assist emergency and crisis management decisions.
4. A multi-tiered information processing architecture, the output of which will be widely available to all parties involved.

2. METHODOLOGY

The methodology of the project follows an iterative process. Various technologies are developed based on the scenarios of the pilots. After the end of each pilot, we collect valuable feedback from the participants and use it to improve these technologies to be used in the next pilot. The aim is to create a framework best adapted to the needs of rescuers and first responders.

3. S&R TECHNOLOGIES

Various devices, equipment, tools, and services were created and implemented for use in the Search and Rescue project. Many of these technologies were already available within the S&R project by members of the consortium. The integration of such technologies is essential as they guarantee higher safety for both victims and rescuers and help increase the accuracy and effectiveness of SAR operations. Below most of these technologies are presented.

3.1. COncORDE Emergency Management System (EMS)

COncORDE EMS, offered by **Konnektable Technologies(KT)** is a state-of-the-art system of systems software platform used to enhance coordination and decision-making during crises and medical emergencies. The open-source/community version of this technology has been further evolved through the S&R project to bridge the gap between first responders/rescuers and command centres/hospitals. COncORDE is the common platform where all the S&R components that are going to be used in the pilots are running. The COncORDE platform offers various capabilities, such as data retrieval from the disaster scene, notifications, role classification, and decision making through the DSS component.

3.2. Volunteer App

An application is developed by **CERTH** and **KT** that provides volunteers with an inventory of resources and specialized skills that are available in the field for the emergency event to the field command centre. It also provides the possibility for volunteers to indicate an emergency alert and receive general information about emergency events, such as meeting points and team planning. The application allows registered citizens to receive information about assembly points or safe routes to follow in the emergency area.

3.3. GPS Tracker

A Global Positioning System tracker developed by **UNICA** is used for the needs of the project. This device is connected to the rescuer's smartphone or the integral GPS tracker of the smartphone. It is integrated into the wearable system along with other wearables and runs regardless of network connectivity.

3.4. Smart Uniform and Rescue System for Children

Both components are developed by **UNIFI**. The smart uniform is a really important component for the S&R project as it hosts devices and sensors providing vital information about the health status and the location of the rescuers on the field. The rescue system for children has been developed in case there is a need to transport an injured child away from the field. These two components are independent from the S&R platform as they are not software based.

3.5. Situation Awareness Model

UBITECH provided to the S&R Project the Situation Awareness Model. The purpose of the SA model is to provide general situation awareness services to first responders and rescue teams and notify them about critical events happening in the field. According to the received data, situation awareness alerts and notifications will be sent to the first responders and involved devices.

3.6. Rescue Robots

DFKI is providing Rescue Robots for the needs of S&R Project. Robots can assist first responders in search and rescue operations. They can explore an area, reach dangerous locations inaccessible to Humans, create a spatial map of that area, take measurements at crucial locations and overall help first responders finding victims under rubble.

3.7. Rescue MIMS

NTUA is providing the RESCUE-MIMS3, a prototype of technology detecting a plethora of chemical masses on the field area. Its aim is to detect considering its masses, if there is a possible human-sign in the area.

3.8. Obstacle Avoidance System

THALIT is providing obstacle detection algorithms for the S&R Project's needs. The object detection algorithms applied on autonomous vehicles and rescue robots are a set of algorithms developed for the collision detection.

3.9. E-learning Platform

CERTH is providing an e-learning platform for development of training materials and organization of online platform training courses for first responders in order to enhance participants' understanding, knowledge and skills in terms of safety and security management at strategic level. In such way, users may enhance their understanding and background in safety and security issues prior to the operationalization of a field operation in accordance to relevant regulations and expert guidance.

4. PILOTS

In this section two of the pilots that are going to take place in Greece are presented.

4.1. Plane crash in a mountainous region around Thessaloniki

This Use Case, organised by the Hellenic Rescue Team (HRT), begins with a forced landing of a passenger aircraft approaching Thessaloniki airport. The aircraft crashes in the mountains in a remote location. In this incident HRT first responders will be involved. Depending to their availability, the fire department, the civil protection, the army, and other organisations may participate. Some of the technologies to be tested in this Pilot are the e-learning platform, situation awareness tools, and Volunteer application.

4.2. Forest fire expanded and threat to industrial zone (Kineta, Agioi Theodoroi, Greece)

This pilot, organised by EPAYPS, will take place around Kineta and Agioi Theodoroi, in an urban area mixed with forest that is situated nearby an industrial zone. The scenario is that a wildfire is initiated by arson and due to the local conditions, it expands towards the residential area and approaches industrial facilities. Technologies to be tested are chemical sensors, drones, rescue robots, radiation sensor, etc.

5. RESULTS

At the time of writing two pilots have already taken place. The first pilot was organised by CNR and the Regional Department of Civil Protection of Sicily in Italy and titled “The Poggioreale Old Town Demo Victims trapped under rubble”. The second was organised by Pompiers de l’ Urgence Internationale and held in France entitled “Victims trapped under rubbles”. Some of the KPIs derived from these previous pilots are notification and coordination time, time until the victim has been triaged in the field, time until first treatment is performed, time until victim is evacuated from scene, number of victims evacuated from scene, time needed for a user’s post (e.g., text, photo) to be transmitted in other user’s mobiles, effectiveness in supporting the communication and coordination between first responders on the field and the Command Centre, effectiveness in monitoring the first responders/volunteers/victims’ health vitals and average time until unaffected persons reach safe assembly points.

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VISUAL COMPUTING AND RADAR TOOLS FOR IMPROVED SITUATIONAL AWARENESS IN SEARCH AND RESCUE OPERATIONS

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ABSTRACT

First responders are often called to operate in adverse conditions, such as low visibility or unknown environments, both of which may degrade their situational awareness, reduce their efficiency and expose them to risk. This paper presents four technological tools exploiting radars and computer vision aiming to counter these adversities and improve situational awareness in search-and-rescue operations. Prototypes of the tools have been validated in realistic conditions as part of a first responder exercise.

Keywords: *computer vision, radar, situational awareness, adverse conditions*

1. INTRODUCTION

In recent years, numerous technologies have been developed or adapted to aid First Responders (FR) in their work, increasing both their efficiency and safety. These include communications, robotics, cloud processing, AI, and more. However, access to such is not always guaranteed: FRs often need to operate in adverse conditions, in which such tools may be unavailable or have reduced efficiency. RESCUER is an EU project aiming to provide technologies to address such adverse and infrastructure-less conditions.
This paper presents four technological tools researched in RESCUER. Radar technologies are harnessed to detect objects moving relative to the FR, allowing obstacle avoidance in darkness or smoke, while a different wavelength range is used to detect breathing victims behind walls. Computer vision is used to improve AI object detections in the presence of smoke and to localize an FR inside known buildings.
Early prototypes of these four tools have been tested and validated in a field trial in realistic conditions, organized as part of a local FR drill exercise. Initial results have been very promising, and feedback from the FRs has driven the ongoing development and research direction for each.
The next section describes the concept and research background of each tool, while Section 3 presents early results during the field trial.

2. TOOLS AND METHODOLOGY

Radar sensing tool: Radar sensing is employed in order to perform scene analysis of the individual FR's surroundings, even in totally blocked vision conditions (e.g. under heavy smoke). This is a distinct feature that sets radar apart from other sensors like camera or lidar etc. To this end, we are employing a mmWaves, FMCW-type radar sensor [1] that supplies a cloud of detected target points. Point cloud detection is followed by an unsupervised clustering technique for grouping points into meaningful objects, a location predictor and an object identifier that jointly track targets' trajectory over time. It is then straightforward to set soft or hard thresholds for issuing alarm signals to the FRs when the object(s) is either too close or the time needed for the object to collide with the FR is too low. On top of that, we have developed a user interface (UI) that provides for visual feedback and interactive controls.

Signs of life detection tool: Ultra-wideband radars may offer a cost-effective and accurate solution for detecting human activity, including breathing, even when there are obstacles that completely block the line of sight between the radar and the subject. In this respect, we have developed a tool in order to detect if a survivor is present behind walls or obstacles. The proposed solution is low-cost, small and lightweight, and is complementary to current commercial solutions that scan large areas but are bulky and expensive. Our tool is meant to be used in order to pinpoint the survivors in a more localised manner and offer indications about their exact position and health state. To this end, we employ a microwave radar sensor (pulse power type) that operates in the X-band (8.0 – 10 GHz) [2]. A more detailed discussion, as well as extensive experimental results of our solution tested in detecting people behind walls and obstacles may be found in [3].
Robust Vision Tool: This tool is a pipeline of two different sub-tools: image denoising and object detection. For denoising we exploited the DW-GAN [4], a state-of-the-art dehazing network that leverages the 2D discrete wavelet transform and the architecture of the Generative Adversarial Networks. Although there are no dedicated models for removing transparent smoke, smoke and haze can cause similar noise in an image, thus a dehazing model can also be applied for desmoking. DW-GAN was chosen as it shows excellent performance in removing haze and is able to handle even non-homogeneous cases. After denoising, the clear image is fed into the object detection tool, which adopts the YOLOv4 algorithm [5]. The results of this model are bounding boxes of the objects that have been detected in the image accompanied by their classes and the confidence scores.
Indoor visual localization tool: This tool utilizes panoramic 360 images taken by a helmet-mounted camera at frequent intervals to perform camera view registration based on an extension of the algorithm presented in [6]. Given the building's 3D and a snap from the camera, it essentially navigates a virtual camera inside the 3D model, optimizing its pose (translation, rotation) to minimize the colour-difference between the actual snap and the synthetically rendered one, taken by the virtual camera. After a number of candidate-poses optimization sessions and evaluations in parallel are completed, the best one is output as result. By iteratively running this procedure, coupled with motion extrapolation to optimize the search-space of each iteration, we can achieve good accuracy in tight time intervals.

3. FIELD TRIAL AND EXPERIMENTAL RESULTS

The presented tools were tested in a field trial at an abandoned mining site near Vavdos, Greece, on June 18, 2022. The Hellenic Rescue Team's Urban Search & Rescue Department, in cooperation with RESCUER partners CERTH and the University of West Attica, carried out tests in realistic conditions, testing the limits and efficiency of each tool. Participating FRs had the opportunity to see the tools in action and familiarize themselves with their use. They gave the tools favourable reviews, while the subsequent discussion the provided researchers with valuable feedback and direction for future steps.
To ensure the most effective implementation of the trial, two reconnaissance visits were made to the site. During these preparatory visits, mapping-recognition of the area, scanning with 3D scanners of the buildings concerned, and an initial planning (on a map) of the field were carried out. For the implementation of the trial, a real earthquake scenario was designed, according to which all the required actions were implemented as defined by the INSARAG guidelines.
Radar sensing tool: This tool was demonstrated during the field trial, and feedback is gathered regarding its ability to track objects and supply early warnings regarding future collisions. The UI offers the ability to interact with by using sliders; also, three operational modes are foreseen (appropriately named "sensitive", "robust" and "rough") and will be made available in the UI under the form of a selection button. Demo measurements were acquired in different scenarios with multiple moving targets (FRs, as well as by throwing objects within the field of view of the radar so as to evaluate its ability to detect fast moving objects), under clear vision as well as heavy smoke conditions. The tool offered successful

detection of targets, identified them and tracked their trajectory, and also issued appropriate warnings under heavy smoke conditions. Fig. 1 depicts an example of early warning for an approaching target (FR with white t-shirt on the right). In the specific example, the early warning signal is generated due to the object (FR) violating both thresholds of distance and time to collision.

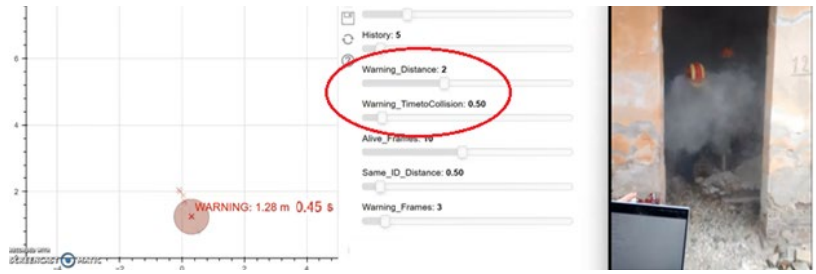


Figure 1. Radar sensing interactive user interface.

Signs of life detection tool: For this test, the radar sensor was placed on a fixed, flat surface, in such a way that it faced the direction of the victim to be detected. Normally, it is placed in front of a wall like in Fig. 2 (left), but in some cases it can also be placed at the entrance of a room in order to scan the entire area for survivors. Upon activation, the radar collects measurements for a time span of ~30 s, feeding an embedded algorithm that transforms scattered electromagnetic waves' measurements into a simple message that readable by the FRs. This message either reads "Person found in XXX m", where XXX is the distance of the person with respect to the radar, or "No person found". Fig. 2 (right) depicts a photo from the field trial while preparing the tool demonstration. The tool provided accurate detection of persons behind walls while it did not return false positives when no person was present.

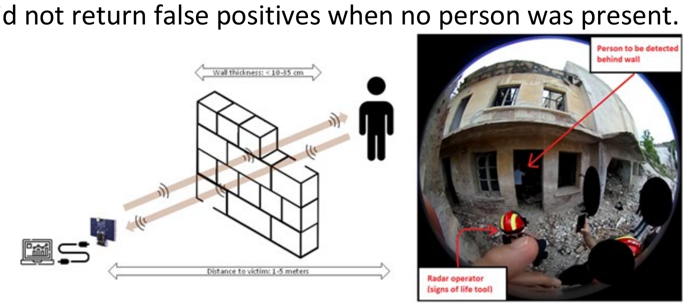
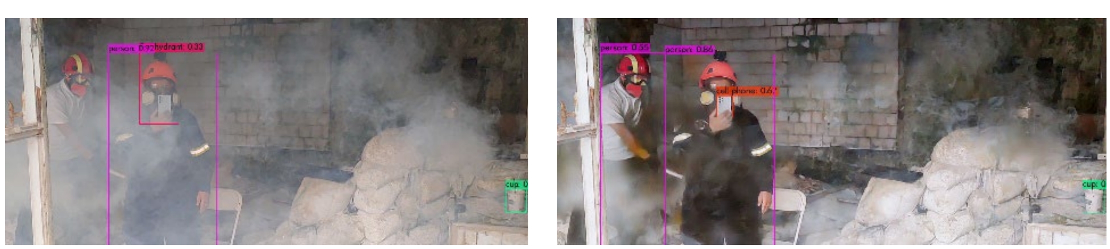


Figure 2. Signs of life detection tool principle of operation (**left**) and photo from the field trial (**right**).

Robust Vision Tool: During the field trial, an experiment was set up to assess the impact of image restoration in AI object detection, in the presence of smoke. Two people using breathing equipment and several objects included in the classes detected by the YOLOv4 algorithm were placed in a room. This was subsequently filled with smoke, which was then left to gradually dissipate. Several photos of this process were taken, corresponding to various densities of smoke. For each frame, YOLOv4 was applied to detect objects, with and without dehazing pre-processing.



(**a**) (**b**)

Figure 3. Object detection in smoke: without **(a)** and with **(b)** dehazing pre-processing.

The results showed a marked improvement in object detection after dehazing. An example frame is showing in Fig. 3. On the smoky image on the left, one person and the cell phone are not detected, while the helmet is misclassified as a hydrant. In contrast, all of these errors are corrected in the dehazed image on the right.

Indoor visual localization tool: As part of the field-trial, we tested a preliminary version of the tool and gathered valuable data, both 3D and test images that will be crucial for further developments. At first, we scanned a multi-room semi-collapsed building using a 2021 Apple iPad Pro with Lidar sensor and produced its 3D point cloud. Then, we mounted the protective helmet of a subject with a GoPro Max 360 camera and recorded various walks in random routes inside the building. At this stage, the tool is mostly offline. We extracted sequential frames from the recorded walks and fed them to separate instances of the localization tool, to search for their location independently, yielding promising results. See Fig. 4. In later iterations of the tool, the frames will not be dealt independently, most possibly leading to even better results.

(a) (b) (c)

Figure 4. (a) Building point cloud. **(b)** 360 image input from FR's location. **(c)** Rendered view inside the point cloud as it is moved around by the optimizer, trying to match it with (b).

4. CONCLUSION

During the field trial researcher have collected data as well as feedback from the FRs in the field. The processing and the analysis of the new data is a key contribution to the further development of the RESCUER tools and technologies in order to be tested as an integrated system in future pilots.

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UNLEASHING THE UCREWED AUTONOMOUS SYSTEMS POTENTIAL FOR CIVIL PROTECTION

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ABSTRACT
Uncrewed Aerial Vehicles have been widely used in a plethora of civil protection related applications. In most cases, the engagement of UAVs is restricted on data acquisition transmission and processing in a ground station, or simply focus on cloud-based environments where the internet connection is mandatory. All these applications are inadequate to comply with emergency conditions where real-time monitoring and autonomous UAV processing is required to decide how to act in an unknown environment without the presence of internet connection or even GNSS signal. Under this study, the contribution of SenseLab research team of the Technical University of Crete is demonstrated, through the introduction of five discrete novel UAV functionalities and methodologies that include precision and rapid mapping, GNSS-denied localization, aerial and ground cooperative systems and autonomous navigation based on deep reinforcement learning. The evaluation of the proposed UAV functionalities proves the invaluable potential of research on UAVs for the enhancement of their contribution towards civil protection.

Keywords: Uncrewed Aerial Systems, Precision mapping, Rapid mapping, Autonomous navigation, Cooperative systems, Reinforcement learning

1. INTRODUCTION

In recent years, Uncrewed Aerial Vehicles (UAVs), or systems (UASs) have gathered much attention from researchers and scientists in various scientific fields. Applications, systems and tools are developed based on the UAV industry which is growing at a very fast pace in terms of applicability [1], but not in terms of innovation. In the sector of civil protection, UAVs are used quite widely, while comparatively few studies demonstrate their potential mostly in the theoretical realm. Most studies denote data collection and image inspection for damage evaluation of affected areas or architectural heritage. These applications utilize images / video or lidar data acquired by a UAV in order to reconstruct a 3D environment of the survey area based on photogrammetric and computer vision algorithms aiming to be used for further analysis of the survey area [2, 3, 4, 5]. Furthermore, with the emergence of 5G technology, several studies propose the use of UAVs as a part of an ecosystem based on Internet of Things (IoT) in order to monitor parameters that reinforce the security of citizens [6, 7].

Even though there is a plethora of UAV applications, most of them utilize the UAVs as a means to collect, transmit or receive data in order to process them through a ground station, visually or even in a later timeframe. These restrictions constitute a devastating scenario for emergency situations and become unreliable for real-time applications. For example, after a disaster the morphology of an area may change, while digital communication becomes often unavailable or compromised. Thus, the UAV research should focus on the improvement of the UAV functionality internally, as a machine that is able to “think” and “act” autonomously without the need of an internet connection, human interpretation, or even GNSS signal.

In this study, a portfolio of five novel UAV research functions is presented, to showcase the actual potential of UAVs for civil protection related applications.

2. METHODS AND DATA

The research <u>for</u> the UAVs and not <u>with</u> the UAVs is based on multi-disciplinary range of scientific fields such as robotics, computer vision, mechanics, geodesy, machine learning, etc., where most of the processing is running during the UAV flight in its embedded computing systems. Localization, mapping, autonomous navigation, monitoring and detection are some of the core ideas that are able to establish novel invaluable solutions for the civil protection regime. In the next paragraphs we showcase some of these functions that are developed in SenseLab research team.

2.1. Rapid mapping in emergency conditions

A rapid mapping procedure using a simple aerial platform was implemented using only a visual marker on the ground. The developed system is capable to localize points in a GNSS-denied environment with an accuracy of 50 cm. The methodology utilizes Simultaneous Localization and Mapping (SLAM) algorithms, multi-view geometry, image processing and coordinate system transformations in order to map an unknown area and localize points in a dynamically created coordinate system. In comparison to other mapping techniques such as photogrammetry or conventional surveying, the proposed function is much faster and does not require GNSS coverage. This approach is a cost-effective surveying alternative for rapid mapping since only some minutes of a UAV flight are enough to map an area and provide point coordinates in a respectable accuracy for rapid mapping applications [8]. This technique is applicable for mapping a post disaster scene to assist geolocation, assessment and crisis management.

2.2. Precision mapping in GNSS-denied environments

The drones2GNSS integrated system was developed to provide precision mapping through a custom aerial platform that may be considered as a novel surveying alternative. More specifically, a custom-built UAV attached with an RGB camera and a range-finder on a gimbal, is able to detect visual-points on the ground or on a topographic pole without GNSS coverage and extract their coordinates in a well-known geodetic reference system with an accuracy of about 5 centimeters. The procedure can be divided in three stages: At first the camera of the UAV detects the visual points while the gimbal system tracks this point, in each position of the UAV. At second, the range-finder calculates the distance between the UAV and the target while subsequently the embedded computing system calculates the coordinates using localization algorithms. The operator is able to plan and perform all the procedure using a mobile application while all the results are received in real-time during the flight. The presented approach is one of the few if not the only autonomous mapping systems that may understand and solve the challenging and unsolved task of precise geolocation of obstructed areas.

2.3. Seamless navigation in mixed environments

Regarding the UAV navigation, an auxiliary module of a UAV was developed which is responsible for the spatial awareness of a UAV, a key factor for the UAV navigation. More specifically, a multi-tier localization architecture was implemented where GNSS estimations and sensor data from an RGB-Depth camera and an IMU (Inertial Measurement Unit) are combined, aiming to provide continuous localization in mixed environments (outdoors, indoors, GNSS-denied, etc.). All the above functionality was built and tested in a custom hexacopter equipped with a three-axis motorized gimbal system, a camera, and rotary encoders while the evaluation was conducted in both simulated and real-flight conditions in different environments [9].

2.4. Autonomous cooperative uncrewed systems

Concerning e.g. search and rescue applications, an uncrewed aerial (drone) and ground collaboration system (humanoid robot) is implemented. At first, a UAV maps an unknown environment (Octomap[https://octomap.github.io/]) in order to extract a 2.5D occupancy grid map of the area. Subsequently, a humanoid robot receives a goal position in the created map and estimates the trajectory path in order to reach a predefined goal, e.g. finding trapped personnel. During the robot navigation, it uses an adaptive Monte-Carlo Localization algorithm, UAV sensor data and local odometry data in order to localize itself in the map. Finally, the robot utilizes a pre-trained convolutional neural network in order to detect humans with the aid of its camera. It’s worth mentioning that all the processes are performed on the embedded computing system of the UAV and humanoid robot in real time [10].

2.5. Learning for new environment

A completely autonomous navigation methodology was developed, using deep reinforcement learning to investigate the potential of the UAV autonomous navigation in a dynamically created and completely unknown for the UAV 3D environment with a number of auto-generated obstacles. The aim of the UAV or the agent in reinforcement learning terminology is to navigate through the environment detecting and approaching a predefined set of visual markers, placed in the area. The evaluation of the methodology was conducted in five different environments with graduated difficulty level, proving that deep reinforcement learning is quite promising for autonomous UAV navigation. Unknown environments are a common problem in post disaster search and rescue, where geomorphology and infrastructure have been altered and any prior mapping knowledge cannot be used.

3. CONCLUSIONS

In this study, five novel UAV applications with promising potential in civil protection are presented. Mapping, geo-localization, autonomous navigation, real-time monitoring and detection are some of the core ideas of the proposed applications. Concerning the mapping, two different approaches were presented: a precision mapping methodology which uses a custom UAV equipped with an optical sensor and a range-finder aiming to estimate point coordinates while on the other hand, a rapid mapping and cost-effective alternative based on SLAM, multi-view geometry and coordinate system transformations was developed. Subsequently, a multi-tier localization architecture was presented, which combines GNSS with camera and IMU data in order the UAV to localize itself even in GNSS-denied areas. Finally, two methodologies with great potential in search and rescue applications and autonomous navigation were proposed: an aerial and ground cooperative system, uses the aerial platform to share a dynamically created map of the environment, while a humanoid robot with the aid of UAV, approaches the goal position referred in the map, and detects humans using a deep convolutional neural network. At the second search and rescue application, a UAV was trained to navigate autonomously using deep reinforcement learning achieving to detect and approach a set of pre-defined visual markers placed in a 3D unknown environment.

It is clear that UAVs can be considered as valuable intelligent systems that make decisions during their flight, interacting with their environment. UAVs are not just flying objects that collect data for processing in a later stage. UAVs, as autonomous and intelligent machines are capable to change the way that we interact with our environment with a great impact on civil protection applications, improving the well-being of citizens.

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USE OF UNMANNED AERIAL SYSTEMS FOR THE PROTECTION OF PUBLIC SPACES: POSITIVES AND THREATS

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ABSTRACT
The use of Unmanned Aerial Systems has many social and economic benefits, especially in public safety operations, emergency response and law enforcement situations. However, at the same time UASs can also be seen as a threat, especially with their widespread availability and the evolution of UAS technology that generates possibilities of abuse them with unlawful acts. The terrorist use of UASs, that has already materialised in theatres of conflict with devastating impact, are techniques that could be used as part of domestic terrorist events in Europe.
While legislation and education may provide some deterrent to users who wish to fly recklessly or illegally, the choice of technology is critical to successful and effective detection. Today, there is a clear need to develop technology, support continious education and training of LEAs and establish regulations to prevent such acts. Therefore, the choice of drone detection and tracking technology is of outmost importance to regulate hostile behaviour and especially when it becomes a threat to facilitate that decisions can be made on an appropriate response-time to prevent the threat from becoming a public safety hazard. This paper presents the positives and threats of UASs' use in public spaces, gives an overview of the dominant regislation and regulations dispalys their use in public spaces, as part of the EU funded project "DroneWISE".

Keywords: Unmanned Aerial Systems (UASs), drones, public space, publıc safety, C-UAS.

1. INTRODUCTION
Unmanned Aerial Systems' (UASs or Unmanned Aerial Vehicles (UAVs) or drones) use for commercial (and recreational) purposes offers many potential social and economic benefits, including aerial observation, critical infrastructure monitoring, security applications and public spaces' protection. The last years the use of UASs for public safety continues to expand, so too does their usefulness in emergency and law enforcement situations. By providing responders with a wide range of aerial reconnaissance and mapping capabilities, UASs have revolutionized public safety operations. Yet, UASs, especially today with hundreds of thousands being used per country, pose potential challenges for safety, security and privacy, as they may facilitate even crime.
The misuse of civilian UASs becomes a serious concern across the world as terrorists, activists and insurgent groups deploy them for attacks. Despite measures in place to prohibited rogue drone activity (i.e. flight zone definitions; fines for flying illegally, etc.) and the risks that arise by the illegal use of UASs, reports of such unlawful acts continue to occur with alarming regularity worldwide, causing substantial concern and significant financial loss. Although most countries now have regulations in place in order to fly a UAS (in an urban, suburban, areas), however, groups of people do not adhere to the regulations.
Given the current technologic advancements in the fiedls of geoinformation, security and safety, there are many positive aspects associated with UASs use in civil protection domain. However, as beneficial as these uses are, the threats are vast, and are presented in this paper.
The rest of the paper is structured as follows: Section 2 provides an overview of UASs-related legislation and regulations in European Union, the misuse of UASs rapidly becoming a threat, as well as counter

measures are presented in Section 3. The next Section refers to the benefitial use of UASs for the protection of public spaces, while the last one is devoted to discussion and future work.

2. UASs-RELATED LEGISLATION AND REGULATIONS

EU Regulations 2019/947 and 2019/945 set out the framework for the safe operation of civil UASs in the European skies. They adopt a risk-based approach, and as such, do not distinguish between leisure or commercial civil drone activities, while what they consider is the weight (defining 5 classes based on the Maximum Take Off Mass (MTOM) and the specifications of the civil drone and the operation it is intended to conduct. The Regulations cater for most types of civil drone operations and their levels of risk, defining three categories of civil drone operations: the 'open', the 'specific' and the 'certified' category [1].

Open category is considered as a low-risk category where safety is ensured thought operational limitations, compliance with industry standards, requirements on certain functionalities and a minimum set of operational rules. The open category is subdivided in three sub categories A1: fly over people but not over assemblies of people, A2 fly close to people and A3 fly far from people [2]. Specific category which is considered as a medium risk category and requires authorization by competent authority before the operation takes place, what is more requires taking into account the mitigation measures identified in an operational risk assessment except from certain standard scenarios where a declaration by the operator is sufficient of the organization holds a light UAS operator certificate (LUC) with the appropriate privileges. Certified category which is considered as the higher risk category that has requirements similar to manned aviation requirements and is oversight by NAAs and complied with Air Traffic Management (ATM) and by European Union Aviation Safety Agency (EASA).

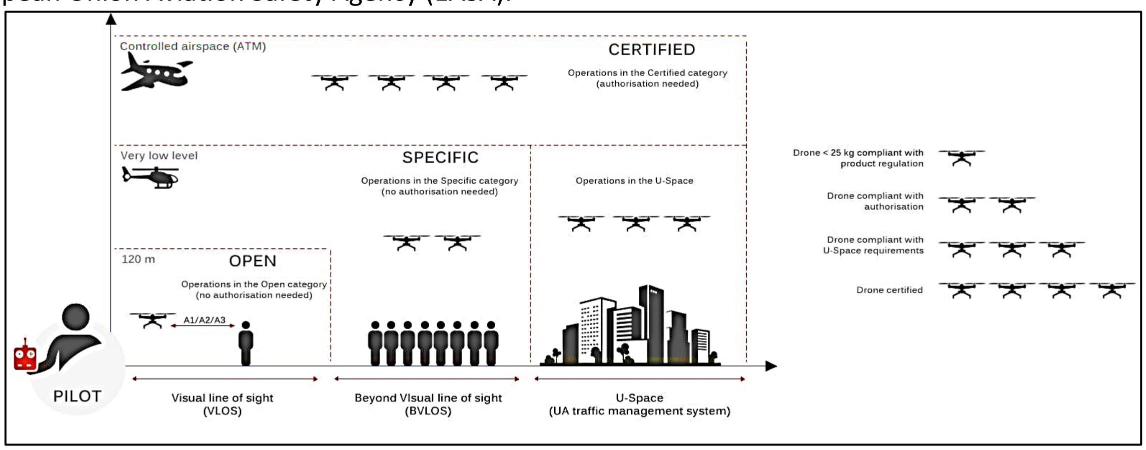

Figure 1. Drone Rules [3]

3. THREATS FROM UASs AND COUNTER MEASURES

The main benefit of employing UASs in public space protection is the opportunity of having real-time (day and night) sensors able to detect the presence of crowds in urban areas where they might be at risk [4]. They have been proven perfect for capturing footage of crime scenes and natural disasters and can also be used for firefighting and search and rescue operations. Despite those benefits, the UASs can become a dangerous weapon in the insurgent groups' hands. Namely, the following threats arise:

- terrorist use of UASs (i.e. terrorism or harassment; UAS retrofitted with explosives; attack against a critical infrastructure ;etc.),
- organised criminal use of UASs (i.e. smuggling drugs, telephones or other stuff and weapons into prisons; etc.)
- aviation safety (i.e. how aircrafts and drones can legally share airspace) and rogue drone incursions at restricted aviation sites (fly drones into airport areas [5].

- rogue drones at public spaces (i.e. stadiums,) and high-profile public events (i.e. football competition, conferences, etc.).

The potential use of UASs as a threat is a growing concern and becomes more widespread globally. The main resons are:

- UASs are easily accessible for everyone and are quite easy pilotage for the wide public. Therefore, it is easy to find, buy and fly them without being noticed for suspicious usage.
- A swarm of UASs can be piloting by only one person, while it is possible to travel (pre-programmed) long distances.
- It can be hard to detect and neutralize UASs, as they cause minor visual, thermal, acoustic and radar signature/ emission, while automated flights can be performed and silent drones can be used, without being considerably noticed, or noticed when it is too late. Whilst, custom-made drones are often difficult to be detected even by the state-of-the-art counter UAS (CUAS).
- The response time, right after a drone sighting is limited, as a decision usually should be made within the first 2 minutes after the drone sighting.
- UASs are able to slide over 2D protection measures and carry significant payload comparing to its size.
- Small-rotor UASs are really available for a wide range of population, including terrorists.

Any UAS that flies above a non-permitted area (No-Drone Zone) results (minimum) to disruption and should be managed accordingly by Low-Enforcement Agencies (LEAs). CUAS systems are developed and installed in order to provide technological foundation for countering UASs, which is a complex multistep process involving iteractions between several distinct systems and between those systems and the human operators. Typical neutralization techniques include jamming, spoofing, hacking, laser guns, high power microwaves, water canons, shooting nettings, ınterceptor drones, falcons, guns and missile systems.
All the above mentioned counter systems are supported by different and diverse sensors in order to perform their actions. Such kind of sensors are, radars, electro-optical and infrared (EO/IR) sensors, radio-frequency (RF) detection sensors and acoustic sensors as well. In addition to them sophisticated algorithms thought tailored software solutions utilizing artificial intelligence / machine learning, classification techniques and pattern recognition methods enhance the ability of such systems and provide high percentage accuracy in detection and classification of drones.

4. UTILIZATION OF DRONES FOR THE PROTECTION OF PUBLIC SPACES

While the uncontrolled use of UASs in public spaces has generated a lot of discourse regarding safety and security risks, drones can also constitute very valuable operational tools for their operators, LEAs and first responders for their protection, especially during large scale events and social gatherings. Such public spaces may include parks, open squares, pedestrian streets, religious sites, nightlife areas and others.
Traditionally, UASs are commonly utilized in the aerial surveillance of areas for threat detection. This is due to their ability to survey large, inaccessible, or dangerous areas, remotely, with little effort, that would be otherwise difficult to access and cover with ground patrols. In addition, as they can be equipped with thermal cameras, they greatly increase the surveillance capacity during night hours, allowing the detection of persons in low light conditions, dark areas and through foliage, bushes and vegetation.
From the perspective of public spaces protection, taking for instance, the case of a music festival at an open public space, where the line of sight of ground patrols is interrupted by a large crowd, buildings, vegetation, plant fences or any other structures, UASs can assist the detection of persons in distress, under attack or trapped in case of a fire outbreak, suspicious persons who might be hiding from the authorities, or timely detect crowd disturbances in general. Furthermore, they can be used to provide a picture of the people’s allocation and congestion points within an area of interest, and when combined with the proper software, they allow for people counting [6] thus enhancing the authorities’ situational awareness and their ability to control the crowd and plan their response in case of emergencies.

Finally, aside from the response to threats, drones can be used proactively during the security planning process in light of future events. A drone can be assigned to fly in a specific predetermined pattern over a designated area, capturing a large number of aerial pictures in a short amount of time. Through photogrammetry, these pictures can then be processed to create 3D models of the area of interest (incl. buildings) and its surroundings, which can then be used by the operator of the public spaces, LEAs, first responders and urban planners for several purposes such as security planning, vulnerability or risk assessments, adoption of security measures, tabletop exercises (TTX) and architectural adjustments within the concept of security-by-design or crime prevention through environmental design (CPTED).

5. CONCLUSIONS AND DISCUSSION

With drone technology advancing quickly, UASs are quickly becoming a valuable tool for public safety, while at the same time they can be seen as threat especially when used on public spaces. Those aspects are been research at European and international level, and in this scene, this paper presents the objectives and findings of the EU ISFP “DroneWISE”. The project aims to improve the security of public spaces by enhancing the cooperation between first responder agencies to effectively plan against and manage, the aftermath of a terrorist attack by use of UASs [7].

Given the persistent severity of the terrorist threat, governments across the world no longer accept that they should simply prepare to respond to the types of terrorist attack already encountered. High-level officers recognise that this reactive posture will not preserve their national security and, so, an increasingly proactive and creative approach has been implemented, dedicated to identifying new and emerging terrorist threat vectors, founded upon the security principles of preparedness and assessing risk and managing the consequence of past, present and future terrorist events. This new proactive posture now forms an essential part of tackling contemporary terrorism. The new era of global international terrorism reveals, with alarming regularity, that terrorist plotters achieve their intended objectives, defeating all of the state’s security measures put in place at the time. Therefore, governments across the world shall be well-prepared to prevent further terrorist atrocities, a fact that rises many challenges. The main are linked with the evolution of drone technology and there is a clear need to develop technology, support continious education and training of LEAs and establish regulations (i.e. the creation of ‘urban airways’ for drones).

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FIRST PILOT TESTING OF TACTICAL COMMUNICATION SYSTEM, SYMBIOTIC OPERATION CONTROL MODULE, SMART UGVS AND SMART UAVS AT THE STOCKHOLM METRO STATION – INTREPID (EU HORIZON 2020)

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ABSTRACT

On November 4th and 5th 2021 the first piloting field activity for INTREPID project (EU H2020) was hosted by SBFF in their training facilities in Stockholm. The pilot location was the Stockholm Skarpnäck metro station. The INTREPID project aims at developing tools for supporting First Responder (FR) operations in the field in the early, time-critical phases of a disaster. A vital part of INTREPID is the field-validation of the tools, which will be conducted in three consecutive field-test pilots. For each pilot, tools will be tested in different environments and facing different difficulties. Technical partners and First Responders from the consortium gathered after covid-19 outbreak, almost 50 people, and collaborated for the purposes of the pilot. The storyline of the scenario divided into four phases: Before arriving at the scene, deployment phase, rescue phase and post-event assessment. Results showed that collaboration time between technical partners and FRs is critical for the successful integration of the various components and FRs felt comfortable using the new technologies currently being developed within the INTREPID toolkit.

Keywords: Search and Rescue, field tests, crisis management, security and safety, first responders

1. INTRODUCTION

The first hours after a disaster are critical. First Responders (FR) deal with extremely pressing challenges in a chaotic, dynamic, and dangerous environment, while having to locate and neutralize threats or rescue victims during Search and Rescue (SAR) missions. What makes their job even harder is the lack of reliable information regarding obstacles they might be facing, which deepens their sense of uncertainty. The INTREPID project [1] aims to make these first hours and beyond safer and more efficient for FRs by developing tools to accelerate the exploration and assessment of hazardous, potentially inhabited, sites. INTREPID creates a unique platform that improves the exploration and assessment of disaster zones. The project follows a user-centric approach according to which tools are validated frequently by end-users [2].

Ensuring that these tools fit the needs of FRs is naturally of great importance. INTREPID relies on end-users to guide the development of the tools, sharing their experience and current practices in Urban Search and Rescue (USAR) missions [3], while providing feedback about the functionalities of the tools, the design of the user interface and how they can be improved.

2. METHODOLOGY – DESCRIPTION OF THE FIELD TRIALS

As part of the practical assessment during their development, these new technologies are to be extensively tested and evaluated in the field by FRs. The first of these piloting events took place at the Stockholm Skarpnäck metro station (Figure 1), on the night between 4-5 November 2021, and it was hosted by SBFF.

In this field test, a major natural disaster (simulated) focuses on excess water in the city's metro caused by a damaged water line, with fire caused by shortcuts, possible toxic smoke and potential trapped victims in hard-to-reach zones. The objective of this pilot was to get an early assessment of the relevance of the technical choices and to reinforce the end-users' understanding of the tools' possibilities and limitations, enabling the preparation of future pilots.

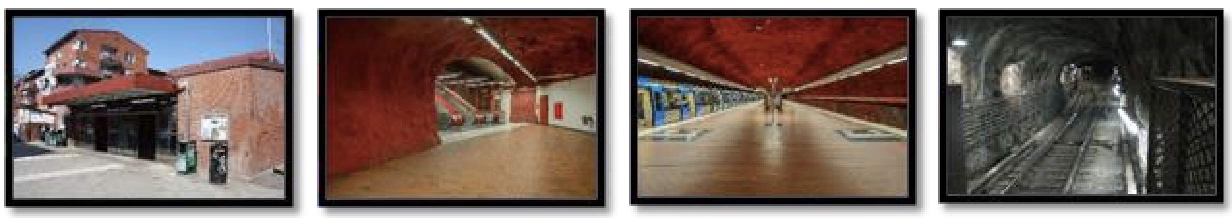

Figure 1. The Skarpnäcks metro station at Stockholm, Sweden.

2.1. Pilot Scenario

The pilot scenario was organized around a timeline of threat elements and a description of the actions that FRs take according to established procedures. The storyline and the response of FRs are broken down into four phases: Before arriving at the scene, deployment phase, rescue phase and post-event assessment.

Phase 1: Before arriving at scene

In the Skarpnäck metro station, routine night-time maintenance work is performed. An electric work vehicle used by the workers for maintenance work hits or tears down a water pipe. This leads to water flowing out of the pipe over the electric vehicle and as a result, short-circuiting the electric work vehicle. This accident generates fire and smoke. Personnel in the vicinity of the vehicle is injured because of the incident. They alert their supervisor in accordance with safety protocols. Another work crew, four persons, further down the tunnel is trapped by the smoke, because this metro station is at the end of the metro line. The supervisor on site, who is responsible for the workers, contacts the traffic control center for the affected metro line/station. The traffic control center, in turn, alerts the rescue services (Fire Brigade, ambulance, Police).

Phase 2: Deployment

Upon arriving at the scene, the first step for the police unit and the L3 (the rescue leader: fire engineer, highest in command), is to set up/activate the management vehicle. If necessary, the management vehicle can be expanded (in terms of space of tools). Possible entry routes and sectors of the metro station are identified by fire station personnel to streamline the rescue operation. Sectors can be determined for searches or can be based on where water, smoke or victims are located.

After this is done, the rescue effort will begin with an analysis from within the metro station. If possible, a reconnaissance unit is sent down to quickly search the scene of the accident and provide a basis for decision making, at the rescue phase. The emergency exit is found to be relatively thick with smoke. The passenger entrance route must be used. Other fire fighters, who just arrived at the scene, check if nearby buildings are free of smoke, as this could spread and move up from the tunnel.

Phase 3: Rescue

After receiving reconnaissance information, the actual rescue work is initiated. The highest priority for the fire fighters is rescuing the severely injured victims around the short-circuited work vehicle and getting them outside to the medical team. Meanwhile, other fire fighter teams work to ensure a good evacuation environment for the trapped squad at the end of the tunnel. They do this with the help of ventilation and other rescue equipment (to carry people out, flashlights, sounds, oxygen tanks). They follow the protocol for evacuation of the metro station. Ambulance workers set up a station, nearby, to receive the injured. Meanwhile, the police ensure that no unauthorized persons enter the work and rescue area. They use tape to mark the areas not meant to be entered.

Phase 4: Post-event assessment

After any major operation, the FRs involved share information regarding the resources that played a role in the rescue operation during the mission debriefing.

2.2. Scenario execution – Tools and functionalities tested

Within this scenario and overall SAR context, several components of the INTREPID toolkit were deployed and tested in the field for the first time. Due to their nature, they are involved mostly during the initial phases of the mission, i.e., rapid deployment and scene assessment (Figure 2).

In preparation, the user (FR team) identifies pre-set actions and conditions in different disaster situations (based on response procedures, guidelines, steps) and saves these in the system. Before arriving at the scene, the user adds multiple FR teams, i.e., the FR organizations and assets available. A map/geographical information of the scene connect in the system and FRs can interact with it.

During the deployment, the user sets up/activates the Tactical Communication System (TCS) and deploys the high-bandwidth networking capabilities. Subsequently, reconnaissance assets with communication systems are sent to locations indoors. The positions of the FRs and UxVs are available and information is gathered regarding the type of accident, people involved and the accident environment. UGVs move on the scene indoors and collect objects, while UAVs move on the scene (indoors/outdoors) to gather additional data and video feeds. FRs and UxVs are assisted by the system in choosing optimal movement paths (w.r.t. safety and speed) to the trapped victims.

"Smart" UAVs are capable of exploring large areas, both indoors and outdoors, navigating in cluttered environments and interacting with its surroundings. Similarly, "smart" UGVs are capable of navigating in complex terrain and explore its environment that may introduce various types of obstacles.

Finally, the Symbiotic Operation Control Module (SOCM) is responsible for handling any "symbiotic" missions as proposed by the INTREPID platform. Specifically, the aim of SOCM is to facilitate the collaboration of "smart agents", in order to amplify their capabilities beyond what is individually possible for any FR, therefore unlocking possibilities that are not available when the FRs act in isolation or when using individual sensing modalities.

Figure 2. TCS, SOCM and UGV deployment during the Stockholm pilot.

3. CONCLUSIONS

First INTREPID pilot was conducted successfully and the whole consortium had the ability to interact for first time after covid-19 outbreak. It is highly important for these new technologies to be developed and tested in close collaborations with FRs and in realistic operational conditions. During the pilot at SBFF training facilities and in Stockholm metro station, many of the components were tested and integrated for first time together. The results of the test provided initial feedback and valuable understanding of what a real SAR operation may need, as well as for the FRs to become more familiar with state-of-the-art technologies and how they can be adopted in USAR missions.

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ONTOLOGY-BASED TECHNOLOGIES FOR DISASTER PREPAREDNESS, RESPONSE AND RECOVERY

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ABSTRACT
Natural disasters such as forest fires, earthquakes, floods and heat waves have a tremendous impact on the economy, the environment and the people. Every year, manmade and natural disasters lead to human and property losses and resettlement, the disintegration of infrastructures and degradation of society's resilience. The key role in the efficient management of such a crisis is information and knowledge management. The fusion of heterogeneous information, sensors and data processing is the stepping stone for every system architecture. This paper proposes the use of ontology-based technologies for disaster preparedness, response and recovery to ensure effectiveness. Innovative semantic structures that have been used in relevant EU projects are explored and adapted in the respective framework.

Keywords: Semantic Web, Ontology, Semantic Reasoning, Decision Support, First responders.

1. INTRODUCTION

Natural and manmade disasters are becoming more frequent and more devastating. The use of technology could leverage the response and make societies more resilient. Data acquisition, taxonomy and fusion from multimodal services (video and image analysis, Earth Observation-EO tools, social media, weather forecasts, wearables, etc.) can provide an advantage for crisis management. Decisions could be supported by facts and analysis (even trial and error) instead of being intuitive. Human fatigue and limited cognitive could be overpassed by Disaster Management Systems (DMS) and Disaster Support Systems (DSS). Early warning messages provide alerts to prepare and protect citizens and first responders. Meanwhile, wearable equipment monitors first responders' status and reflects the feasibility to fulfill their missions.

A promising approach to building complex systems is the use of Semantic Web technologies [1]. These technologies, with their ability to integrate heterogeneous data from various sources, offer a significant amount of potential to extend the information available on the Web by giving the information an understandable meaning that can be used by applications for assisting emergency management. Information is represented via ontologies while semantic reasoning schemes run on top of the ontologies and facilitate situational awareness and analysis for decision support. The use of semantic technologies for disaster management has been used in different disaster cases, e.g. earthquakes [2], in order to reduce the response time in disaster detection scenarios, and wildfires [3], in order to enhance knowledge dissemination and operational stakeholder preparedness. The inference process is essential wherever there is a need to identify potential data inconsistencies, evaluate data, identify new relationships, and build new knowledge.

In this paper, we present a framework for combining heterogeneous data from multiple sources, by using a unified ontology model for disasters. This framework can be used in each domain (disaster management, sensing and observation, emergency response, etc.) to support decision-making for the relevant stakeholders. To achieve this goal, we use the OWL2 language to create interoperable Knowledge Graphs (KGs) and semantic reasoning techniques capable of assisting decision support. In addition, we use real-world data to illustrate use cases and highlight how our framework supports various stakeholders.

2. ONTOLOGY-BASED FRAMEWORK

The proposed semantic-based framework (Figure 1) acts as a middleware between the multimodal content analysis inputs from the acquired data and the generated output services. During the semantic analysis process, the heterogeneous analysis results are captured, interlinked and transformed in RDF structures, and stored in a semantic database (TripleStore). The population of these data is based on specific ontological frameworks, which facilitate the semantic reasoning process; the main tool for inferring high-level information to feed the decision-making process is in the form of alerts and reports.

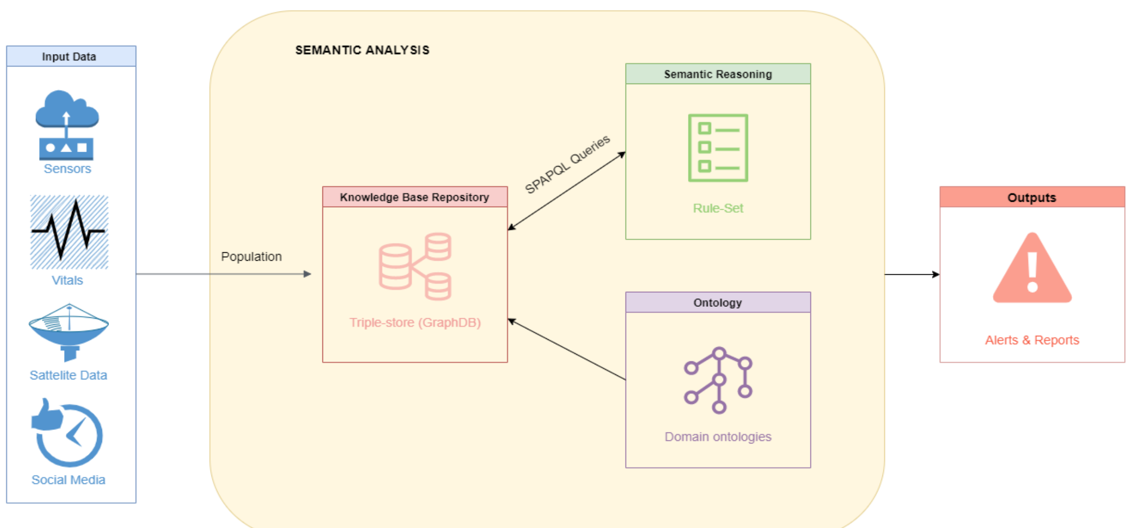

Figure 1. The position of semantic analysis in a high-level architecture.

2.1. Ontologies

The design of specific ontological structures, which can address the abundance of data that need representation in each respective domain, while also being easily adjustable and reusable, is a complex process and can be divided into three phases. The first phase includes the construction of the Ontology Requirements Specification Document (ORSD) [4] by understanding the user requirements and use case for the optimal matching with the ontology requirements. After the acquisition of the ontology requirements, in the second phase, the development of an initial ontology takes place using generic (e.g., SSN [5]) or domain dependent ontologies (beAWARE [6]). In Figure 2, a sample high-level ontology is depicted containing some of the fundamental concepts that are found during a crisis management situation. Some of these concepts are: the Disaster (e.g. manmade or natural), the Stakeholders (e.g. FR, citizens), the Equipment (e.g. wearables, assets), the Sensors (each module that makes an observation) the Impact, etc.; for simplicity, we have omitted data type and inverse properties, as well as extensive class hierarchies. Finally in the third phase is the enrichment of each respective framework with sophisticated design patterns and inclusions of the inferred knowledge from the semantic reasoning.

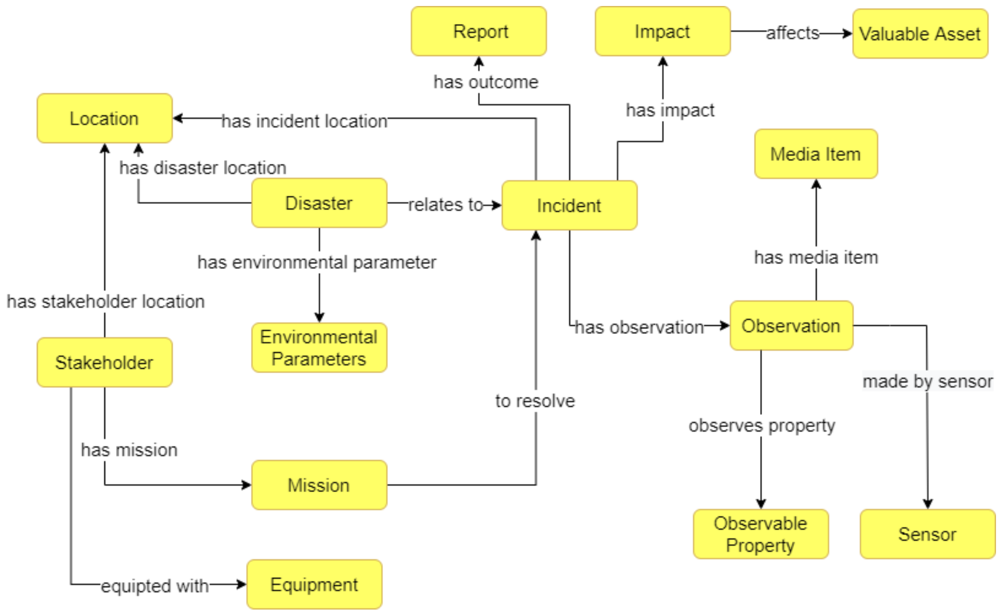

Figure 2. A high-level overview of initial disaster management and response ontology.

2.2. Reasoning component

The semantic reasoning component is responsible for inferring implicit knowledge from explicitly asserted facts existing in the ontology and detecting connections between ontology objects and concepts [7]. Data from multiple sources such as weather forecasts, earth observations, sensors, cameras, wearable technology and social media are integrated into the reasoning component. Moreover, SPARQL queries over OWL 2 ontologies have been used to create the reasoning mechanism. These queries traverse the ontology to identify situations of interest, e.g. alerts that are stored back to the Knowledge Base (KB), providing useful information and assisting end-users in evaluating alternatives and making decisions.

A rule-based interpretable technique is implemented that searches for relationships between data set attributes and class labels and extracts a set of rules. For instance, the weather conditions like wind, temperature and moisture can indicate the potential fire ignition in a specific forest location. The warmer and windier conditions associated with CO_2 emissions are a scenario that produces fires that burn more intensely and spread more quickly in most locations [8]. In this situation, the semantic reasoning module retrieves information regarding the weather forecast variable Fire Weather Index (FWI), which is one of the most popular techniques for predicting the risk of forest fires [9], analyzed the relative data and through the assistance of the SPARQL queries, create early warning messages to inform the citizens and the first responders. The early warning rule is shown in Table 1. Another rule example is presented in Table 1 in which real-time monitoring of the condition of the FR is needed. The vitals that are measured through wearable sensors are combined with other modalities (boots for FRs that recognize their motion status and personal info), and the rule generates pertinent alerts if the conditions are met.

Table 1. A sample of rules for early warning and real-time FR health condition monitoring.

Early warning Rule	FR Condition Rules
IF (FWI >21.3 and FWI<38) THEN PROBABILITY OF FIRE IS VERY HIGH and RECOMMENDATION IS SENT TO CITIZENS “*Do not burn litter, dried grass and small branches in open air.*”	IF (BODY TEMPERATURE >=41) and(DURATION >=1’) THEN SEVERE HEATSTROKE IF (HEART RATE <=60) and (BOOTS == IMMOBILIZED) and (DURATION>= 1’) THEN FR IN SERIOUS DANGER

3. CONCLUSION

In this short paper, we have presented the ontology-based framework for knowledge discovery to facilitate the decision support during disaster incidents. Having the right information at the right time is essential and crucial while managing a disaster event. Situational analysis and the combination of all information in a more productive manner is a key fundamental for raising situational awareness while handling a major event. Therefore, the overall goal is to increase the efficiency of the decision-making process while reducing the required time. The proposed semantic framework and the respective domain ontology aim to enhance the management of all incoming information from various sources that will support authorities and first responders in addressing disasters in a more effective way. Future work includes the validation and evaluation of these techniques in real situations which will take place in different pilot areas.

ACKNOWLEDGEMENTS

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ASSISTING FIRST RESPONDERS IN WATER-BORNE HAZARDS IN NORTHERN GREECE THROUGH PATHOCERT SOLUTIONS

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ABSTRACT

As water is a valuable and indispensable ingredient of life, drinking water's safety is extremely important both for ensuring consumers' health and for the proper functioning of the ecosystem. The implementation of new technologies aiming to ensure that water quality and monitoring in water utilities lies in compliance with current EU and national standards, prove very promising for enhancing risk assessment processes and management of water supply systems. The overall objective of the PathoCERT project is to strengthen the coordination capability of the first responders in handling waterborne pathogen contamination events, allowing the rapid and accurate detection of pathogens, improving their situational awareness and their ability to control and mitigate emergency situations involving waterborne pathogens. The developed methodologies involve the processing of a vast amount of data of different sources; PathoSAT collects data and images from satellites, analyse them to identify water contaminations and their extent and relays them to PathoCERT's platform. PathoTWEET analyses data and photos from social media to assess the occurrence, severity and extent of water contamination events. To align PathoCERT's various components with the needs of the first responders, three Community of Practice (CoP) meetings were organized, where the scenarios are formed based on the usability of the presented technologies.

Keywords: PathoSAT, PathoTWEET, water-borne hazards, satellite view, citizen observations, Chlorophyll-a

1. INTRODUCTION

In Greece, emergency management on earthquakes, floods, fires and industrial accidents, is organized in a top-down approach. Preventive activities include risk assessments as well as communication of these risks and strategies. Preparedness activities revolve around conducting trainings and emergency drills as well as developing the operating procedures. In the response stage, all relevant actors are coordinated and the set plans are implemented. The recovery stage focuses on set of actions aiming at restoring affected sites to the status quo prior to the emergency event. This top-down planning is further complemented by regional and local organizations plans and strategies. The Greek scenario underpinning the pilot activities is located in Thessaloniki and the implementers are the Hellenic Rescue Team (HRT) and the Thessaloniki Water Supply & Sewerage Co S.A. (EYATH), with the support of the Centre for Research and Technology Hellas (CERTH) that is delivering state-of-the-art research in Artificial Intelligence. The Greek scenario and pilot activities focus on the management of contamination incidents, due to severe flooding phenomena that occur in the open flow river channel that transports water to the

Thessaloniki Drinking Water Treatment Plan, as well as in the delta of Axios river where Search and Rescue activities must take place. The performance and impact of the developed tools for pathogen monitoring, threat assessment and incident management will be studied. Accordingly, CERTH's PathoSAT and PathoTWEET technologies will be tested, while the stakeholder engagement and has already started offering continuous feedback to the technology providers through the Communities of Practice (CoP).

2. COMMUNITY OF PRACTICE TO SUPPORT FIRST RESPONDER TEAMS

A set of three CoP meetings have been organized in Thessaloniki thus far: one in June 2021, one in January 2022 and one in June 2022. Due to the increasing number of COVID-19 cases in Greece the first two meetings were held online to comply with health regulations and ensure the well-being of the participants. The external stakeholders covered a wide range of expertise and responsibilities with deep knowledge on the existing protocols, measures and emergency plans. Organizations such as Regional Civil Protection Departments, Public and Municipal Authorities, Research Centers, Universities, First Responders and Water operators create a complete set of experts to support the methodology for collecting requirements and feedback from first responder teams.

2.1 Communities of Practice for user interaction with technology providers and stakeholders

The key objectives of the first CoP meeting in Thessaloniki were to introduce the PathoCERT project, its objectives and technologies as well as the CoP approach and the related engagement activities to be undertaken. In addition, stakeholders were able to discuss and exchange on the role and responsibility of each organization in the management of the incidents described in two pilot exercise scenarios. In the first exercise scenario, polluted water from Axios river overflows due to flooding, to the water transportation channel towards the Thessaloniki Water Treatment Plant posing a potential risk to the safety of drinking water. In the second exercise-scenario, also due to a flooding event, two photographers are missing in the area of the Axios river basin and delta (including also the wider sea area). Specifically, the discussion was structured around four key questions:

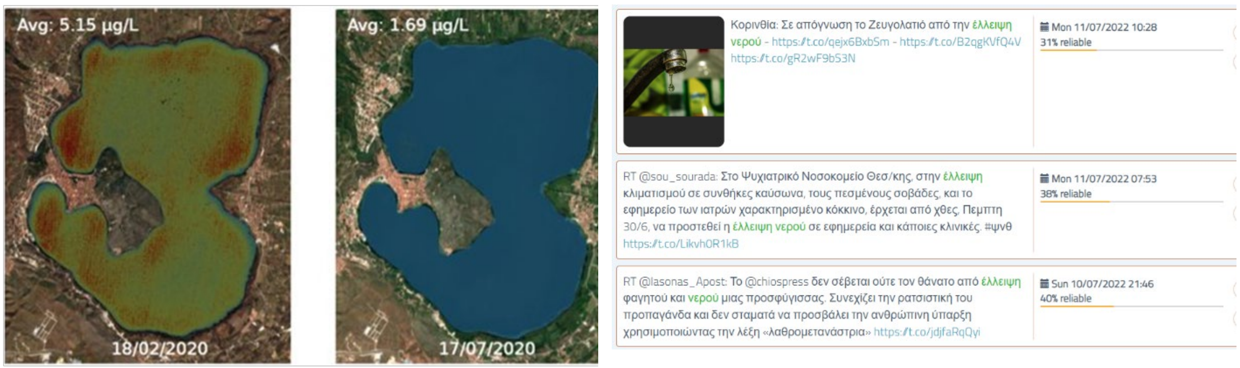
- What actions do you take today when an incident occurs per exercise-scenario?
- What information is available today when one of these exercise-scenario incidents occurred?
- What information is missing today when one of these exercise-scenario incidents occurred?
- What technologies and tools do you think are needed to tackle both exercise-scenarios?

These guiding questions allowed for the collection of stakeholders' requirements and needs regarding the collaboration and coordination procedures when managing an emergency or disaster incident, but also the collection of an initial dataset regarding the relevance and ease of use of the PathoCERT technologies in the exercise-scenarios developed. Following up on the discussions of the first CoP meeting, the aim of this second online CoP in January 2022 was to look more closely at some of the technologies that will be tested in the Thessaloniki exercise-scenarios and gather the stakeholders' inputs. The key aspects where the interaction with the stakeholders focused were the advantages and disadvantages of each technology, the potential interest in using the technology, and the applicability of each technology in the different stages of the exercise-scenarios.

2.2 Overview of the technologies that contribute to the Greek Community of Practice

2.2.1 Support to first responders

First responders can be exposed to waterborne pathogens when they are responding to an emergency. The PathoCERT project's goal is to enhance the protection of first responders from these waterborne pathogen contaminations and augment their ability to react to dangers. This is achieved through developing technologies, services and governance mechanisms that enable the fast and accurate detection of waterborne pathogens as well as improve the communication between different emergency management actors. To this direction, two technologies namely PathoSAT and PathoTWEET are able to provide insights, events and valuable information to first responders during an operation in a timely manner.



(a) (b)

Figure 1. PathoSAT and PathoTWEET functionalities: (**a**) Visualization of estimated levels of chlorophyll concentration in water as a heatmap to assess the severity level before a search and rescue scenario; (**b**) A set of tweets that need to be automatically assessed with AI algorithms in terms of their reliability and relevance, with location estimation from raw text when geospatial information is missing from a Twitter post.

PathoSAT monitors the formation of algal blooms on surface water using satellite images. Algal blooms can be poisonous for human and animals via skin contact, or via consumption. Through PathoSAT, the First responders have open access to recent satellite information and thus can obtain the most recent information on the quality of the water and avoid exposure to infected waters. The outcome of PathoSAT is visualised on the map of a GIS system, as it is shown in Figure 1(a). The development of the AI algorithm that is able to quantify the severity level through algal bloom estimation is based on previous historical events that were used for training Deep Learning models [1, 2]. PathoTWEET collects information from citizens, as it is shown in Figure 1(b), aiming to reduce noise, identify relevant tweets with useful text description or mobile photos from the field.

2.2.2 Support to water utility operators

The technological tools are expected to be combined with the legacy systems of EYATH SA and to provide necessary data for an integrated risk assessment and an in-depth study to highlight the vulnerabilities in water safety and security. There is a high expectation that a series of appropriate mitigation measures and actions will be defined (concerning water resources monitoring methods, communication procedures amongst the first responders, information-harvesting methods to exploit social media etc.). This systematic approach will bring out the general rules and procedures to be integrated into a framework of a solid standardized methodology. Moreover, EYATH SA is currently in the process of developing its Water Safety Plan (WSP), in accordance with the recently revised Drinking water directive (Directive (EU) 2020/2184 of the European Parliament and of the Council of 16 December 2020 on the quality of water intended for human consumption [3, 4]) with a holistic Risk Based approach within the whole water system it manages.

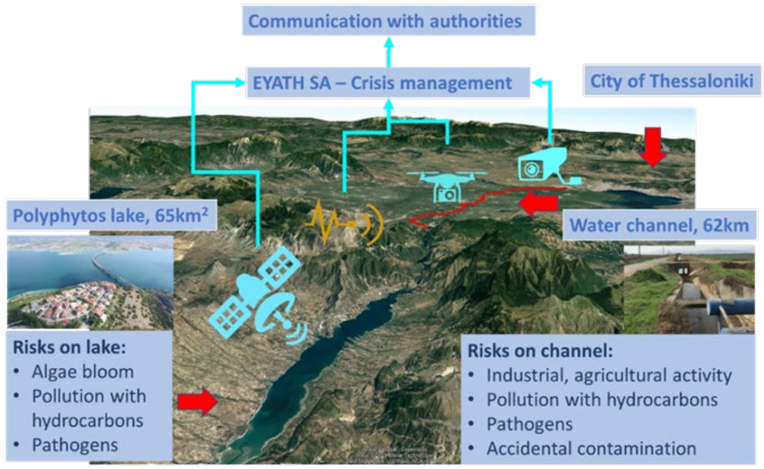


Figure 2. Description of the case study for EYATH SA indicating the potential risks and the forecasted tools to be used in order to mitigate the risks (i.e. satellite images, network of sensors, drones-UAVs and cameras)

3. CONCLUSION AND FUTURE STEPS

During the first two rounds of CoPs in Thessaloniki, the organizers have collected a significant amount of feedback with respect to challenges and needs as well as on expectations in terms of usage for the presented and discussed technologies. As a next step, stakeholders and the CoP organisers have identified the need to engage more directly with the respective technology developers in order to specify and clarify technical aspects. These specifications will then allow for a more detailed review of the exercise-scenarios and targeted adjustments to the technologies of interest. Furthermore, since not all the PathoCERT technologies have been fully discussed with local actors, similar exercise will be repeated in the upcoming CoP meetings. Finally, the Greek stakeholders will also further define the roles and responsibilities of the various actors involved in the emergency management system in order to define a common and detailed framework of their operational coordination, in connection to the PathoCERT technologies.

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INTERANNUAL AND SPATIAL DISTRIBUTION OF MARINE HEAT WAVES IN AEGEAN, IONIAN AND CRETAN SEAS

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ABSTRACT
The interannual and spatial distribution of the Sea Surface Temperature (SST) and the formation of Marine Heat Waves (MHWs) are investigated based on long-term satellite-derived SST data of high-resolution (~1km) over the NE Mediterranean Sea (Aegean, Ionian, and Cretan Seas) for 14 years (2008-2021). The increasing SST trend of the mean annual values is mainly associated with the interannual increase of the lowest values (weaker minima during the cold seasons). MHWs were more frequent over the northern Aegean Sea, especially at Thermaikos Gulf which is characterized as "hot spot" for MHWs. The number of MHWs over the entire study region showed an increase of approximately 1.7 event and 21 days of MHWs per decade; the spatially- and annually-averaged number of events was approximately 1 with less than 10 days duration on 2008 and increased to more than 3 events with almost 30 days by 2021. In particular, the warm year of 2021 showed significant high SST levels both in winter (January-February) and summer (July-August) during a prolonged period of an atmospheric heat wave. The increasing temperature levels and the associated MHWs may have significant envriomental and socioeconomic implications affecting the water quality, the biochemical characteristics and the quantity and quality of fish populations.

Keywords: Ocean Warming, Satellite Observations, Marine Heat Waves, Water Quality

1. INTRODUCTION

Sea Surface Temperature (SST) is an important parameter of the natural environment strongly related to the earth's climate and the hydrological cycle, mainly due to exchanges between the atmosphere and the ocean. The Aegean, Ionian, and Cretan (AIC; Figure 1) Seas together with the Levantine Basin revealed the highest increasing trends of SST (>0.05°C/year) in the Mediterranean during 1982-2018 [1]. Skliris et al. (2011) based on long-term satellite-derived (1985-2008) and in situ data (1950-2006), showed a small SST decreasing trend of the Aegean Sea until the early nineties and a rapid surface warming right after, analogous to the temperature rise observed on the global ocean scale. Ibrahim et al. [3] have shown that over Eastern Mediterranean, Marine Heat Waves (MHWs) frequency increased by 1.2 events per decade between 1982 and 2020. In this study, we focus on the spatial and temporal SST variability during the most recent 14-year period (2008-2021) using high-resolution (~1km) satellite-derived data. We discuss the spatial differences between 7 sub-regions of the AIC Seas (Figure 1) and we focus on the Thermaikos and Chalkidiki areas. The main goal is to detect the interannual SST trend of each sub-basin and their spatial differences, focusing also on the formation of MHW and their interannual variability. In addition, we will examine the interannual evolution of the MHWs over the entire study region in comparison to the extreme conditions of 2021.

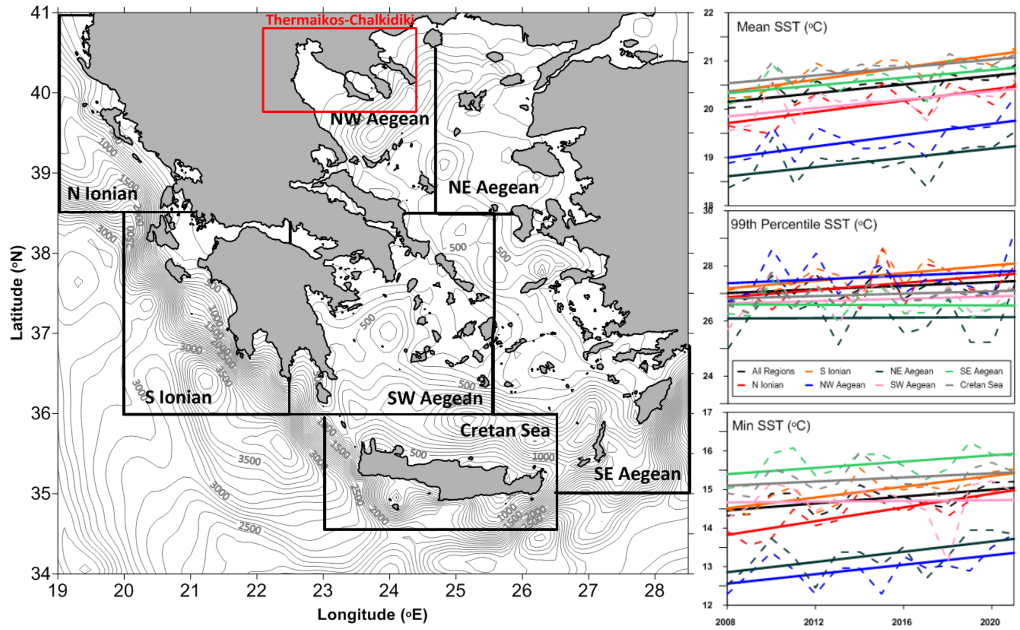

Figure 1. Bathymetry of the study area divided in 7 sub-regions (Black boxes; left panel). The Thermaikos-Chalkidiki is marked with a red box. Annual variability and trends of the mean SST, the 99th percentile of SST, and the min SST, averaged over 8 regions (all regions and 7 sub-regions) for the period 2008-2021 (right panels).

2. MATERIAL AND METHODS

The satellite data used in the study include an SST set, distributed by the E.U. Copernicus Marine Service (https://www.copernicus.eu/; Mediterranean Sea High Resolution and Ultra High Resolution Sea Surface Temperature Analysis; spatial resolution: 0.01°) covering the period 2008-2021. A longer dataset of lower resolution (0.05°) derived from the Advanced Very High Resolution Radiometers (AVHHR) was also used to compute the interannual variability over the Thermaikos Gulf during 1982-2021. The study adopts the definition proposed by Hobday et al. [4] to determine the MHW events, based on abrupt SST increases above a "climatologic" value (the baseline temperature) for a certain time period.

3. RESULTS-DISCUSSION

The mean SST of the entire study region (Figure 1) reveals a clear increasing trend derived from annual means (0.49°C/decade) with significantly high annual mean in 2021 (~20.9°C), while the respective annual mean was approximately 20°C in 2008. The increasing trend of the mean annual minima is stronger (0.38°C/decade) and statistically significant (p_{value}=0.026<0.05) in comparison to the trend of the maxima (99th Percentiles). This trend indicates that during the cold season when the lowest values usually occur, the winter-spring surface waters became warmer through the years. The highest statistically significant (p_{valu}e<0.05; Figure 2) Sen's slopes are observed at parts of the N Aegean (>0.75°C/decade) and central and southern Ionian (>0.65°C/decade). The eastern Aegean Sea and the SW Aegean revealed the weakest trends with very high p_{value}. The straits between the Peloponnesus and the northern Greek mainland are also characterized by strong SST trends. Especially a distinctive region between Peloponnesus and Crete showed trends less than 0.1°C/decade. Very low Sen's slopes (<0.35°C/decade) were also computed at the area southeast of Crete. The largest number of MHWs was observed in the northern Aegean Sea (>35), where the accumulative period of all MHWs is more than

300 days; especially the entire northwestern region of the Aegean and Thermaikos Gulf can be characterized as a "hot spot" of MHWs affecting the respective coastal area (Figure 3).

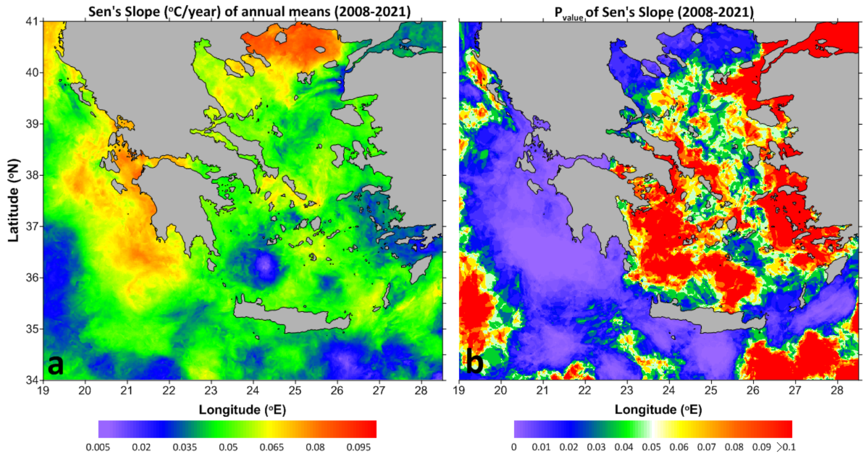

Figure 2. Spatial distribution of (a) Sen's slopes of annual SST means and (b) statistically significance threshold

The largest number of MHWs was observed in the northern Aegean Sea (>35), where the accumulative period of all MHWs is more than 300 days; especially the entire northwestern region of the Aegean and Thermaikos Gulf can be characterized as a "hot spot" of MHWs affecting the respective coastal area (Figure 3). The increase of the MHWs days is 21.3 days/decade and the respective increase of the MHWs events is 1.7 events/decade in agreement with the trend for the whole Mediterranean Sea using a different MHW definition and a longer period [5].

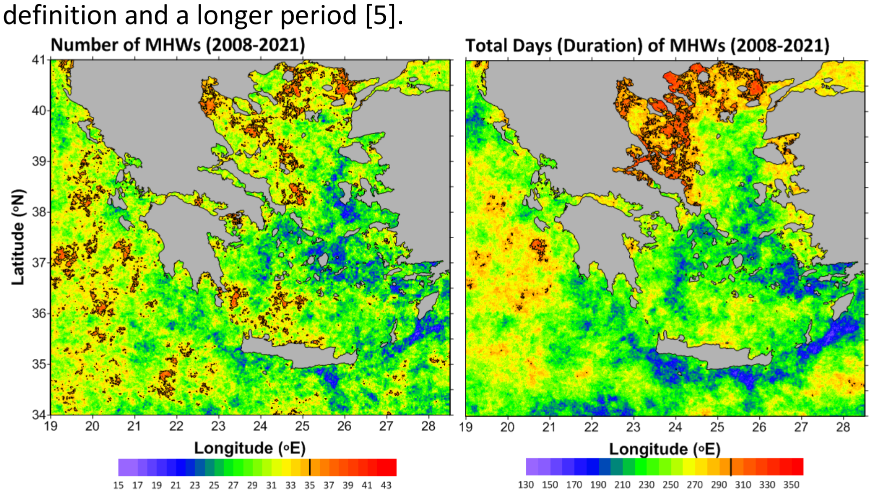

Figure 3. Spatial distribution of the total number of MHWs events (left) and total duration (right) in days

The largest number of MHWs was observed in the northern Aegean Sea (>35), where the accumulative period of all MHWs is more than 300 days; especially the entire northwestern region of the Aegean and Thermaikos Gulf can be characterized as a "hot spot" of MHWs affecting the respective coastal area (Figure 3). The increase of the MHWs days is 21.3 days/decade and the respective increase of the MHWs events is 1.7 events/decade in agreement with the trend derived by Darmaraki et al. (2019) for the whole Mediterranean Sea using a different MHW definition and a longer period. The year of 2021 was characterized by successive atmospheric heat waves especially in August. (http://magazine.noa.gr/archives/4560). The highest values of the N Aegean in the summer of 2021 are mainly related to the MHWs that were formed in the western part of this region, and especially in the broader Thermaikos Gulf. The duration of the MHWs was more than 20 days in August 2021 and reached 30 days close to the western coasts of the central Gulf.

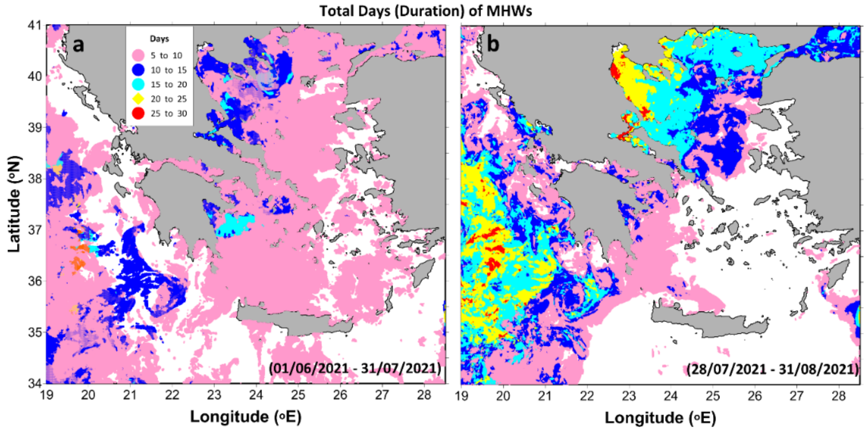

Figure 4. Spatial distribution of the MHWs duration (days) for (a) June-July 2021 and (b) August 2021.

We focus on the broader Thermaikos Gulf (Thermaikos-Chalkidiki; Figure 1) using a longer SST dataset (1982-2021) when the number of fishing landings are available (Anchovy and Sardine). A strong increasing SST trend was detected for the Thermaikos and Chalkidiki Gulfs (Figure 5). The respective fish landings revealed reducing trends during the same 40-year period showing a relatively strong statistically significant counter-correlation with the SST variability (R=-0.46 for Anchovies and -0.49 for sardines).

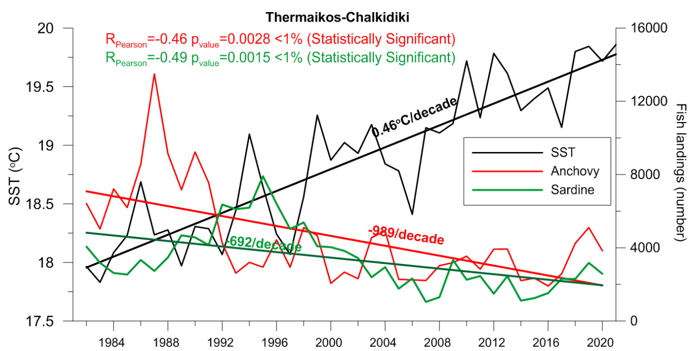

Figure 5. Annual variability and trends of SST and fish landings over Thermaikos-Chalkidiki during 1982-2021

ACKOWLEDGEMENTS

The fish landing information were kindly provided by professor A. Tsikliras (AUTh)

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WATCHING OUT LARGE-SCALE WATERLINE AND COASTAL CHANGES IN GREECE, THE SPACE FOR SHORE PROJECT, UNDER ESA'S COASTAL EROSION PROJECT

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ABSTRACT

Coastal areas are facing extreme pressure due to climate change and sea level rise, intense urbanization and population growth, but also strong dynamics and severe coastal hazards. These phenomena have multiple impacts to coastal societies, such as geopolitical risks, socio-economical threats and ecological losses.

Space for Shore project proposes a large-scale, affordable and efficient strategy, based on multi-temporal satellite imagery to supplement field surveys. In particular, Space for Shore project, funded under the ESA Coastal Erosion Project, prototyped coastal erosion monitoring tools and products. These tools and products extend over the entire coastal system, from nearshore to the inshore, exploiting the archives of Copernicus European Programme and other satellite missions, to cover a time span of 27 years. The project is highly end-user driven with around 70 end-user entities providing their requirements, while the studied areas are cover all types of European coasts and geomorphologies. The adopted temporal frequency matches the addressed, by the end-user operational needs and matches the dynamic of each area.

During the third project year, Terra Spatium and i-Sea has processed hundreds of satellite images from 1995 to 2022 to produce several indicators over time in Greece, which has been then turned into a preliminary coastal erosion assessment at the scale of the island of Evia and the island of Rhodes.

We hereby present the results of high-frequency coastal monitoring, of the Greek study areas, during the third project year, using satellite imagery over highly sensitive regions to show the potential for the scientific community but also and above all to help coastal managers in their fight against coastal erosion and hazards.

Keywords: Coastal Erosion, Satellite Earth-Observation, Remote Sensing.

1. INTRODUCTION

Coastal erosion is a natural process that is a non-linear phenomenon, varies in time and magnitude and show successive phases of erosion/accretion, which sometimes is shifting trends upon the decades. Nevertheless, the issue of coastal retreat appears everywhere around the world under the effect of those natural processes, which are aggravated by climate change and human activities.

Coastal authorities are, on the one hand, securing coastal city attractivity, while on the other facing the challenge of sustainable shoreline management and the need for coastal monitoring actions to be undertaken in order to upgrade the knowledge of coastal dynamics.

Nowadays, a plethora of methods is currently used by scientists and coastal managers for monitoring beach and shoreline changes. It includes, field surveys using DGPS, terrestrial scanning and/or aerial photogrammetry techniques with the deployment of UAVs, which offer the best accuracy but are time consuming and cover limited areas. Airborne surveys using LIDAR usually cover larger areas, but the cost is too high to permit repetitive surveys, and the data processing is too long for the majority of coastal stakeholders that need rapid delivery for immediate decision support. A need has raised for alternative large-scale and affordable techniques, which is what satellite remote sensing can offer.

Together, we prototyped coastal erosion monitoring tools and products over 2,400-km of coastline between 2019 and 2020. A third project year (mid-2021/2022) allows us to add more than 1,700-km of coastline, including a new country, Norway. This coastal monitoring extends over the entire coastal system, from nearshore to onshore, exploiting deeply the archives of the Copernicus European Programme and other satellite missions to cover 27 years of coastal dynamics and capture erosion episodes occurring at variable rates.
The Coastal Erosion project is end-user driven, where several end-users: (i) have defined the required products; (ii) have been sharing their ground truth datasets issued from their current monitoring program; and (iii) finally test the new products and give feedback about their relevance.

In France, Germany, Greece, Romania, Portugal, and the Svalbard Archipelago (Norway), we have processed thousands of satellite images from 1995 to 2022 to monitor the shoreline evolution over time. The philosophy of Space for Shore is based on cooperation between different specialists in SAR and optical remote sensing, who together address the most comprehensive coastal erosion indicators, as required by European coastal managers. The ambition is to set up a wide range of validated satellite products covering all types of European coasts and patterns of coastal erosion, and finally to define a multi-criteria classification of coastal and human vulnerability to erosion.

The project is the opportunity to start designing a scalable commercial service to be then deployed at the European scale. The Space for Shore consortium has currently 5 national contact points in each of the participating countries enabling proximity with local and national authorities.

2. THE GREEK RESULTS

Terra Spatium backed by i-Sea has processed hundreds of satellite images over the 1995-2022 period to perform the very first dataset describing the location and evolution of waterline over time in Greece, that has been a preliminary coastal erosion assessment for the study areas over the island of Evia and the island of Rhodes.
In Greece, as well as in every coastal Mediterranean region and similar enclosed seas where the tidal range is low, coastal erosion can be monitored by focusing on waterline temporal variations during low energy wave conditions. Optical satellite archives (Landsat, Spot, Sentinel-2) have been processed using supervised classification algorithms to extract land/sea interface in a semi-automated and robust way ensuring readiness for large database processing and method replicability at regional and national scales.

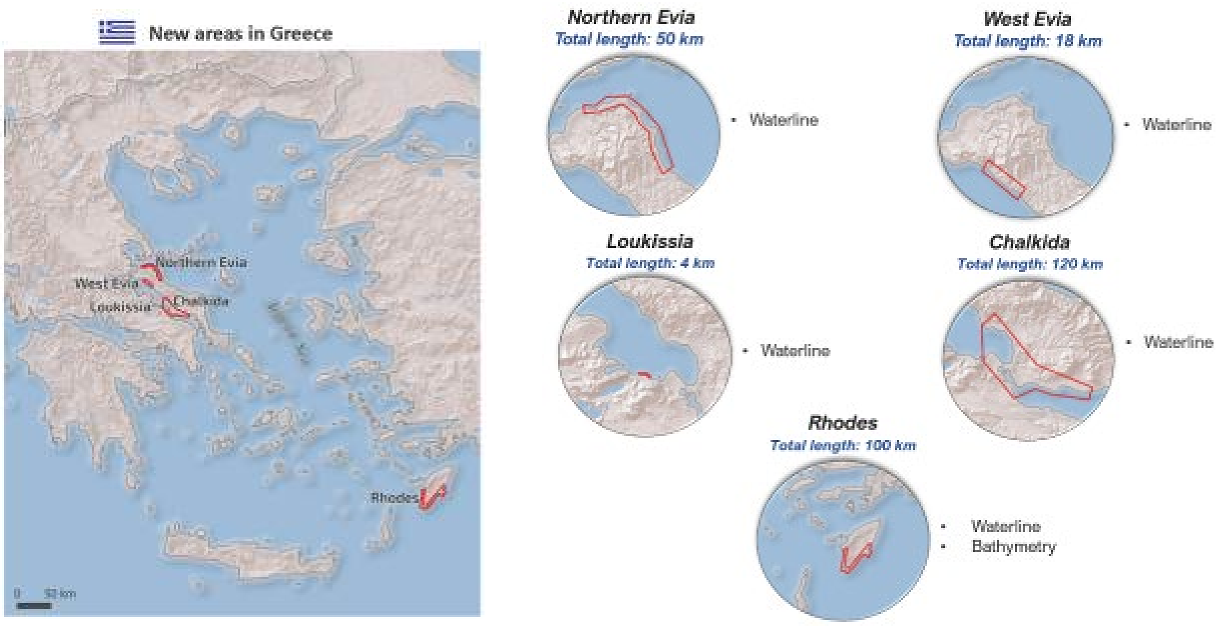


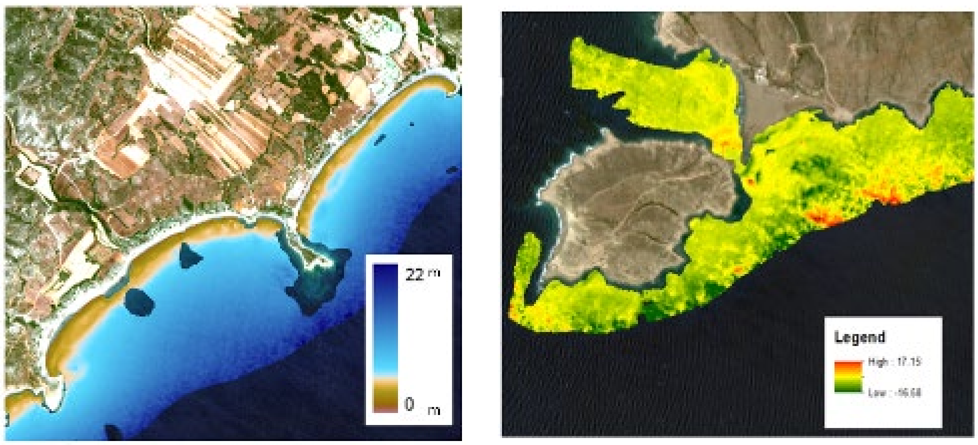
Figure 1. New coastal areas in Greece mapped by Space for Shore project during the third project year.

Changes in the waterline position are usually computed and estimated along regularly spaced profiles perpendicular to the coast and highlighting hot spots of shoreline retreat and which are facing strong coastal dynamics or being particularly vulnerable to coastal erosion hazard.

Directly derived from satellite-based waterline time series, variations in shoreline position may be computed at every required time scale, as here along in the Southern coast of island of Rhodes, where shoreline evolution was computed on a 5-year basis. The same has been done in other European regions at higher frequency (monthly) thus enabling catching storm impact and beach natural recovery in the months following storm events.

Figure 3. Rhodes site, Waterlines from 1995 to 2022.

A first demonstration of satellite-derived bathymetry has been achieved over the study area of Southern Rhodes Island, where the underwater topography has been retrieved up to depths of 20 m. This provided the opportunity to systematic monitoring of shallow water bathymetry changes over sandy areas suffering from coastal erosion and in complement to beach and shoreline monitoring with the overall objective of achieving a better understanding of coastal dynamics and sediment budgets.



(**a**) (**b**)

Figure 4. Rhodes site: (**a**) Bathymetry product 2022; (**b**) Bathymetric changes on yearly basis.

The results obtained in Greece, i.e. more than 1,200 kms of coastline produced for the period of 27-years, testify how mature is the Space for Shore coastal erosion service and ready to play an active role in the future coastal monitoring infrastructure in the service of the Greek authorities.

3. ACKNOWLEDGMENT

Space for Shore project is funded under the ESA Coastal Erosion Project, ESA EOEP-5 program.

DEVELOPMENT OF AN INTEGRATED OBSERVATORY SYSTEM FOR PREVENTING AND MANAGING THE RISK OF COASTAL EROSION DUE TO THE IMPACT OF CLIMATE CHANGE THROUGH THE UTILIZATION OF EARTH OBSERVATION DATA

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ABSTRACT
Due to the effects of climate change, coastal erosion is an emerging and pressuring phenomenon commonly accompanied by significant consequences, resulting in land loss and infrastructure damage and threatering the wellbeing of local communities. Monitoring small scale changes in the coastal landscape and their evolution with time, within the Earth's dynamic system, is considered a useful tool for predicting major future impact and support comprehensive plans for the management of coastal zones. With that in mind, an observatory for the management of coastal areas has been developed and is operational by the Management Authority of the Region of Central Macedonia. This observatory collects and utilizes Earth Observation (EO) parameters and operates as a hub for the collection and dissemination of specialized data, observations and products in the coastal zone. The provided services and indicators rely on satellite, airborne and in-situ land and marine data as well as model outputs combined with land use and other datasets. One of the first actions was to develop a number of specialized algorithms and workflows to obtain automatically all the necessary factors for spatial analysis of coastal risks and furthermore to map the predisposition of coastal sectors exposed to coastal hazards. The developed geodata bases were integrated in a web GIS application, conventionally named "Integrated Observatory System for Preventing and Managing the Risk of Coastal Erosion due to the Impact of Climate Change through the Utilization of Earth Observation Data", designed to ensure interactivity, interoperability and exchange of information, support decision making and evaluate alternative coastal zone development strategies, fully compatible with the national Integrated Coastal Zone Management (ICZM).

Keywords: coastal erosion, climate change, Earth Observation, monitoring, GIS application

1. INTRODUCTION
Monitoring the dynamic evolution of the coastline has become essential for risk management, especially from the perspective of sea level rise that exacerbates the vulnuarabitlity of the exposed coastal regions [1]. The ecological damage, societal and economic problems that can be caused by coastal erosion are quite significant, making the creation of a framework for the management of such phenomena a necessity. For this purpose, a digital observatory for the coastal areas of Northern Greece, was developed and operates on a continuous base by the Region of Central Macedonia (RCM) to provide fundamental information about a large number of indicators related to coastal erosion and its accretion. The coastal areas of RCM in northern Greece are subject to land subsidence phenomena, presenting low but significant deformation rates. In most cases, local authorities cannot identify the problem until significant damage occurs. Such was the case of Anathemountas basin, where the integrity of critical infrastructure and buildings has been damaged irreparably [2,3], Paralia Katerinis, where posterior interferences that attempted to reduce the effects to the disrupted coastal sediment balance only

managed to transfer coastal recession northwards and, in some cases, even intensify it locally [4], Fourka Torrent [5] and Vrasna Beach [6].
The observatory was set up in 2019 and its main objective is to collect, strengthen and transmit scientific knowledge and data on coastal erosion as a tool for hazard management. Furthermore, it aims to respond to the need of combining dynamic data timeseries with decision-making processes of all involved parties.

2. METHODOLOGY

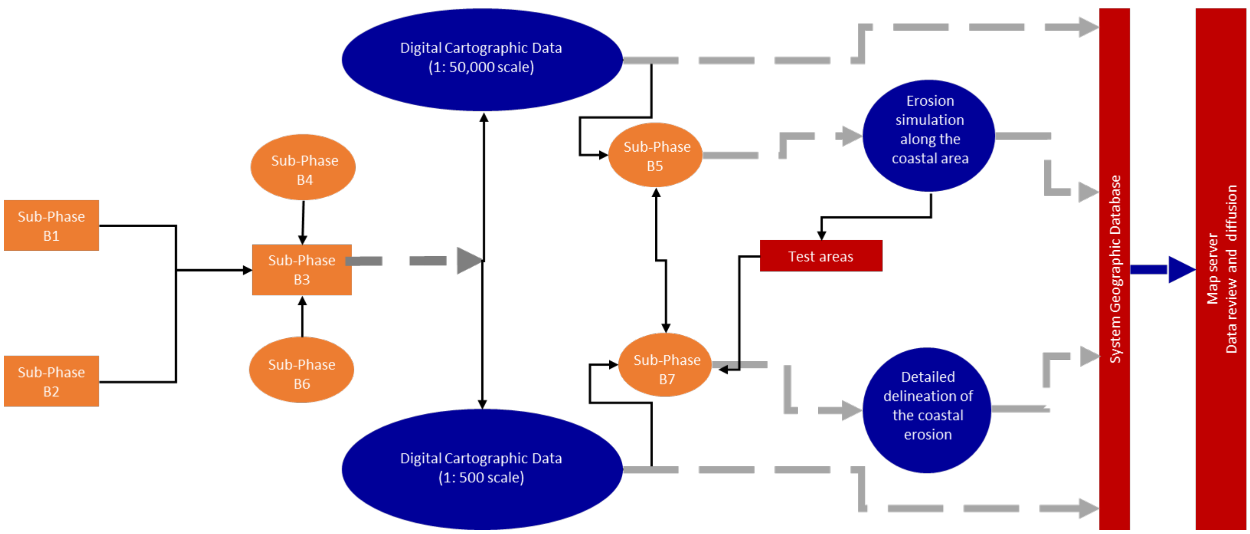


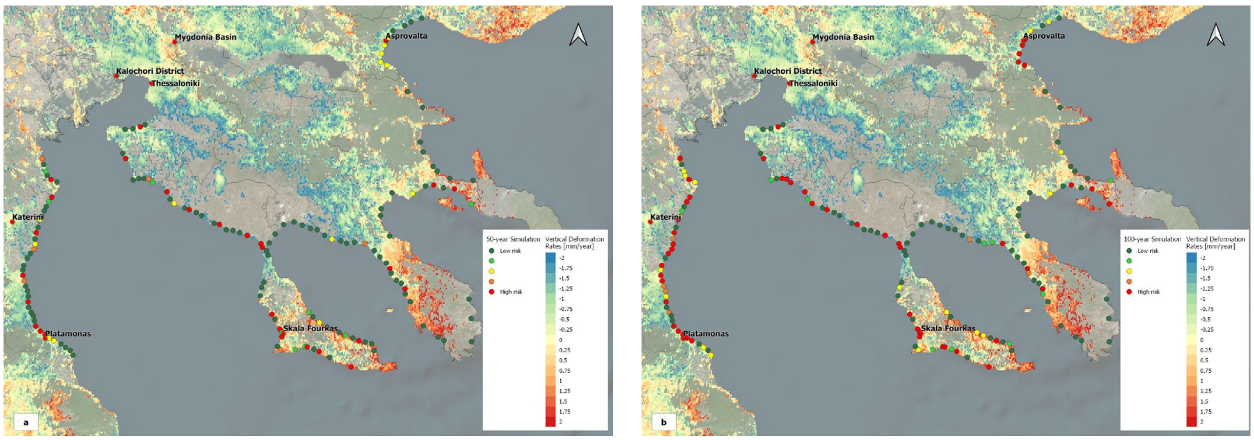
Figure 1. Process flowchart.

The applied methodology included three (3) thematic phases, referring to:

- The design of the web GIS application that hosts the observatory, its services, and derived datasets (Phase A).
- The creation of the algorithms and tools for the calculation of all the necessary indicators (Phase B).
- The evaluation of the current state and the proposal of alternatives for risk management (Phase C).

The web GIS application was being re-evaluated throughout the project in order to host the digital products created through Phase B (see Figure 1), after applying specialized algorithms that processed satellite and in-situ observations. These referred to optical images from the Sentinel-2 and Landsat-8 satellites; Sentinel-1 SAR acquisitions; satellite altimetry observations from the Cryosat-2, Jason1/2/3, SARAL and Sentinel-3a/3b missions; and in-situ observations of the coastal area and the topography bathymetry via GNSS, UAV mapping and echo sounding.
Phase B was divided in sub phases, as shown in Figure 2, with each sub-phase dedicated to a different group of tasks. During Sub-phase B1 and B2 automated algorithms have been developed to process the EO data and the in-situ observations. Simultaneously (Sub-Phases B4 and B6), the necessary in-situ data were collected from dedicated campaigns along with other needed information such as land use, geological formations, etc.. Since these heterogeneous sets of data presented variable spatial resolutions, different workflows were followed to produce digital thematic maps of low (1:50,000) and high (1:500) spatial scale (Sub-phase B3).

The low scale thematic maps were used to estimate a 50- and 100-year simulation of the vulnerability of the coastal area under the pressure of tidal waves (Sub-Phase B5), since the vulnerability of a coastal area is indissolubly linked to erosion phenomena. As shown in Figures 5a and 5b the most vulnerable areas for a 50- and 100- years period, under high pressure of tidal waves, are those of Paralia Katerinis, Epanomi, Fourka, and Asprovalta (red and orange dots along the coastline of the areas).
In those specific areas a subsidence trend is also observed from the InSAR analysis based on Sentinel1a/1b. For those pinpointed as critical areas (Test Areas) further investigation was carried out, such as sand and soil sampling, high accuracy topographic and bathymetric surveys, to derive high resolution maps and results regarding their vulnerability (Sub-Phase B7).



(a) (b)

Figure 3*:* The results of the 50 –year (a) and 100-year (b) simulation in comparison to the derived SAR deformation rates

All generated products, the erosion simulation model and the detailed delineation of the phenomenon at the test areas (listed in Table 1) were integrated in the web Observatory that was developed during Phase A. The online tool was enriched with other geospatial datasets, such as the CORINE Land Cover maps, for extracting land use information, geomorphological maps and real time wind direction and speed. The aim was the creation of an interactive application that would enable the correlation between the factors that were measured or used throughout the project with the human activity and the coastal vulnerability.

3. RESULTS

The "Integrated Observatory System for Preventing and Managing the Risk of Coastal Erosion due to the Impact of Climate Change through the Utilization of Earth Observation Data" is now used by the Department of Environment and Industry, Energy & Natural Resources of the Region of Central Macedonia. There have been already networking activities between stakeholders and public authorities regarding the erosion problems that are highlighted from the project's results as well as potentional prevention measures.
The various databased of the observatory databases and the produced services are still complemented by new earth observation (EO) data aiming at its continuous growth and idevelopment into a unified tool for the monitoring of the effects of climate change, not only for the coastal areas but for the land and marine regions as well. Through the constant upgrade of the observatory of the project, new products have been developed to provide tools for hazard management and strengthen the scientific and stake holder knowledge on the climate change effects to the anthropogenic and natural environment.

Table 1. The Integrated high- and low-resolution products and maps.

High Resolution Products and Maps	Low resolution Products and Maps
Near real time timeseries from data buoys	Topographic Diagramms (HMGS)
UAV Digital Surface Models for the Test Areas	Geological Maps
Soil Sampling areas	Hydrographic network
HR Multibeam Sonar Bathymetry Model for the Test Areas	Coastline and its evolution from 2016 to 2018
HR Survey for the Test Areas	CORINE 2012 land use
General urban plan for the coastal areas	NATURA network and Wetlands (RAMSAR)
Coastal erosion vulnerability	Bathymetry model (Sentinel 2)
Topo-Bathymetry model (LSO25-GEBCO)	DEM (Landsat 1)
	SRTM DEM
	OCN Component Extractor Speed and Direction
	Vertical Surface Deformation Rates (Sentinel 1)
	Vertical Absolut Deformations (Sentinel 1)
	Sea Surface Temperature – SST (Sentinel 2)
	Total Suspended Solids – TSS (Sentinel 2)
	Chlorophyll a (Sentinel 2)
	Sea Level Anomalies – SLA (Jason 2/3, Cryosat-2, Sentinel 3a/3b)

ACKNOWLEDGEMENT

Funding for this work was provided in the frame of the “Monitoring climate change induced coastal erosion in the region of Central Macedonia with satellite and in-situ data” and the “Operation of the observatory for the integrated management of the coastal zone” projects, financed by the Managing Authority of the Region of Central Macedonia.

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STATISTICAL ANALYSIS OF ROAD TRAFFIC ACCIDENTS INVOLVING PUBLIC BUSES

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ABSTRACT

Road accidents have been investigated thoroughly by many researchers all over the world due to the safety risk imposed to the public trasnport, and, especially buses, by the vehicular traffic. The overall target is to reduce traffic flows and velocity in order to reduce fatalities and serious accidents involving public buses and improve the environment. This paper attempts to analyze and evaluate the road accidents involving public buses in the city of Thessaloniki, Greece. In the framework of this research, a survey was carried out to Thessaloniki's Traffic Police colected data in terms of road accidents. The analysis was based on the accidents involving public buses in Metropolitan area of Thessaloniki, the accidents involving persons, the type of accidents and the records of accidents near bus stops. The investigation provides information about the traffic accidents in the last decade in the city of Thessaloniki and evaluate the reasons of traffic decrease. Publıc buses constitute the major mean of public transport in Thessaloniki's Metropolitan area. Findings show that during COVID-19 period (restrictions measures), the road accidents that involved public buses were fewer although the number of public buses has been increased. In addition, the spatial analysis of accidents highligthed the black spots of road traffic accidents recorded near bus stops in the city of Thessaloniki

Keywords: road safety, road accidents, public buses, bus stops, circulation study, type of accident

1. INTRODUCTION

Thessaloniki is the second largest city in Greece with a population in the metropolitan area of 1,006,730 residents in an area of around 1,450km^2, according to the 2011 census [1]. The population density in Thessaloniki is very high, especially in the city center, reaching the nunber of 20,429 inhabitants/km^2, with an average 8,000 inhabitants/km^2 [2]. Due to its geographical location, Thessaloniki plays an important social, financial, and commercial role in Balkans [3]. Transportation is the "lifeblood of cities" and public transportation is the key for sustainable cities [4]. Car is the dominant vehicle used for transportation in Thessaloniki (scooters and bicycle are also present in summer months) while buses constitute the only public mean of transport of Thessaloniki [5]. The bus system is operated by the Organization of Urban Transportation of Thessaloniki (OASTH) founded in 1957, assisted by other providers (KTEL Thessalonikis, KTEL Serron, KTEL Kilkis, KTEL Chalkidikis covering mainly the peri-urban routes since May 2019). The use of private transport has increased over the last years in the city and especially during COVID-19 period while the use of public buses has dramatically decreased [6]. The street network of Thessaloniki's city centre is highly congested and delays are presented during peak periods as approximately 1,600,000 trips are made daily in the city and especially in the city centre [7]. Although public buses are the safer means of transport than private [8], the heavy traffic conditions, especially in the city center of Thessaloniki, increase the risk of traffic accidents. The severity of accidents inside urban areas was found to be influenced by variables such as: light and heavy vehicles (e.g. bicycles, buses), time of the accident, location, age e.g. [young (18-30 years) and older (>60 years)] and three collision types (sideswipe, fixed object, rear end) [9]. The EU average fatality rate in accidents involving buses in Greece was 1.5 per million population and 1.6 respectively [10]. The scope of this study is to analyze the traffic accidents involving public buses and those who were in proximity to bus stops.

2. METHOD AND DATA

The statistical analysis focused on the period from 01/01/2012 to 31/12/2021. The data, provided by the Thessaloniki Traffic Directorate, concern incidents that took place in the entire Regional Unit of Thessaloniki. Graphs were created in Microsoft Office Excel spreadsheets software. The statistical analysis focused on traffic incidents where, at least one vehicle, was a public bus. In addition, a spatial analysis referred to traffic accidents that concentrated near bus stops in order to define road's accidents blackspots.

3. RESULTS AND DISCUSSION

Figure 1 presents the total number of road accidents occured in Thessaloniki's urban and peri-urban area during the period 2012-2021. The number of road accidents lays between 1500-2000 for each year, with the exception of the last three years of 2019, 2020 and 2021 when the number of road accidents is reduced due to reductions of traffic. This was a result of the COVID-19 transportation regulations such as quarantine, SMS rules and teleworking which decreased the demand and volume of vehicle trips. Figure 2 presents the total road accidents involving public buses per year and the persons involved to those accidents for the last decade 2012-2021. It is mentioned that the last five years, a reduction is appeared as a result of the drivers' training (e.g. bus drivers), the increase in penalties for driver's behaviour and the appearance of COVID-19 which change people's habits. In addition, as it was mentioned above, people required to stay at home and to move only for certain purposes. Thus the reduction of vehicles' trips resulted to the reduction of traffic accidents. In this point, it should be referred that Thessaloniki is one of the cities worldwide which increased its bus fleet (+260 buses) during the COVID-19 period. Figure 3 corresponds to the type of accident involving public bus per year. For this reason, most accidents concern "passenger fall/injury", followed by "vehicle collision", "pedestrian struck by vehicle" and "collision with fixed object". This was a part of the statistical analysis performed for traffic accidents with public buses involved. Figure 4 presents a spatial analysis of accidents recorded near bus stops which highlighted the accident "blackspots" (or just black spots) where road traffic accidents have historically been concentrated. Generally, the results identified bus stops that service multiple lines or they are near significant land uses (e.g. hospital, ancient monuments, historical center) or near road junctions. These black spots need to be examined for a possıble transfer to a better point or to take measures and place traffic signs for greater attentıon to avoid accidents. Unfortunately, traffic accidents records near bus stops do not always accurately describe exact position, with limited accuracy on the correct bus stop (lane of traffic).

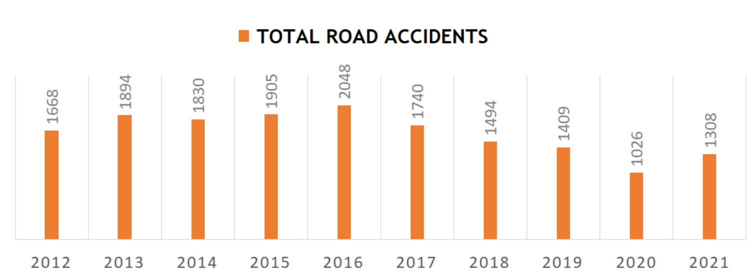

Figure 1. The number of total road accidents per year for the urban and peri-urban area of Thessaloniki

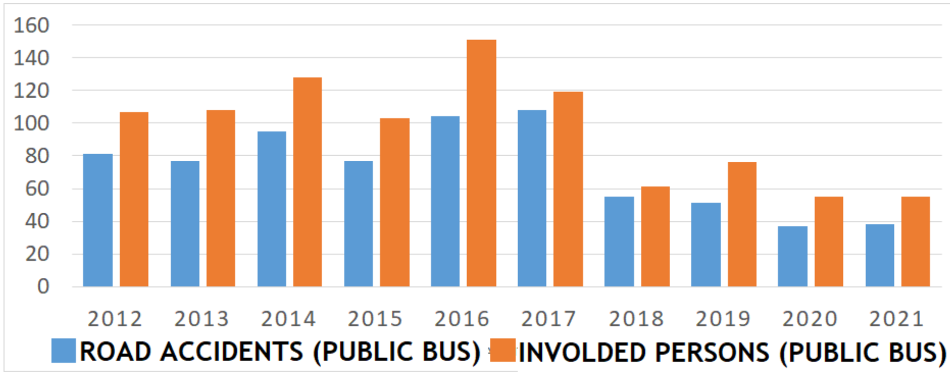

Figure 2. The road accidents involving public buses per year (in blue) and the persons involved in those traffic accidents (in orange) for the urban and peri-urban area of Thessaloniki.

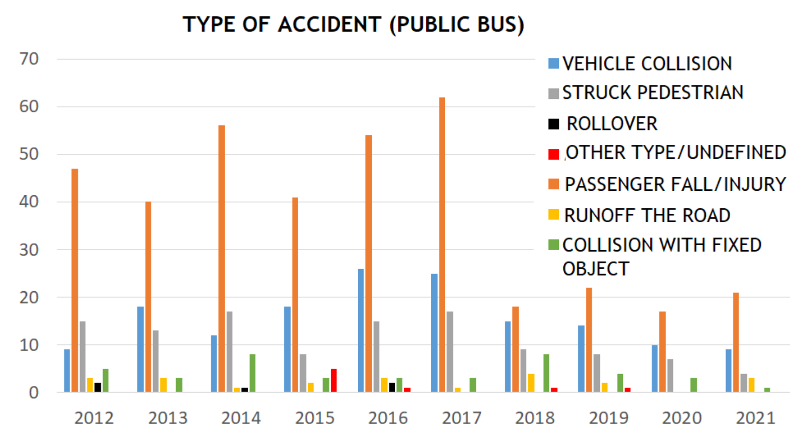

Figure 3. The type of accidents involving public buses per year for the urban and peri-urban area of Thessaloniki.

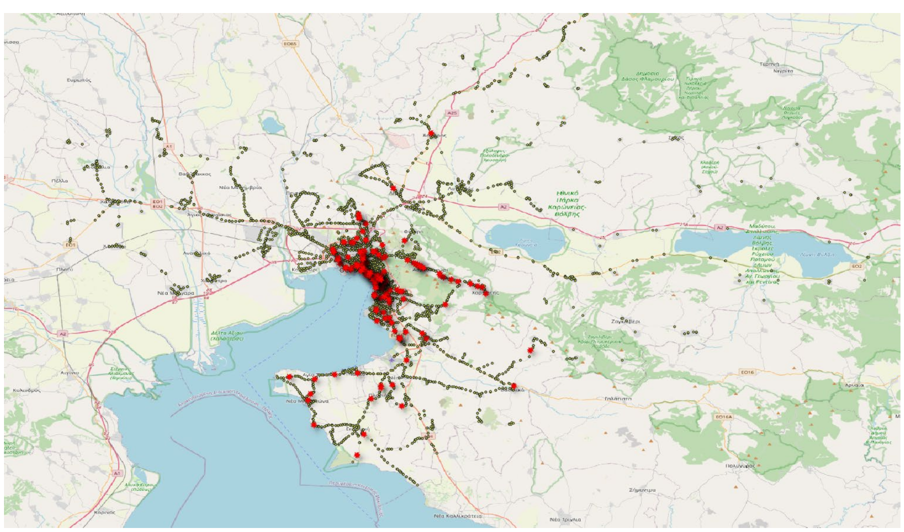

Figure 4. The accidents recorded near bus stops (in red) and the bus stops (in green) for the urban and peri-urban area of Thessaloniki.

4. CONCLUSIONS

Over a period of 9 years, the impact of bus shortage due to functional issues is imprinted on the total number of accidents. Although this shortage was resolved proportionally in late 2019, COVID-19 in 2020 and 2021 affected also the total number of accidents leading again to a low rate. It is of great interest that “passsenger fall” is the commonless type of public bus accidents and the “pedestrian struck” which comes in third place. This a matter that has emerged from this analysis and precautions should be taken in drivers and passengers’ enrichment of awareness with proper public seminars, demonstration events, etc. In addition, the spatial analysis highlighted the “black spots” related to specific land uses. Finally, there is a number of accidents near bus stops that cannot be extracted due to the lack of necessary information in the reports. Future recording using the GPS of the police vehicle or via mobile smartphone to record the coordinates (either in EGSA87 or WGS84) would enhance the procedure of crash recording and set the foundation of a more accurate vehicle-crash spatial analysis [11]. Finally, the construction of the new metro system, along with the redesign of the bus network and other future targeted transportation interventions (e.g. “Fly Over”), are expected to relieve the overall traffic in the center of Thessaloniki and hopefully decrease the rate of traffic accidents.

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STRUCTURAL SAFETY OF BRIDGES, ONE CONCISE AND EFFECTIVE WAY OF SCREENING OLD BRIDGES

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ABSTRACT
Overwhelming catastrophes on a global scale due to the major and essential crises of recent years, geopolitical, climatic and economic and health, which interact with each other, require changes in the way we respond and manage crises, with a holistic planning to immediately strengthen security, the functionality of infrastructures and by extension the durability of the built environment. Keeping the country's important transportation infrastructure fully operational is more critical than ever, especially during the unfolding of multiple crises. The inspection, recording and monitoring of bridges, among other transport infrastructures, which had been wholly overlooked and left to their fate, must be done not only systematically but also immediately. A "smart", fast and effective first-stage-screening of old bridges, is therefore proposed, in order to register in a single, easily accessible and interactive platform for data storage and processing, the existing bridges of the urban and the old national and provincial network, and in this way to identify those with the biggest problems. In a simple but systematic way, the wear and damage of the structures are recorded and distinguished according to their form, static system and other given mechanical characteristics, so that an Inspector in the field can have a first impression of the structural adequacy as well as the pathology of their possible failure (failure modes). The simplicity of the method enables the non-specialist Engineer to participate in the strengthening of social resilience by contributing to civil protection as the case may be. The second degree audit and treatment for the measures taken to avoid collapse and restore functionality is thus expedited, and is prioritized, targeted and more effective.

Keywords: Bridge inspection and monitoring, smart safety and functionality audit, road safety, social resillience, multiple crisis management, civil protection

1. INTRODUCTION
It is known that with the exception of the modern highway bridges built in recent years and subject to systematic inspection and monitoring, the bridges of the old national and provincial network are left to their own fate. There is even, sometimes, a confusion in terms of responsibilities between Regions and Municipalities, a fact that was shown very badly on the occasion of he recent case of the collapse of the Kavala bridge. In addition to the Kavala Bridge, which collapsed trapping two vehicles and a crane vehicle, without, fortunately, there being any casualties, there is also the Iasmos Bridge in Rhodope region which collapsed two years ago. In the Region of Central Macedonia, we have the bridges of Nestos and Axios, whose bearing capacity is known to be insufficient. There is also the known for the many problems of the bridge of the elevated road connecting the port of Thessaloniki with Kalochori, PATHE and Egnatia Odos. As far as the cost of rehabilitation of Greek bridges suffering from structural inadequacy is concerned, this is estimated to be in the order of several billion euros. Of course, this problem is not only national but global.
As of 2003, it was known in the US that to cover the maintenance and rehabilitation needs of 27.1% of its 590,750 bridges, which presented corrosion and serviceability problems, $9.4 billion was required annually for the next 20 years (ASCE 2003). After the collapse of a 40-year-old bridge in Minneapolis on

August 1st, 2007, which swept 50 cars and 133 people into the abyss, the American public was surprised to learn that engineers had issued similar negative reports for another 74,000 bridges that were deemed "inadequate in structural level". Engineers and officials rushed to call for repairs to those bridges, but emerging estimates for the total cost of the necessary repairs were approaching $188 billion. Congress then appropriated just over a billion dollars for repairs, or $13,500 per bridge.
According to another relevant survey of the same period (U.S. Department of Commerce Census Bureau), the economic consequences of bridge erosion are estimated, as direct annual costs, at 6.43 to 10.15 billion dollars. Of this, $3.79 billion is for structural bridge rehabilitation that will be required over the next ten years, $1.07 to $2.93 billion for deck slab maintenance, $1.07 to $2.93 billion for bridge maintenance (excluding deck), and $0.5 billion for metal bridge maintenance painting. All this adds up to an average annual maintenance cost of $8.29 billion.
Furthermore, in the full cost analysis, projecting the above costs into the next decade, based on more recent data and taking into account the indirect social costs due to delays and lost productivity from poor traffic operation, one should add to the above direct costs, more than tenfold amount.
Regarding our Europe, recently in France the Minister of Transport estimated that 1/3 of the country's 12,000 bridges need strengthening. In fact, in 7% of cases the situation is considered dangerous for collapse and needs immediate treatment. For this reason it is recommended to limit the loads on them. Also in Italy they estimate that around 300 bridges are at risk of collapse, such as the already mentioned Genoa bridge At the same time, in Germany, only 12.5% are judged to meet modern requirements. The rest were clearly not designed for today's traffic loads. in Germany, the cost of maintaining bridges is 1% to 3% of the cost of their construction, annually (i.e. approx. 500 million Euros per year) [1].
The planning phase is of critical importance for ensuring the durability of R/S structures, a fact that was already demonstrated in 1994 in a relevant research in Germany. According to it, even a limited increase in the construction budget of a bridge is enough to drastically reduce its maintenance costs [2,3]. In particular, it is stated that the costs for the restoration of durability problems increase by a ratio of 1:5, if they are not properly predicted and dealt with, already in the design phase, and the required interventions in the project are made after the appearance of the damage. The partial change of the static system in the rehabilitation study phase and the construction methodology of the interventions can minimize wear and damage and significantly extend the remaining technical life of α bridge
Bridge maintenance and rehabilitation costs can be drastically reduced and their management can be optimized and accelerated through the appropriate grouping and standardization of maintenance and rehabilitation interventions, especially when a large number of structures are involved. For this reason, the practicality and appropriate classification of structures in a single monitoring-register, based on form, structural and static characteristics, construction methodology, maintenance requirements and cost-benefit ratio for the remaining technical time is of particular importance.
Until now and at least as far as Greece is concerned, the Budget of a bridge construction project to be tendered is a selection criterion, but it is not related, at all, to the expected cost of its maintenance, let alone to its total technical life time. This has the consequence of choosing between the cheapest offers and implementing solutions that achieve minimum construction costs, but in no case, minimum total costs for the Technical Lifetime of the project. This fact has the consequence that durability issues do not weigh on the design of bridges to the extent that would be appropriate in a country like ours, where care for the maintenance and restoration of technical road works is insufficient to non-existent [4].
Therefore, in order to make at least the beginning in the establishment of an Active National Register of Bridges, an effective first stage screening is proposed, in order to list the existing bridges and identify those with the biggest problems and vulnerability. Then to be examined directly by a higher-level

Committee, “second-stage-Checking” which will propose the measures to be taken to avoid collapse, after conducting a more detailed check compared to that of the primary Committee [5].

2. SAFETY AND FUNCTIONALITY

What does safety mean in transport infrastructure? how is it related to their functionality or failure? What is the role of civil protection in social resilience in terms of infrastructure security? The exercise of civil social protection is one of the fundamental responsibilities of regional or local authorities and their contribution is crucial in the effort to improve the quality of the provided security services and cooperation with the users of the infrastructures. Issues of empirical crisis management in this context of infrastructure security and its importance in dealing with natural or technological disasters should be raised from experience, e.g. of the bad weather named "Oceanis" in February 2019, the recent earthquakes in Thessaly, Samos and Crete and even the health crisis of the COVID-19 pandemic.

Resilience can be built in not only with hard engineering (structural and hydraulic) works but also with preventive measures, with collective actions of inspection and "light" bridge and river bed maintenance, for example by clearing banks, removing mature tree growth and removing fallen trees upstream of the bridge, by preventing deterioration of the waterway, and by notifying to the competent regional authorities of obvious wear or damage to the deck and its approaches or the safety barriers and the bridge lighting, or the need to carry out de-silting and disposal of the waterway to ensure that all river spans and any useful flood relief openings or arches are clear and open.

Regarding the bridges of the "old national" and regional road network in Central Macedonia, a significant number of them are under inspection for possible serious damage, due to their many years of use and many problems associated with high traffic of heavy vehicles as well as many seismic events and catastrophic floods. Particular importance could be given to the synergy of Civil Protection and competent technical services of the regional authorities for the preventive management of bridges and crisis management.

2.1 Inspectıon Form for Screenıng Old Brıdges

Prelımınary Screenıng Form

Using the experience of inspecting bridges after a major earthquake the scientific group [5] prepared a feasible form for determining the most vulnerable bridges. The form includes all the typical and important static systems of the older Greek bridges and provides a description of the wear (corrosion) or damage as well as the level of damage in deck, girder and piers. According the severity of damage we can classify every bridge in red, yellow and red category (Table I). For red cases regional authorities should forbiden traffic. After the first stage screening a second one should follow, to finalize the findings and weak-vulnerable points and to propose the design solutions and the bridge rehabilitation and strengthening method. In Figure 1 guidlines are given to help complete the inspection form.

3. CONCLUSIONS AND DISCUSSION

A 'clever' effective and concise way to check a large number of bridges in the region of Central Macedonia is presented. The problem of maintenance of old bridges is critical in Greece and especially in Macedonia. After a lot of bridge failure events, recently, in Greece and abroad, an effort to find the most dangerous cases in the regional road network in Central Macedonia, has been started. The presented tool addresses the aforementioned issue with social responsibility in an practical and way and synergistically. Parallel objectives of the present proposal for the fast creation of an easy-to-use and interactive Register of Bridges at the Regional level are the (a) Holistic Approach and Re-design for Infrastructure Resilience (b) possibility of timely creating a Road Safety and Civil Protection Observatory for the transport infrastructure (c) Civil Protection as a factor of the holistic approach to City Resilience.

Table1 Inspection form for screening old bridges

HELLENIC REPUBLIC REGION OF CENTRAL MACEDONIA TECHNICAL PROJECTS DIVISION TRANSPORTATION PROJECTS SUBDIVISION	PRELIMINARY SCREENING FORM		REGIONAL UNIT - MUNICIPALITY
INSPECTORS NAMES	1. .... 2.	Reg. Number	Date
BRIDGE POSITION (e.g. Kleidi-Kouloura)			
BRIDGE SKETCHES Number of spans Total length			
Structural System (see GUIDELINES at the second page)	1. Underpass Bridge............ 2. Overpass Bridge............ 3. Cast-in-situ Beam Bridge............ 4. Slab Bridge............ 5. Box Girger Bridge............ 6. Precast-Prestressed Bridge............ 7. Gerber Bridge............		

DAMAGE ASSESSMENT		
	BRIDGE CONDITION	DESCRIPTION
GREEN	No damage in critical elements - No reduction in bridge capacity	
YELLOW	Local damage in specific bridge elements that need restoration - No reduction in bridge capacity	
ORANGE	A more detailed assessment of bridge capacity is needed to be carried out (see GUIDELINES at the second page)	

The second page, i.e. the page of GUIDELINES, may also be used for comments.

THE INSPECTORS

1. ....

2. ....

GUIDELINES		
Critical regions and definitions of critical damage are suggested for each bridge structural system		
Structural System	Critical Regions	Critical Damage
1	Inner faces of the slab and of the side walls	Longitudinal cracks at the central region of the deck slab, spalling and exposure of main reinforcement bars.
2 to 7	Lower deck face	Flexural cracks at the central region of the deck, shear cracks close to the supports and especially in case 7 flexural cracks at the supports. Spalling at slabs and beams and exposure of reinforcement bars and tendons.
Bridge Structural Systems and the corresponding Critical Regions		

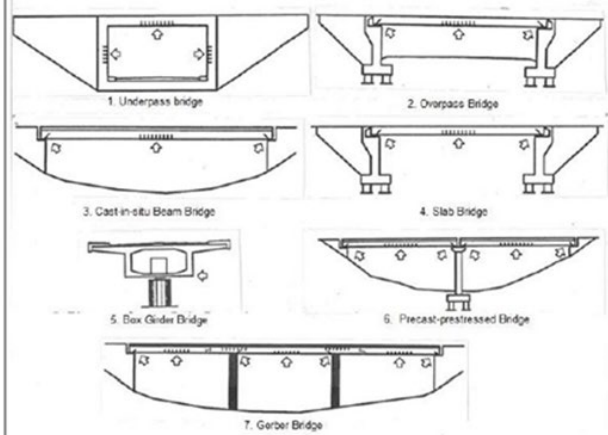

Figure 1 Critical Areas of Damage and Typical Bridge Forms

AKNOWLEDGMENTS

The authors wish to thank the Working Group established for this purpose of Bridge Structural capacity Screening. Special thanks to Ms. Mitrakaki, for her technical support both in the Working Group and in the permanent Committee for Natural Disasters.
This work is dedicated to our unforgettable Professor Ioannis Tegos, who with his valuable morals and profound scientific knowledge made us better people. His unexpected death did not yet allow the presentation of the results of this work which we believe gives to the problem of the above subject a rationalized and effective solution.

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CRITICAL INFRASTRUCTURES CONSTRUCTED UPON SUSCEPTIBLE TO LİQUEFACTION SEDIMENTS: THE CASE STUDY OF NESTOS RIVER

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ABSTRACT
This study focuses on the delineation of liquefaction susceptibility zones in Nestos river delta (Thrace). Existence of tectonic structures capable to trigger large earthquakes in the broader area of Thrace and high potential onshore active faults in correlation with the critical infrastructures constructed on the recent and upper Holocene sediments of Nestos river delta plain made the assessment of susceptible deposits crucial. Liquefaction susceptibility at regional scale is assessed by taking into account information dealing with the depositional environment and age of the surficial geological units. Using data provided by geological mapping of HSGME, satellite and aerial imagery, and topographic maps, dated before the 1970's when extensive modifications and land reclamation occurred in the area, we were able to trace fluvial and coastal geomorphological features like abandoned stream/meanders, estuaries, dunes, lagoons and ox-bow lakes. This geomorphological-oriented approach clearly classified the geological units according to their depositional environment and resulted in a more reliable liquefaction susceptibility map with 4 classes of susceptibility Low, Moderate, High and Very High. Particular attention was drawn to the critical infrastructure of Kavala International Airport "Alexander the Great", which is located in susceptible sediments.

Keywords: *:* liquefaction, susceptibility, satellite imagery, aerial imagery, Kavala International Airport

1. INTRODUCTION AND OBJECTIVE

Liquefaction is a natural process that can be triggered by earthquakes in saturated loose sandy soils covered with impermeable sediments within a certain distance from the epicenter of an earthquake. The liquefaction susceptibility of a deposit at regional scale is assessed by taking into account information dealing with the depositional environment and age of the soil unit. In particular, the depositional process affects the liquefaction susceptibility of sediments since fine and coarse grained soils sorted by fluvial or wave actions are more susceptible than unsorted sediments [1]. It is widely accepted that the procedure that should be followed for the liquefaction susceptibility assessment is based on published methodologies [2-5].
The geomorphological studies carried out the last decade in New Zealand Japan, Italy, and Greece, feature that variations in river morphology and associated depositional settings of sediments influence the observed manifestations of liquefaction phenomena [6-11]. Specifically, looking at the distribution of the liquefaction features, it is clearly shown that they are not randomly distributed over the areas but are mostly arranged in clusters and rectilinear or meander-like alignments [12]. Therefore, it is crucial to apply a geomorphological-oriented screening of the deposits, aiming to further discriminate the geological units based on their depositional environment and resulting to a more reliable map regarding the susceptibility to liquefaction of the sediments.
Though the fact that Thrace is considered as a low seismicity area comparing to other regions in Greece, it was decided to assess the liquefaction susceptibility of the deposits due the critical infrastructures

that have been designed and constructed within the study area the last 40 years. Considering that a liquefaction susceptibility map can be used as a guide to delineate the most prone to liquefaction areas, the goal of this study is to assess the liquefaction susceptibility of soil deposits mapped at the floodplain of Nestos River with particular attention drawn to the location of Kavala International Airport "Alexander the Great" (KVA).

2. METHODOLOGY

In order to assess the liquefaction susceptibility of Nestos river delta, we used data provided by geologic maps published by EAGME, of 1:50000 scale, as a base layer. However, the lack of detail in this map, concerning the classification of Holocene and Pleistocene sediments and the depositional environment of soil units, increased the necessity for the use of supplementary data such as satellite images, aerial imagery and topographic maps.

The area of Nestos delta is dominated by irrigation crops, and with the majority of current modifications and land reclamation taking place after the second half of 1960's, older imagery was needed. Orthophoto maps of 1945 provided by Hellenic Cadastral organization was used as a basic imagery layer. We also used declassified satellite imagery from USGS/NARA dating back to 1960 and 1968. Thus, aiming to compile a geomorphological-oriented screening of the river deposits instead of a simplified geological one, using remote sensing data we were able to delineate specific fluvial and coastal geomorphological features. More recent land reclamation and surficial changes were added using Sentinel-2 and Google Earth images. In addition, information provided by literature and field surveys were used for validating the outcome regarding the spatial distribution of deposits.

Through geomorphological mapping, it was observed that the west side of the plain is covered mostly by fluvial deposits of abandoned river beds and deltaic deposits. This fact is consistent with the geomorphological evolution of the area, since before 1945 the estuaries of Nestos river were placed in the west part of the plain, where anthropogenic factor had not gained so much influence. Today in this area is situated the Kavala's International Airport (KVA).

3. RESULTS AND DISCUSSION

As a result of this approach, it was shown that despite the fact that geological maps are widely used for regional liquefaction susceptibility assessment, the application of geomorphological maps could be a more precise and reliable alternative for assessing liquefaction potential of a floodplain. In order to assess the importance of this outcome, Youd and Perkins (1978) criteria has been performed, based on the information of the age and depositional environment of the sediments. To apply this method, the geological units of Nestos River floodplain were classified into three categories, pre-Quaternary (fluvial and coastal deposits), Holocene (marshy and lagoonal deposits) and Pleistocene sediments. Thus, sediments, which were formed the last 500 years are classified as high to very high susceptible to liquefaction, Holocene as moderate to low and Pleistocene as non-liquefiable.

Thus, a liquefaction susceptibility map was developed, classifying Nestos River delta in 4 susceptibility classes: Low, Moderate, High and Very High. According to this detailed liquefaction susceptibility map, 85.56km2 (16.66%) of the study area classified as a very high susceptibility zone, covered mostly by fluvial deposits. Presence of these deposits is more extensive in the western part of the plain due to the recently abandoned estuaries of Nestos, which were dried after entrenchment and diversion of the river. After those modifications in delta plain land, Kavala International Airport (KVA) was constructed in early 1980's.

In particular, according to new geomorphological map, the airport has been constructed over the old/abandoned Nestos river channels. Consequently, the airport's area is classified as high to very high susceptible to liquefaction. Thus, is emphasized the importance of the detailed geomorphological mapping of soil units for accurately assessing the liquefaction susceptibility. In addition, is highlighted the necessity of conducting a detailed geotechnical investigation based on in-situ tests at the area of airport for evaluating the liquefaction potential of soil units and the relevant induced displacements.

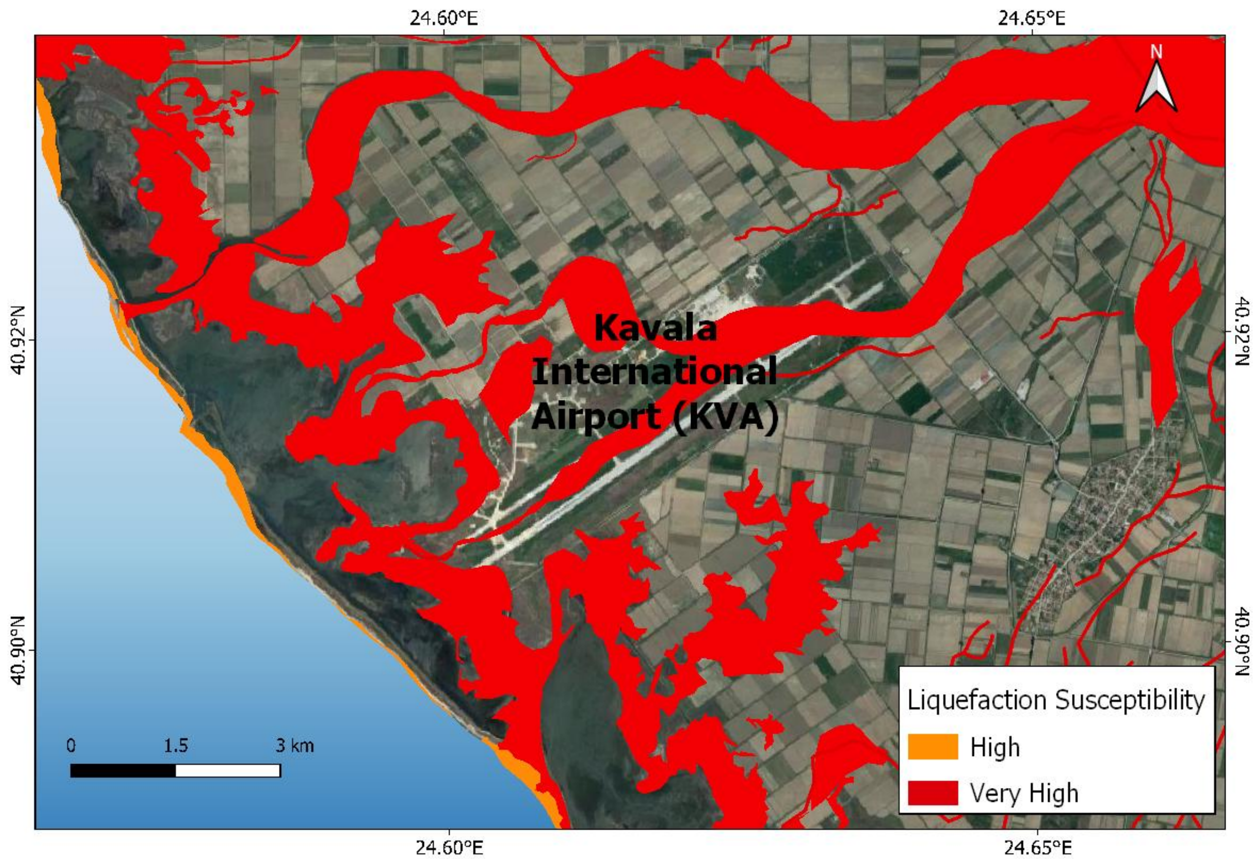

Figure *1.* Liquefaction susceptibility map focusing in the critical infrastructure of Kavala International Airport (KVA) based on the new geomorphological map produced by processing of satellite and aerial imagery.

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SANDMAP: AN EDUCATIONAL PLATFORM TO ENHANCE CRISIS MANAGEMENT SPATIAL INTERACTION

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ABSTRACT
Responding to, recovering from and preparing for a disaster requires a coherent set of accurate and up-to-date geospatial information of appropriate scale and precision. On an operational level, analysis of this multi-source information is carried out by crisis experts and decision makers. The plethora of technological tools available in the market to support decision making have been developed to aid humans towards a concrete set of actions. Thus, although these tools support effective processing and visualization of the crisis-related geospatial information, the bottom line is that humans have to take the appropriate decisions. Hence, the capability of the human brain for fast perception, appropriate understanding, and agile reaction upon geospatial information is of outermost importance in disaster crisis management. This work presents a prototype educational platform called SandMap, which aims to enhance crisis managers' spatial understanding and subsequently improve the effectiveness and correctness of their decisions.

Keywords: spatial intelligence, SandMap, decision support, geospatial information.

1. INTRODUCTION
Geospatial information and technologies derived by geographic information systems, remote sensing, ground instruments, crowdsourcing, etc. are employed in all stages of the disaster risk management cycle: mitigation, preparedness, response, and recovery [1]. Unsurprisingly, major investments are made by both the private and public sector towards the advancement of these technologies in an effort to meet the end-user requirements. These investments focus on infrastructure, instrumentation, and processing techniques. Interpretation of the data is often carried out on a manual/visual way, aided by computational analysis techniques [2].
Irrespectively of the method employed to analyze and interpret the available geospatial information, there is an evident role of proper understanding of the impact that space involves, on effective disaster management. Spatial intelligence may be defined as adaptive spatial thinking which supports diverse domains such as medicine, meteorology, mechanical reasoning, and physics problem solving [3].
This work presents an easy-to-deploy educational tool to support visual-spatial intelligence for crisis related decision makers. Section 2 details the architecture of this tool and the basic instrumentation used. Subsequently, section 3 presents some practical examples of how this tool may be used towards a more efficient disaster management system. Finally, Section 4 discusses the next steps towards the realization of this tool in real-life environments and ways to quantify its impact.

2. IMPLEMENTATION
The augmented reality sandbox first introduced by UC Davis [4], has been modified and used as an interactive tool in several scientific domains such as geosciences, natural sciences, mathematics, civil and construction engineering, etc. [5].

Under its first implementation, the UC Davis' sandbox consists of a depth sensor, a projector and a physical box filled with sand. The concept underlying the sandbox functionality is to project a visualized form of the surface on top of the sand. This visualized form can be either a display of different colors based on the elevation of the sand or even a projection of realistic graphics representing how the landscape might actually look like. The distinctive feature of the UC Davis' sandbox was the simulation of hydrologic dynamics, meaning that the user can study the behavior of watersheds on different terrains. Another tangible Geographic Information Project (GIS) is SimTable [6]. This project relies on agent-based modeling and ambient computing and has been tailored for emergency management. The interaction with the sand is made using a laser pointer. In Simtable the user has to define a vast number of parameters that affect both the simulation of the natural disaster and the response to it. Thus, it requires significant expertise by its users although it can certainly be used in assisting search and rescue teams and fire brigades.
In our approach we implemented SandMap (figure 1), a similar product, yet, encompassing updated instrumentation and a series of software related advances [7].

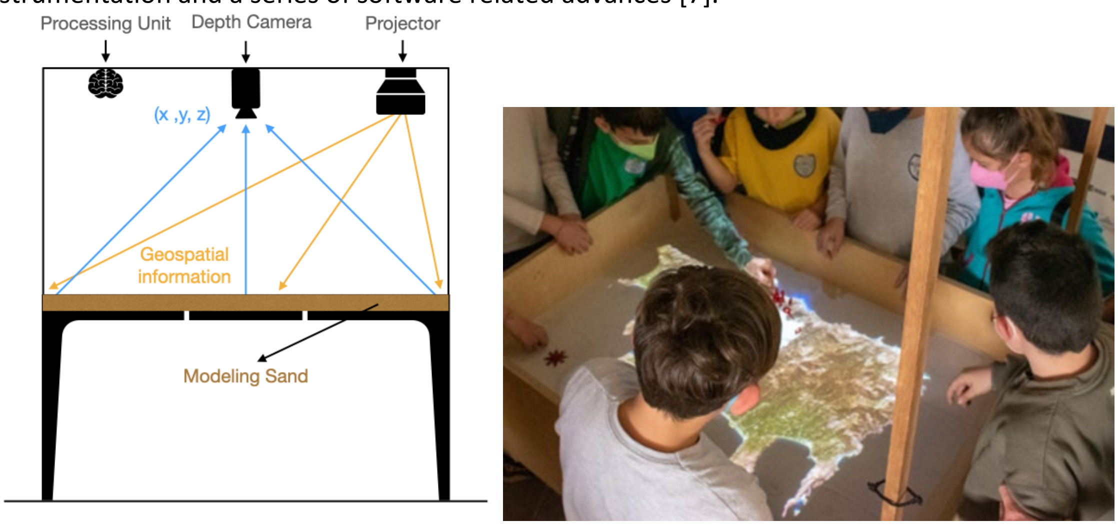

Figure 1. The SenseLab's SandMap architecture (left) and its demonstration (right).

Our SandMap's modularity in terms of cameras and projectors is secured by the development of a control software which automatically identifies the area illuminated by the projector and subsequently projects the available spatial information to this area. Another, novelty of the SandMap's design is its user centralized approach. This is accomplished by incorporating functions like object localization, motion tracking and gesture controls. Thus, the user can effectively interact with the presented scenery by placing objects at specific locations and test different outcomes (e.g., change the starting point of a fire or of the closest firefighting station). Additionaly, the gesture controls allow the user to change the parameters of a phenomenon (e.g., speed of fire expansion) or save the current scenario without losing focus from the SandMap surface by controlling the device from a connected computer. Another, feature of SandMap is the use of transparent material (plexi-glass) to hold the sand in order to move to pure 3D experience. This, way the user can see a section of the presented area and concurrently observe the height and inclinations along with the other two dimensions.

3. SANDMAP AND WILDFIRES

In order to demonstrate the functionality and specific features of our SandMap implementation in effective natural disaster management and training, a wildfire paradigm was taken into account. This task was accomplished in four phases:

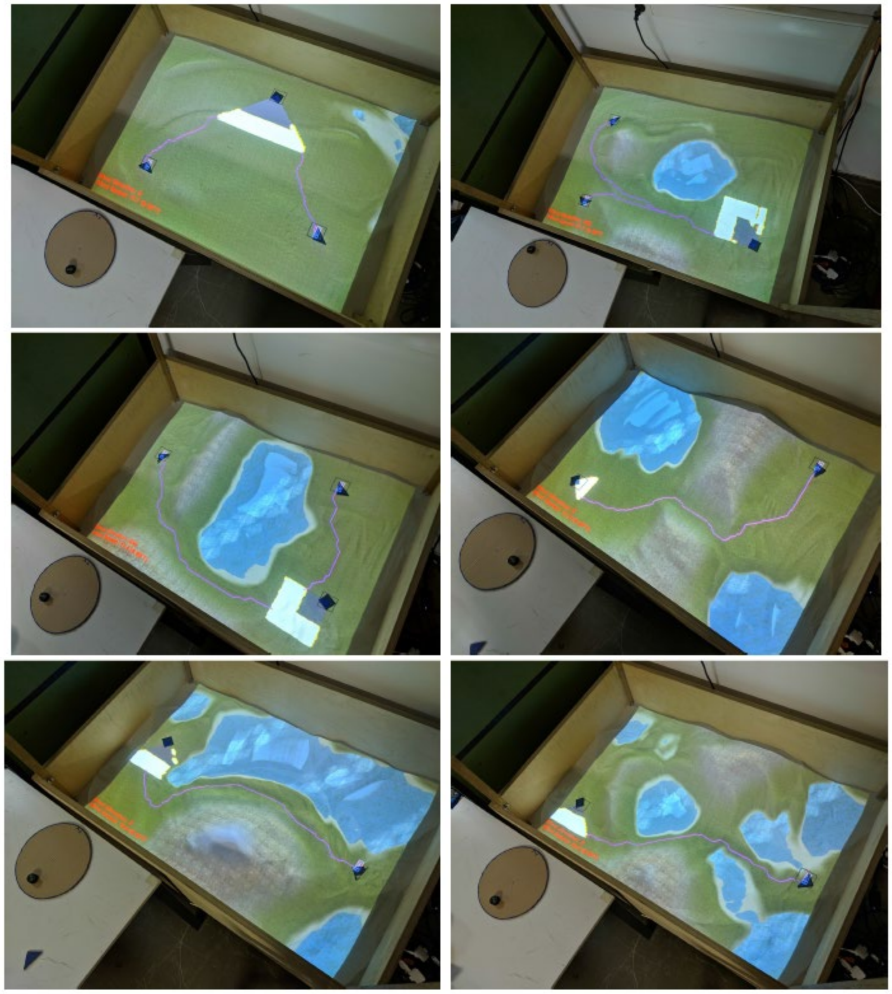

Figure 2. Firefighting simulation using the SandMap. Different scenarios result in different, easy to be interpretated visualizations of the fire spread and the optimal pathfinding route.

1. *Tangible GIS*: Here, digitization of the physical model and the generation of its 3D model was made. Then, this 3D model is projected on the sand, so that the users can observe and interact with it.
2. *Wildfire Model*: The cellular automata model for forest fire spread prediction published in [8] has been adopted after several modifications. The basis of this type of algorithms is its grid, that is a two-dimensional array of square cells which represent a pixel-sized part of the land and contain all the propagation data in the form of variables. While the slope of the land as represented by the sand is calculated by the SandMap, other variables which affect the fire propagation have to be known for each cell: vegetation type and density, wind speed and direction, initial state of each cell, etc. After selecting three types of land based on its vegetation type and density, four states of each cell have been defined: inflammable, flammable but not burning yet, burning, flammable but burned out.
3. *Minimum Cost-Path Finding*: SandMap automatically calculates the optimal path which would take all the fire-fighters from their starting point to the fire front in the least amount of time and effort. This is accomplished utilizing the weighted A* algorithm [9]. This tool may be also used for the evaluation of the evacuation plans if, for example, a city/village is in the proximity of the simulated fire front.

4. *Object Detection*: In this feature, objects of different colors and/or shapes can be placed on the sand. These objects are automatically detected and correspond, for example, to the location of the fire brigade vehicles, the start/end point of the fire, meteorological stations, etc. In order to ensure that the location of the detected objects is correct, a two-stage calibration procedure is carried out.

Fig. 2 illustrates the final results of the end product after implementing these phases

4. CONCLUSIONS

There is a growing need for tangible GISs to visualize any change in the landscape as, for example, in the case of a natural disaster (landslide, wildfire, flood, etc.). Based on previous tangible GIS products which use sand to represent the landscape, the SenseLab team has devised, manufactured and tested a novel multi-functional platform. Key innovations such as the adaptability in diverse depth cameras and/or projectors, automated minimal pathfinding, object detection, modular box design, etc. have been implemented and demonstrated.

In the case of natural disasters management, this work provided evidence on how SandMap may be used not only for educational purposes but also on an operational scale. Next steps include the demonstration of the system in real-life environments in order to provide qualification and quantification criteria and score on the enhancement of users' spatial and visual comprehension.

AKNOWLEDGMENTS

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CIVIL PROTECTION FIELD EXERCISES FOR FOREST FIRE PREPAREDNESS AT LOCAL LEVEL: THE EXPERIENCE OF REGION OF ATTICA, GREECE, DURING THE 2022 FIRE SEASON

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ABSTRACT
Civil protection exercises are considered the most effective tool for improving the preparedness of civil protection mechanism to respond to a disaster and to handle the emergency needs. To this end, Region of Attica organized the Field Exercises "AENEAS 2022" during the fire season of 2022. The aim was to test the forest fire emergency operational plans and to enhance communication and collaboration among the involved agencies. The exercises involved first responders, municipalities and NGOs and took place in four sites (Poikilo Oros, Mount Aigaleo, Piraeus - Profitis Elias, Salamina İsland-Kanakia). New technologies have been employed to support “AENEAS 2022” and specifically: a) A specialized G.I.S was developed that allowed the generation of maps illustrating the exercise scenarios and sharing the maps with all involved. In addition, the system supported the evaluation of the exercises through online questionnaires and the qualitative analysis of results. b) Unmanned Aerial Vehicles (UAVs-drones) were used to collect and transmit information on the situation on the ground. The whole process added experience in civil protection exercises and contributed to the continuous efforts to improve disaster preparedness in the region.

Keywords: fire season, civil protection exercises, Region of Attica, forest fire preparedness

1. INTRODUCTION
The devastating forest fires that occurred in Greece in August 2021 are associated with the extreme heat waves that were recorded in Greece and the wider area [1]. Recent research by the National and Kapodistrian University of Athens featuring climate simulations, indicates that the intensity, the frequency and, most importantly, the duration of future heat waves is expected to increase gradually by 2050. These factors lead to the formation of extreme dry combustible matter, which in turn leads to rapid spread of forest fires that are hard to extinguish [1,2]. Therefore, Attica, as well as other Mediterranean regions, must face the climatic conditions, along with their consequences, such as forest fires. Therefore, climate crisis must be at the epicenter of the country’s fire protection planning in all phases of forest fire risk management and especially during the pre-catastrophic phase.
Preparedness in disaster planning involves measures that are being implemented in advance, in order to ensure an effective response to emergencies and disasters that may arise. Preparedness is based on four main components: 1) Emergency plan set up, 2) Supplying equipment, 3) Training, and 4) Exercise [4]. Exercises allow us to evaluate the efficiency and effectiveness of the emergency plan and its components and to test the systems, facilities and personnel involved in plan implementation. Furthermore, exercises are carried out to test and ensure effective communication among organizations, to identify weaknesses, to test response time and finally to generate necessary changes. Exercises are designed based on the desired goal and may vary from simple to complex. The types of exercises may be classified as follows [3,5,6]: a) Table-top (or theoretical) exercises designed to trigger discussion, b) Field (or practical) exercises, focusing on the implementation of actions.

2. FIELD EXERCISES “AENEAS 2022” IN THE REGION OF ATTICA

2.1. Aim and objectives

The Practical Field Exercises "AENEAS 2022" aimed at testing the operational emergency planning for forest fires and at enhancing communication and collaboration among the parties involved, thus improving interoperability.

The objectives of “AENEAS 2022” were: 1) To test and improve the cooperation among the involved organizations, 2)To improve communication, coordination and information management, 3) To identify and assess the necessary resources (human and materials), 4) To test the procedures for the convention and operation of Coordinating Bodies of Civil Protection at the level of Regional Unit (SOPP) and at the level of Municipality (STO) in case of an emergency, 5) To assess decision-making under pressure by simulating emergency conditions, and 6) To test the preparedness of volunteer groups and foster their internal cooperation. [5]

2.2. Exercise design and organisation

The Field Exercises “AENEAS 2022” were conducted in four different areas (Poikilo Oros, Mount Aigaleo, Piraeus - Profitis Elias, Salamina İsland-Kanakia), all located within the administrative boundaries of the Attica Region (Table 1, Figure 1).

.**Table 1.** Information on Field Exercise AENEAS 2022

Code name of Field Exercise	Regional Unit in which the Field Exercise took place	Location of Field Exercise	Date of Field Exercise
AENEAS 2022	West Athens	Poikilo Oros	15/04/2022[1]
AENEAS 2022	West Athens	Mount Aigaleo	15/04/2022[1]
AENEAS 2022	Piraeus	Piraeus - Profitis Elias	07/06/2022
AENEAS 2022	Islands	Salamina İsland-Kanakia	09/06/2022

[1] The Field Exercises at Poikilo Oros & Mount Aigaleo were held on same day at different hours

(a) (b)

Figure 1. Photos taken by UAV (drone) camera during practical field exercises "AENEAS 2022": (**a**) Approach of fire trucks to the point of fire dawning. (**b**) The Coordinating Body of Civil Protection at Regional Unit’s level (SOPP) coordinates the enterprise at Poikilo Oros.

The exercises were organized by the Region of Attica with the crucial support by the Fire Service and followed the guidelines on civil protection exercises issued by the General Secretariat of Civil Protection [5]. Depending on the site, the numerous operational and other entities (among the civil protection volunteer organisations) that took part were affiliated to the following: Region of Attica, Decentralized Administration of Attica, the respective Municipality, Hellenic Navy, Hellenic Coast Guard, Hellenic Police, Traffic Police, National Emergency Care Centre.

3. EVALUATION OF AENEAS 2022

The evaluation procedures were designed to assess the degree of achievement of the aim and objectives of the exercise and to identify strengths, areas for improvement and corrective actions.

The evaluation comprised the following: a) a hot-wash session at the end of the exercise, where initial feedback from all the participants was given, b) an analysis of data and information on the difference between the real performance in the exercise and the planned or intended performance, c) a detailed analysis of video recordings by an UAV (drone) aiming at a better understanding of the situation on the ground and actions that took place, d) an evaluation provided by assigned evaluation teams, and e) evaluation by all participants after the exercise through filling in evaluation forms either in hard-copy or in digital form (QR scanning by smartphone or tablet). The responses to the questions in the evaluation form were provided in a ranking scale from 1 to 4 assessing the respondent perception of the degree he/she thinks that the activity/procedure in focus met the expected /planned outcome (1 depicts the worst ranking and 4 the best). The results were analyzed and the average score can be found in Table 2.

Table 2. Quantitative analysis of the responses provided in the evaluation forms

Objectives	Average ranking "Poikilo Oros"	Average ranking "Mt Aigaleo"	Average ranking "Piraeus"	Average ranking "Salamina"
Cooperation	2.75	4	3.7	3.5
Coordination/communication/information management	3	3.4	3.7	3.4
Identification of and assess the necessary resources	4	4		4
SOPP & STO operation [1]	4	4	4	4

[1] Evaluation provided only by the evaluation team assigned.

According to the results (Table 2), the cooperation level among the actors, as well as the coordination and the communication level were considered very good. The Coordinating Bodies of Civil Protection demonstrated their preparedness and decision-making skills in simulated emergency conditions with success. The overall procedure depicted an exemplary way for the conduction of a Special Meeting in the case of an emergency. The Chief Operational Fire Officer explained the emergency situation to the responsible representatives and a discussion followed, where all the possible scenarios were analyzed and all the resources were identified.

As specified by the feedback obtained: a) emphasis should be given to the participation of more Volunteering teams in the exercises, as their involvement in the civil protection mechanism is crucial. b) The usage of a common communication channel for all the involved units during an emergency would save time and facilitate the communication among the authorities, ensuring all information delivered.

Furthermore, one of the main objectives of the Practical Field Exercises "AENEAS 2022" was to test the readiness of the participating volunteer organizations and the cooperation among them. During the Practical Field Exercises "AENEAS 2022", various volunteer organizations actively participated in the scenarios, working closely with the official operational bodies, thus strengthening the bonds of neighborliness and cooperation among them.

Finally, the exercises were considered by the majority of participants well-organized, the scenarios were found realistic with small weaknesses. In some cases (Poikilo Oros) it was pointed out that the opportunities to express an opinion were not enough.

4. DISCUSSION AND SUGGESTIONS

The Field Exercises "AENEAS 2022" were advanced in many respects. First, they stemmed out of overcoming usual difficulties in the public sector and achieving the cooperation of many different agencies in less than 20 days. Second, they employed the development and use of a specialized G.I.S that allowed the generation of maps that illustrated the exercise scenarios and were shared by all involved during the exercises, as well as an evaluation through online questionnaires and qualitative analysis of the results. Moreover, all four exercises involved the use of UAVs (drones) which provided real-time high-quality images & videos to the Civil Protection Coordinating Bodies in the field.

Overall, the target and the objectives of the exercises were accomplished as shown by the evaluation results, because the operational planning was successfully tested, the cooperation among the operational bodies involved was enhanced and interoperability was fostered.

Additionally, the experience gained from “AENEAS 2022” indicated the importance of drones in civil protection exercises. The drone flights carried out during all four exercises providing footage that led to gaining a better knowledge of the situation. Furthermore, UAVs also contributed significantly to acquiring and transmitting information on the situation on the ground and to better decision making based on awareness of the real situation. For example, monitoring the road network allowed for better decisions, as regards the safety of the evacuation routes.

Concluding, our future efforts will target civil protection exercises that can provide a fuse for raising awareness to the public with back-to-back activities regarding self-protection measures.

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FIRE RISK ASSESSMENT IN THE REGION OF EAST MACEDONIA AND THRACE

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ABSTRACT
This work presents an approach for fire risk mapping over the Region of East Macedonia and Thrace (REMTH). Fire ignition records acquıred from NASA's Fire Information for Resource Management System (FIRMS) and the Hellenic Fire Brigade, were analyzed using spatiotemporal clustering analysis to indicate fire locations in the study area, for the period 2000-2020. A random forest model using fire density points was developed based on human related factors, topographic and bioclimatic variables, land use/land cover, and vegetation density data. The fire risk zones produced by the random forest model presented satisfactory accuracy. The results of this study indicate that 52.7 % of the study area is at high and very high fire risk. Moreover, the results highlight the importance of bioclimatic and elevation variables in estimating the probability of fire ignition occurrence. The findings of this study allong with historical fire observations could be used for a more in-depth analysis of fire risk and burned area trends, through time, in the REMTH, supporting fire management planning and decision making.

Keywords: archived fire records, Random Forest, geospatial drivers

1 INTRODUCTION

Forest fires are a key component in almost all terrestrial biosystems and play a key role in ecosystem composition, structure and functions. The increasing frequency of wildfires in recent years is exacerbating forest degradation and biodiversity loss. In southern Europe, the frequency of forest fires is increasing rapidly, creating significant challenges also for Greece, in terms of ecological balance, human health, as well as ecosystems and biodiversity conservation. Therefore, there is a need for appropriate spatially explicit assessments of fire risk and drivers in these areas to identify high-risk areas and effective fire suppression efforts, and to understand the interactions between parameters affecting fire regimes.
A critical element of effective fire prevention policies and strategies is the long-term fire risk assessment, based on reliable methods that take into account the spatial and temporal nature of forest fire risk [1]. In this context, attention has been focused on the analysis of historical fire events and the identification and prioritization of fire risk. At the regional level, the optimization of fire prevention measures, and the protection of critical infrastructure and habitats can be achieved based on the availability of this information [2]. The most widely used approach for modeling fire ignition patterns and identifying high fire risk areas is based on the identification of geospatial drivers of fire risk integrated with a set of high-value forest and semi-natural area attributes [3][4].
In this framework, the main objective of this study was to identify the geospatial patterns of forest fire risk (wildfire occurrence) in the Region of East Macedonia and Thrace (REMTH) and to investigate the importance of factors that shape fire risk, such as vegetation, topography, climate and human related variables. Random Forest (RF) classification algorithm was used to develope a map of fire risk zones for the Region of Eastern Macedonia and Thrace.

2 DATA AND METHODS

The general steps carried out for the attainment of the specific objectives of this study are depicted in the following flowchart (Figure 1).

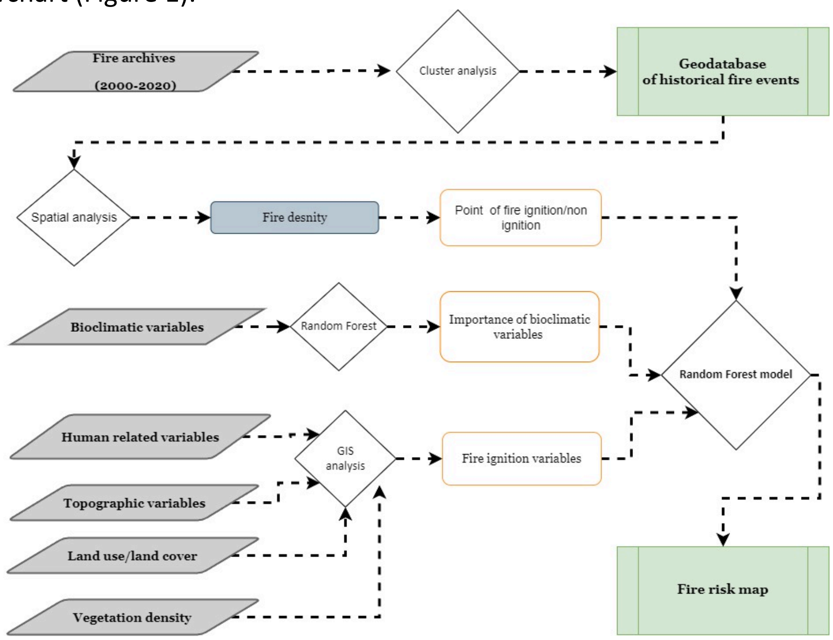


Figure 1 General method flowchart

2.1 Study area

The study area is the Region of East Macedonia and Thrace (REMTH) which is part of the northeastern part of Greece and forms Greece's border with Turkey to the east and Bulgaria to the north. The case study focus on forests and semi-natural areas of the wider region of Eastern Macedonia and Thrace.

2.2 Data sellection and processing

For this study, detailed fire ignition records for the period 2000-2020 were obtained from two official sources a) the Hellenic Fire Brigade and b) the European Forest Fire Information System (EFFIS). The double ignitions records were excluded after running two cluster analysis a) based on distance and b) based on time, using hclust: Hierarchical Clustering and Lubridate R package, within R environment software. A total of 289 ignition points of fires larger than five hectares were identified in forests, woodlands and grasslands within the REMTH. For the calculation of fire ignition density in the REMTH, kernel density estimation was used to minimize the uncertainty of the location and errors of historical fire records. To minimize the presence of spatial autocorrelation in the modelling, points of possible ignition or non-ignition with a minimum distance of 1 km were selected.
After reviewing relevant literature, we included five categories of variables (20 variables) for fire risk assessment (Table 1). Information on land use/land cover was obtained from the Corine Land Cover (CLC) vector data. 19 bioclimatic factors were evaluated using a RF model developed with the points of potential ignition or non-ignition. Based on measures of importance given for each variable, three most important bioclimatic variables were selected. Finally, for the estimation of fire risk probabılıty, RF classification model was developed using the points of possible ignition or non-ignition and the values of the fire risk parameters presented in Table 1.

Table 1 Fire risk parameters

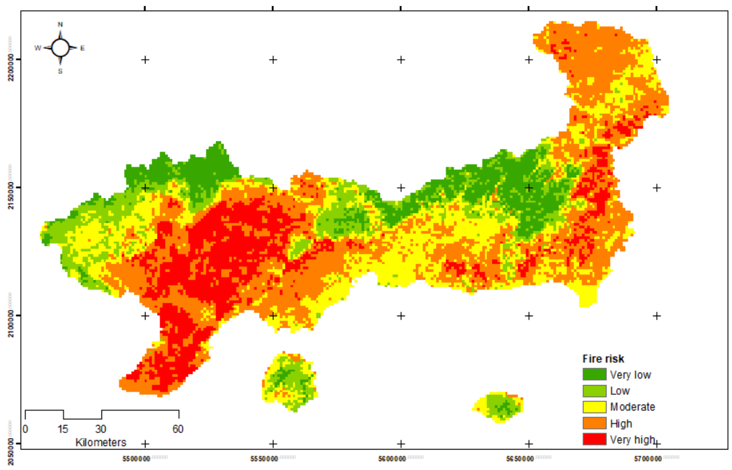
Category	Fire risk variables	Variable name
Variables related to human	National road distance	DISTANCE_ROADS
	Localities distance	DISTANCE_URBAN
	Average population density	POPULATION_DENSITY
	Average road density	DENSITY_ROADS
Topographic variables	Elevation (m)	ELEVATION
	Slope (%)	SLOPE
	Topographic Position Index	TPI-
	Aspect	TRASP
Land use/land cover	Distance of land principally occupied by agriculture, with significant areas of natural vegetation (CLC=234)	DISTANCE_243
	Distance of forest (CLC=311, CLC=312, CLC=313)	DISTANCE_31X
	Distance of transitional woodland/shrub (CLC=324) areas	DISTANCE_324
	Proportion of land principally occupied by agriculture, with significant areas of natural vegetation (CLC=234)	PERCENT_243
	Proportion of forest (CLC=311, CLC=312, CLC=313)	PERCENT_31X
	Proportion of transitional woodland/shrub (CLC=324) areas	PERCENT_324
	Forest Fragmentation	FRAGMENTATION
Vegetation density	Normalized Difference Vegetation Index derıved by Sentinel-2 satellite images acquired on August 2021	NDVI
	Tree Cover Density derıved by High Resolution Layers - HRL of the European Earth observation programme Copernicus)	TCD
Bioclimatic variables	Mean Temperature of Wettest Quarter	MEAN_TWeQ
	Precipitation of Coldest Quarter	PCQ
	Precipitation of Wettest Month	PWeM

3 RESULTS AND DISCUSSION

Figure 3 shows the values of the RF classification accuracy measures. The resulting fire ignition probabilities for the REMTH, were reclassified into five fire risk categories: very low, low, moderate, high and very high fire risk zones (Figure 3), based on the criterion of 'equal intervals' for each zone (i.e. 0.2 intervals for each category). The low and very low risk category covered 23.7 %, the moderate risk category 23.6 % and the high and very high risk categories 52.7 % of the study area. Figure 4 presents the importance of the RF predıctors to the accuracy of fire risk model. Bioclimatic, topography (elevation) and human-related variables (localities distance and road density) are among the most important variables in estimating probability of fire occurrence.

4 CONCLUSION

This study presents an attempt for generating wildfire risk zones over REMTH as well as to provide some insights in the driving factors of forest fire risk in the region. Forest fire risk analysis for REMTH is expected to provide some baseline information for future research over this geographical region, especially under the context of a climate, socioeconomic and land cover changes. Data assimilation from archived fire records obtained for this study, will be also useful for an more in-depth analysis of fire risk and burned area trends, shifts of fire regimes, and factors driving fire activity through time in REMTH.



Accuracy metrics	
Accuracy	0.93
P-Value [Acc > NIR]	9.17E-16
Kappa	0.86
OOB estimate of error rate	8.99%

Figure 2 Fire risk map and accuracy metrics

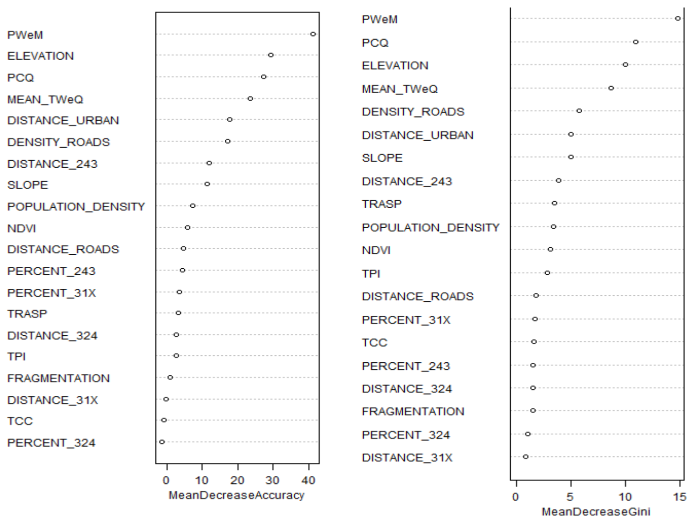


Figure 3 Fire risk variables importance

ACKNOWLEDGEMENTS

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DEADLY FIRE IN MATI, 2018:TRAGIC FACES AND FACTS

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ABSTRACT
Fires are a phenomenon that particularly concerns our country, especially during the summer months. In July 2018, Greece was to be hit by the deadliest fire in its history. 104 people died either trapped in roads and cars or at sea or later in hospitals. The aim of this work was to be able to decode the attitude of these people and explain their movements. First, we made an introduction to the phenomenon of fires and narrated the events of that day. Next, we recorded the details and movements of the victims in a protocol and after categorizing them, some actions are proposed to avoid such a tragedy again.

Keywords: Mati ; forest fire ; victims ; tragedy

1. INTRODUCTION

Our country faces many fires every year, especially during the summer months. Most and larger outbreaks, according to the findings of the Fire Department, are due to intentional arson [1].The General Secretariat for Civil Protection had issued at noon on July 22, as every day, the Fire Risk Forecast Map for the next day. All of Attica was on orange alert but not red [2]. In other words, it was in high danger, which meant that the number of fires that are expected to occur, may be large but, most importantly, any fire can take on large proportions if it escapes the initial attack [3].

2. METHOD AND STRUCTURE OF WORK

In the theoretical part of the work, we recorded the meteorological conditions of July 23, 2018 [4], the evolution of the fire and its consequences [5]. Below are the steps we followed for valid registration of victims. All the information was drawn from survivors' testimonies either in the media or through interviews. We also made three visits to the area and talked to operational employees and survivors. Finally, statistics are presented based on the data.

2.1 Stage 1: Data Collection

- Contacting competent authorities
- Interview with survivors
- Monitoring of news on the day of the fire by the five largest television stations in the country
- Find and record testimonies from videos, interviews, newspaper articles
- Recording of the official list of dead by the General Secretariat for Civil Protection

2.2 Stage 2: Protocol

- Recording name , age and movements of the victims in a protocol
- Recording all the information in an Excel file

- Cross-referencing data from various sources
- Statistical tables and conclusions

3. CONCLUSIONS AND DISCUSSION

3.1 Conclusions

According to the testimonies, the information was confused and people were completely unprepared. They knew from the media about a fire in Kinetta and believed that the smoke due to the strong westerly winds was from there, continuing their activities. Until shortly after 19:00, the television stations broadcast that the front was heading towards Neo Voutza, when in fact Mati had already burned. A common statement of all was that there was no timely information. The residents did not know what was happening or what they were supposed to do. They proceeded to a disorderly exodus.

3.2 Statistics

Four years later no one is able to determine with absolute certainty the number of victims. There have been reports of a large number of unidentified heaps. Based on the data for 104, the following statistics were extracted.

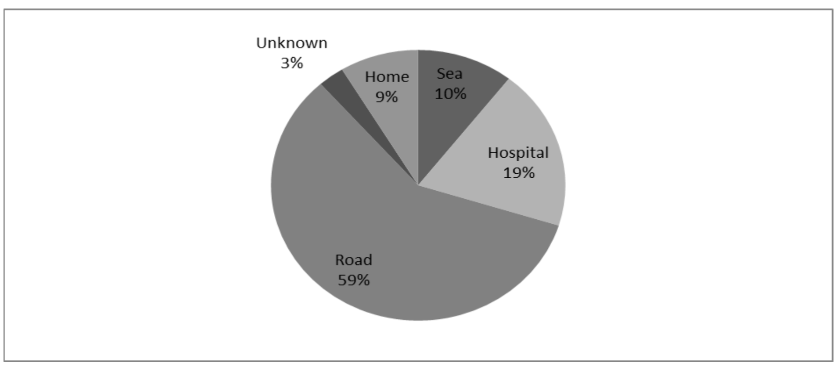

Figure 1 Percentages of points where people ended up

According to Figure 1 :

11 people ended up in the sea, including the teenager who jumped and hit the rocks and the unidentified body found in Kavouri.
20 people ended up in hospitals after their burns.
8 people were found charred inside their house.
1 baby ended up from the fumes in the Beach of Argyra Akti.
30 people were found in Kokkino Limanaki and specifically 26 people charred on the plot of Irini Street.

As it seems in Figure 2 , it is important to note and emphasize that the majority of these people were young people who, if they had the necessary time, might have been saved. On the contrary, older people were locked up in their homes either because they had no means of transportation or because they did not have the strength. About the people who were found in the sea, and there some deaths could have been avoided if the rescue teams had arrived in time as the witnesses state that their people were alive for a while in the water.

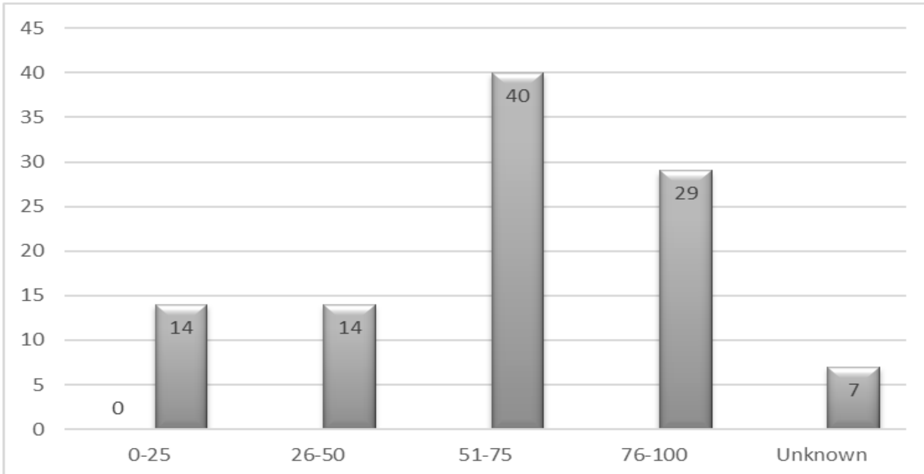

Figure 2 The victims' age

The largest percentage of the victims were from 51 to 75 years old, the same percentages vary (13% and 14%) for the ages 0 to 50 and finally a significant percentage of the order of ¼ of the victims were elderly people who either abandoned them or were trapped in their homes.

Finally, as it turns out in Figure 3, the majority of people knew the area as they were permanent residents or maintained holiday homes for years. However, at that time they could not find the escape routes to the sea.

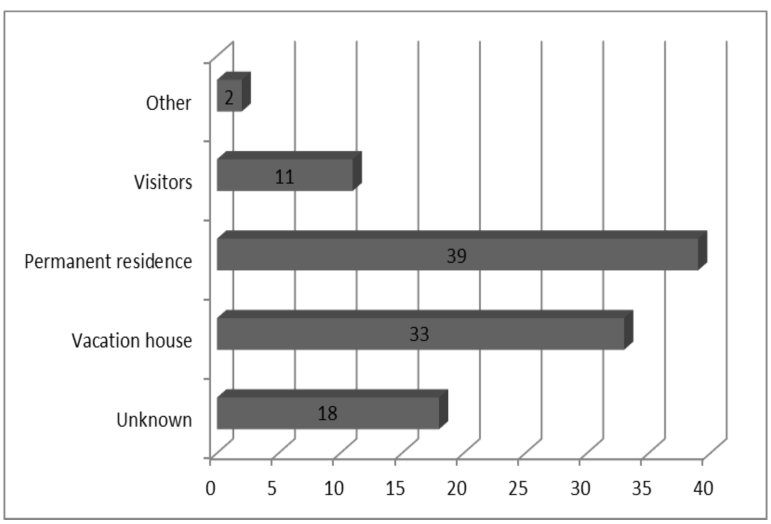

Figure 3 Percentages of permanent residents and visitors

4. SUGGESTIONS

4.1 Prevention

As prevention is better than cure, we initially propose some measures at private and national level to reduce these phenomena as much as possible. The proposals in this diplomacy are the result of the shortcomings recorded.

- Responsibility and individual prevention measures
- Road plan
- Citizen's Education
- Increase in penalties for arson by negligence or intent
- Personnel Evaluation
- Ensuring two-way and seamless communication of those involved
- Device or application for geospatial identification of people with difficulties

4.2. Repression

- Increase permanent staff in crisis management
- Organization chart, clear responsibilities, simplification of procedures (e.g. for the use of human resources and firefighting means)
- Victim care and rehabilitation structures

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WILDFIRE EFFECTS ON SOIL EROSION AND HYDROLOGY IN A TYPICAL MEDITERRANEAN WILDLAND – URBAN INTERFACE: THE CASE OF SOUTH ATHENS, GREECE

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ABSTRACT
During the last decades, the severity and frequency of wildfires have increased, particularly in the Mediterranean basin. The wildland-urban interfaces (WUI) are sensitive ecosystems theatened by wildfire. Aside from the damage to vegetation cover and ecosystem health, changes in erosion and hydrological processes occur following a fire. On the 4th of June 2022, a fire burst in a typical WUI of South Athens (Greece) and burned around 430 ha. Following the wildfire, an increase in soil loss rate (+22.6 t ha^{-1} y^{-1}) and a decrease in water retention capacity (-96.5 mm) was found. The findings provide insights for targeted management and decision making on the implementation of post-fire emergency rehabilitation treatments.

Keywords: wildfire, erosion, hydrology, wildland-urban interface, copernicus EMS

1. INTRODUCTION

Wildfires constitute the most severe abiotic disturbance in the Mediterranean forest ecosystems. Particularly in Southern Europe, the Mediterranean-type climate characterized with the prolonged dry and warm summer period, the flammable vegetation, the complex terrain and human activities, favor the ignition and spread of wildfires. Furthermore, population growth over the last decades has driven an increase in wildland–urban interface (WUI) areas, as housing expands in and near forests. The coexistence of forests and natural areas with humans constitutes a special form of community needs an integrated management system. Wildfires in WUIs are extremely destructive, as they can induce fatalities and damage to properties and infrastructure [1]. In the aftermath of wildfires, significant changes occur in the erosion and hydrological processes [2]. This is mainly due to the complete or partial loss of vegetation, which reduces water infiltration and storage capacity while increasing surface runoff. Additionally, fire alters the texture and the physico-chemical properties of the surface soil, transforming it into a hydrophobic layer and thereby increasing soil erosion rates. This research aims to quantify the effects of the wildfire of June 2022 at South Athens (Greece), on soil erosion and hydrology.

2. MATERIAL AND METHOD

A wildfire started on the 4 June 2022 at the foothills of Mount Hymettus and spread to the southern Athens suburbs of Ano Glyfada, Ano Voula and Vari. Residents were evacuated to nearby areas, whereas around twenty residential homes were reported to have been damaged by the fire. Notably, in addition to the aforementioned fire, other wildfires occurred within the study area in 2009 and 2011. The Copernicus Emergency Management Service – Rapid Mapping was activated (Act. Code: EMSR576) after the fire event of 2022 (Figure 1). This service consists of the on-demand and fast provision of geospatial information in support of emergency management activities immediately following a disaster. On the 6th June 2022, immediately after the event, the spatial extent of the burned area and the severity classes of damage grading in the natural land uses were published (https://emergency.copernicus.eu/mapping/list-of-components/EMSR576). Based on these data, changes in soil loss rate and soil water storage capacity were evaluated. Soil erosion is a major form of land degradation, while water storage capacity is a key hydrological variable affecting both peak discharge but also water supply.

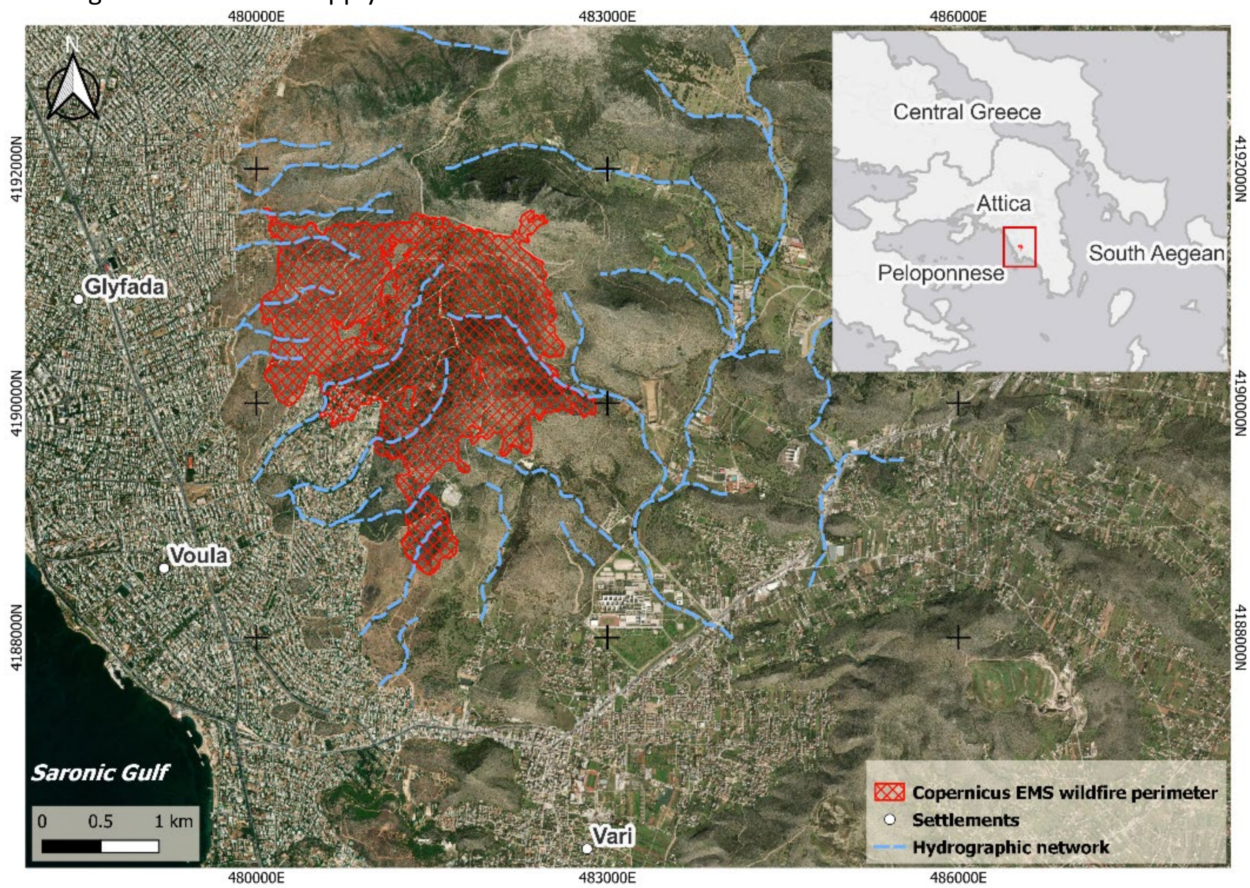

Figure 1. The spatial extent of the Copernicus EMS wildfire perimeter accompanied with nearby settlements and the hydrographic network

The well-known RUSLE model was used to assess wildfire effects of soil erosion. The mathematical description of the model is given below:

$$A = R \times K \times LS \times C \times P$$

where *A* is the computed annual soil loss (t ha^{-1} y^{-1}), *R* is the rainfall erosivity factor (MJ mm ha h^{-1} y^{-1}), *K* is the soil erodibility (t ha h ha^{-1} MJ^{-1} mm^{-1}), *LS* is the combined effect of slope length (L) and slope steepness factor (S) (dimensionless), *C* is the cover management factor (dimensionless) and *P* is the conservation practice factor (dimensionless). The R-factor was estimated using monthly precipitation data from CHELSA (v2.1) dataset for the period 1979-2018 (1 km resolution) (https://envicloud.wsl.ch/#/?prefix=chelsa%2Fchelsa_V2%2FGLOBAL%2F) and a simplified mathematical equation developed by Arnoldus [3]. The K-factor was estimated according to the Renard et al [4] approach based on the soil's sand, silt and clay contents. The data were retrieved from ISRIC-World Soil Information dataset (https://soilgrids.org) (250 m resolution). The LS-factor was calculated in the System for Automated Geoscientific Analyses (SAGA) GIS software, which incorporate Desmet and Govers [5] equation. In this module, the FABDEM of Copernicus (30 m resolution) with artifacts from forests and buildings removed (https://data.bris.ac.uk/data/dataset/25wfy0f9ukoge2gs7a5mqpq2j7) was used. In order to calculate the C-factor, the Corine Land Cover (CLC) v.2018 database (https://data.bris.ac.uk/data/dataset/25wfy0f9ukoge2gs7a5mqpq2j7) was used. The appropriate C value was assigned to each CLC class based on relevant researches [6]. As for the burned areas, the values of 0.35 and 0.45 were given to the natural land cover areas which characterized as damaged and destroyed, respectively.

The maximum water retention capacity (S), according the Soil Conservation Service (SCS) approach, is expressed by the following equation:

$$S = \frac{25400}{CN} - 254$$

The runoff curve number (CN) is an empirical parameter used in hydrology for predicting direct runoff or infiltration from rainfall excess. Herein, an analytical method for the spatial application of CN was applied [7]. This method takes into account soil permeability, vegetation and drainage capacity. To that end, permeability classes were determined based on the soil parent material, as derived from the national scale soil map of Greece (http://mapsportal.ypen.gr/maps/289). Vegetation classes are formulated based on the land water retention characteristics and the filtration capacity due to root zone growth. Based on the Corine 2018 Land Cover Map, the vegetation of the study area was categorized to relevant classes. The drainage capacity of the terrain was evaluated, considering slopes over 30% after processing the FABDEM. Subsequently, the post-fire CN was estimated considering the recent literature [8], where the values 10 and 15 were added to the pre-fire CN values for the damaged and destroyed natural land cover areas, respectively.

3. RESULTS AND CONCLUSION

Based on the Copernicus EMS rapid mapping results, the total burned area was 431.8 ha. The damage grading evaluation, in particular, revealed that 84.6% of the fire-affected area was classified as damaged and the remaining 15.4% as destroyed. Furthermore, the wildfire primarily impacted "transitional woodland shrubs" (69.7%) and "sparsely vegetated areas" (28%). The erosion prediction model of RUSLE and the water retension coefficient (S) of SCS were implemented in a GIS environment using open-access data, for the pre-and post-fire conditions. Conserning the changes in soil erosion rate, an average increase of approximately 22.6 t ha^{-1} y^{-1} were found. On the contrary, the water retention capacity of the ecosystem was decreased by 96.5 mm. The spatial distribution of the above changes is presented in the following figure (Figure 2). Unfortunately, there are no actual measurements to verify the results. However, the quantification of wildfire on the erosion and hydrological process was efficiently achieved by applying the current approach.

The results provide useful information to policymakers for recovery and restoration planning of the affected area. Aside from its practical usefulness, the proposed methodology is straightforward with minimum data requirements and low computational demands. The current approach could be integrated into a holistic wildfire risk assessment in WUIs. Last, research outputs should not be confined to the scientific community but conveyed to the general public, raising awareness of post-wildfire effects on hydrological regime and erosion rate.

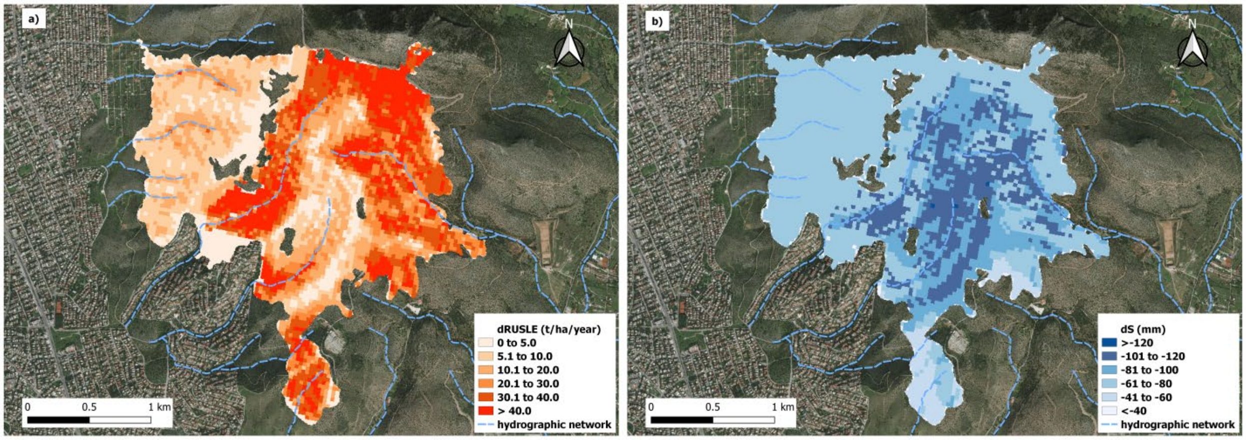

Figure 2. The spatial changes in (**a**) soil loss rate (dRUSLE) and (**b**) water retention capacity (dS) after the wildfire.

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THE CONTRIBUTION OF 3D DIGITAL DOCUMENTATION TO THE SAFETY OF INDUSTRIAL FACILITIES

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ABSTRACT
This study describes the impact of the 3D Digital Documentation in the field of Health and Safety in complex industrial environments. It took place at Hellenic Petroleum facilities in Northern Greece (HELPE). The oil refinery is located several kilometers away from Thessaloniki city center and is one of the leading energy groups in Southeast Europe, with activities spanning across the energy value chain and presence in six (6) countries.Industrial facilities of this scale, where special machines configuration is existing, need to monitor and maintain their industrial equipment on a regular basis. In order to reduce the risk of physical injuries, human mistakes and the total cost of a traditional facilities inspection, we proposed the solution of creating a digital twin model of the industrial facilities. For example, a pump or extruder malfunction in an Oil and refinery industry may cause disruption to the production line and thus, result in significant economic damage and occusionally human injuries.
For this purpose we used Terrestrial Laser Scanners (TLS) for the 3D geometric recording and a GNSS receiver for the position information and the georeference procedure. More specific, digital 3D scanning devices has provided new means to preserve geometric and photorealistic 3D point clouds. An important reason for applying photorealistic models include visualization from a point of view, is because that is impossible in the real world due to size or accessibility, interaction with non-hazardous objects and maximum staff safety, especially in industrial areas with high-risk hazards.3D scanners allow surveyors to capture environments without the need to physically access the restrict area. This reduces the requirement for costly and laborious health and safety measures and ensures the safety of the field staff. The field data can be saved in order to be analyzed (distance measurments, crack inspection, volumetric analysis) from an office environment. Through our work, we tried to emphasize the value of 3D digital twinning on improving the wellness and safety condition of field workers, but also in providing critical information to the management on the operating status of the equipment in a fast, easy and understandable way.

Keywords: Terestrial laser scanning, 3D point cloud, georeference, digital twins, industrial safety.

1. INTRODUCTION
The complexity of technical inspections and maintenance procedures, the extension of industrial infrastructure as well as the volume of production, has highlighted the goal of safety and technical maintenance of equipment more relevant than ever. A big number of 3D mapping and modeling applications has been applied for the documentation of Cultural Heritage sites and monuments [1, 2, 3, 4, 5] and in general constructions of special interest as well as the creation of educational tools for trainee researchers and engineers [6]. Aside from 3D modeling applications, the dense point cloud is also potentially used for a feasibility assessment of a vital object. For example, many oil and gas industries regularly monitor the tank or a pump condition. In such cases, terrestrial laser scanning can be used for inspection, design, deformation monitoring, containment dike analysis, and volume calibration of tank applications. In terms of industrial maintenance, the provision of information to the right staff in real time and its presentation with augmented reality techniques on mobile devices,

combined with intelligent decision-making methods based on machine learning techniques are the future of modern industry and will simplify the equipment maintenance procedures and will facilitate the technical staff in their operational procedures [7]. The advent of new digital 3D laser scanners provided new means of digitally capturing the performance of machines and their complex installations by creating geometric and photorealistic point clouds or 3D mesh models. Other incentives for applying photorealistic models is the visualization from views that are impossible in the real world due to size or accessibility, interaction with non-hazardous objects, and maximum staff safety, especially in industrial areas in high dangerous enviroment. In our case, due to the great importance of the study area to be 3D captured and more specific the Continuous Catalytic Reforming (CCR) unit and the constant rules of Helpe aiming at the maximum safety of all types of employees, the research team of AUTh successfully completed the relevant seminar at Institute of Industrial and Business Education & Training on topic "Health-safety and environmental protection" as well as the appropriate safety clothing fulfilling the ATEX protocol [8] was purchased and used in all measurement campaigns.

2. EQUIPMENT AND MEASUREMENT CAMPAIGNS

As it is known, terrestrial laser scanning is a popular methodology that is used frequently in the process of documenting historical buildings, cultural heritage, highway surveys and special structures like forested areas [9]. It can be used for both outdoor and indoor surveys and delivers millions of 3D points measurements with mm-accuracy, even in situations where other classical surveying techniques are difficult or impossible to use. One of these cases is the oil industry where complex machines are installed and operate 24/7. Our study focuses on presenting the basic stages which we followed to apply laser scanning to obtain the 3D point clouds of several extruders in oil industry. Apart from streamlining measurement taking by making it faster, 3D laser scanning also provides convenience by minimizing travel and revisit. Many oil and gas sites are far away from the main facilities, so making multiple trips for extensive measurements would spend substantial time. With terrestrial 3D laser scanning, surveying engineers could travel once, set up the laser instrument in a sparse locations network, gather field measurement data in minimum time but perform exhaustive analysis at office work. Another efficient way is to perform digital scanning survey at the area of interest, apply basic registration work on portable devices such as tablets or smartphones, and get valuable information in near real time. The high accuracy and precision of 3D laser scannings implies employees won't have to make multiple trips to re-collect faulty data. Thus, to obtain the 3D point cloud of a special instrument, Leica RTC360 scan station was used due to its characteristics [10]: capable of scanning up to 2,000,000 points per second, in a range from 0.5 - up to 130 m from the instrument's center of origin with high accuracy: 1.0 mm + 10 ppm. It is embedding a 3-camera system of 36MPixels resolution, able to provide a spherical panorama image of about 432 MPx. The spherical panorama with a Field of View (FoV) of 360^o in horizontal and 300^o in vertical directions is used to colorize the cloud of measured points using the pre-calibrated information of the imaging sensors. Additionally, the instrument can perform in 2 passes to automatically remove moving objects and uses 1 minute for full spherical HDR image at any light condition. Also, in some special cases, the Leica BLK360 3Dscanner was additionally used, due to the flexibility it provides in the field (very small dimensions). The field work is quite simple and is comprised of the instrument's placement in locations that will optimize the measurements inside and around the area of interest. In order to provide georeferencing information of the scanning sessions proper targets were installed and measured using GNSS data with help of the relevant positioning [15]. More specifically, a Leica GNSS receiver (Viva GS15) was utilized operating in multi-frequency and tracking signals from GPS, Glonass, Galileo and Beidou satellite constellations. The nominal accuracy performance in static scenario is for Horizontal: 3 mm + 0.1 ppm (rms) while for vertical component is 3.5 mm + 0.4 ppm (rms) [11]. Their coordinates were finally referred to the modern reference system

Hellenic Terrestrial Reference System (HTRS07) which use the Transverse Mercator as projection plane [12, 13]. A total number of 127 (laser scanner) traverse points were implemented, fully covering each compressor to be captured and their neighboring installations. After the fieldwork was completed and in order to obtain the unified point clouds and clear the noise, special software (Leica Cyclone Register 360) was used. The scans from the separate dates' sessions were brought in a common reference system and then merged to create a unified model. All the connections of the point clouds from the individual scans were made with an accuracy of 1-2 mm.

3. CREATION OF THE 3D PHOTOREALISTIC MODEL

The availability and use of 3D data opens up a wide range of further applications and allows for new analyzes, studies, interpretations, conservation and safety policies. Therefore, 3D virtual photorealistic should be used more often due to the great advantages offered by modern technologies and the introduction of the third dimension to identify the needs of digital documentation and preservation that are reported worldwide. 3D Modeling is an important parameter for the oil and gas industry. Computer Aided Design (CAD) models include more than just shapes, as they can also provide information such as materials, processes, dimensions and other details to the user. Based on these results and using the Leica Cyclone v.2020 software [14] a model of each compressor was created. Cyclone software allows users to move from import through analysis and publishing their models and results. The ability to produce and display 3D computer graphics is now made it possible to create scenes that could not be created in a purely natural world. The result was the creation of a model, that is, an interactive, three-dimensional computer-built environment. Figure 1 shows the use of the 3D photorealistic model resulting from the 3D capture for HELPE compressor unit in augmented reality environment. Accurate piping length measurement is performed where it is difficult to obtain values on the spot due to operating conditions (eg. high operating temperatures). The image is a recording result from the relevant video created by the research team and for that reason has a lower image quality.

Figure 1. Measuring distance between inaccessible points using augmented reality and 3D photorealistic model.

In addition, another flexible way for handling the register point cloud data is the LGS files. The allignement software that was used to unifiy the point clouds from different dates (Cyclone Register 360) provides the option to extract the 3D surveys into these special files (LGS) files which are Leica's Universal Digital Reality project files. This file format saves a lot of metadata with point cloud and images inside one single file. LGS files can be directly imported in a viewing and examination software to support rapid visualization of the models. The associated software is named JetStreamviewer and is free to download and use by anyone.

4. RESULTS

The study presents the stages that were followed for the creation of a 3D digital survey of complex installations using latest technology such as terrestrial laser scanning and gnss data for product georefernce. It shows that when it comes to Oil and Gas indusrty planning, laser scanners can be used to efficiently and completely survey production facilities, such as pipelines and special machinery. As laser scanning can be performed without physical contact, 3D surveys can be obtained during normal operation of the installation. The scan result is a point cloud providing information about the scanned object. Geometric information can be derived from the point cloud partly in automated modus. Another motivation for applying photorealistic 3D models or proper point clouds include visualization from views that are impossible in the real world due to size or accessibility, interaction with non-hazardous objects, and maximum staff safety, especially in such facilities.

ACKNOWLEDGEMENTS

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CAN ENVIRONMENT BE DAMAGED BY CLOSED OR ABANDONED INDUSTRIAL OR CHEMICAL SITES?

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ABSTRACT
The chemical industry produces a wide variety of substances and products that are essential for use in a very broad range of applications and in virtually all sectors of the economy; though some of them have really hazardous properties. In the case of an abnormal event, these substances may be released into the atmosphere or the soil, or may be ignited causing potential harm to the workers, the environment or /and the civilians living in the proximity of the industrial site. This is also the case, when factories handling or producing hazardous material are closed down without removing from the installation all substances of potentially hazardous nature. In these cases, inadvertent incidents may occur and can challenge public hygiene and peoples' safety [1].. Some of these incidents have occurred in the recent years also in Greece and will be presented in this POSTER.
Keywords: Chemical accidents, environmental protection, Emergency Response

IMAGES

Figure 1. DIANA fertilizers company, Sindos Thessaloniki in early 2004

Figure 2. Aspropyrgos recycle factory on fire, in 2015

DISCUSSION

The management of the remaining hazardous and toxic waste in closing industrial sites is a big puzzle. According to the EU-SEVESO (III) Directive, which has been implemented in the Greek Law [2], the plant owner is responsible for all phases of plant operation, according to the "Total Life Cycle Risk Assessment". Though, the implementation of the legal obligations is often short, owing to responsibilities overlapping between the central administration and the local competent authorities. This fact may lead to unpleasant and, moreover, serious accidents for the public health.

Strick following of the legislation regarding the operation and the closing of a hazardous facility is a "sine qua non" condition for the protection of public health and the environment. Duties and responsibilities of competent authorities should be clearly detailed by Law so that overlapping between the central administration and local officers is being held to a minimum.

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PRAETORIAN: PROTECTION OF CRITICAL INFRASTRUCTURES FROM ADVANCED COMBINED CYBER AND PHYSICAL THREATS

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ABSTRACT
The strategic goal of the H2020 EU funded project "PRAETORIAN" is to increase the security and resilience of European Critical Infrastructures (CIs), by facilitating the coordinated protection of interrelated CIs against combined physical and cyber threats. PRAETORIAN creates a toolset that will support the security managers of CIs in their decision making to anticipate and withstand potential cyber, physical and combined security threats to their own infrastructures and other interrelated CIs. PRAETORIAN is a CI-led project, and ever since the beginning, it uses a "user-driven" methodology which implies the involvement of 9 end users (CI operators) and 3 First Responders (FRs) in the whole project life cycle. It will demonstrate its results in three international pilot clusters, including cross-border scenarios, involving 2 international airports, 2 ports, 3 hospitals and 2 power operators. PRAETORIAN's solutions will be packaged in the form of 4 products that are designed and developed throughout the lifespan of the project, including a Cyber, Physical, Hybrid (i.e. combination of cyber and physical domains) and Coordinated Response system in a response to the identified problems. Project results are validated in real-world contexts of interdependent CIs to improve efficiency, resilience and societal benefits, also considering human factors. PRAETORIAN ensures that the solutions comply with legal, ethical, societal and privacy principles, including recommendations from regulatory authorities and connection with European security agencies. PRAETORIAN solutions will have a great positive impact across different dimensions; economic, social, ethical, privacy, safety, replicability and up scaling, and to the corresponding policy recommendations for European standards.

Keywords: Critical Infrastructures, Cyber threats, Physical Threats, Cascading Effects, First Responders, Security.

1. INTRODUCTION
A major cyber and/or physical attack on a Critical Infrastructure (CI) is a risk not only for the owners and operators of those assets, but also for their suppliers, customers, businesses and persons in the vicinity of the attacked asset, including neighboring and interrelated CIs that may be adversely affected by it. Damages caused by an attack on CI can be widespread, massive, and highly correlated, affecting multiple sectors of the economy.

In fact, there are many reasons why combined cyber and physical attacks on CIs are expected to increase. To mention just a few, there is a proliferation of industrial control system malware and there is an increased reliance of industry and CIs on ICT systems. Additionally, the industrial control system networks are notoriously difficult to secure, while the cyber criminals have a proven business model.

Furthermore, natural incidents (especially those associated to the current climate emergency) and industrial accidents often exceed our expectations and our apparently resilient designs, as several examples show, such as the magnitude 9.0 Japan earthquake and tsunami that caused 15,899 deaths and an extended radiological contamination (2011) [1]. The impact of a coordinated physical attack, a deliberate (cyber) disruption of critical automation systems, a natural hazard or even a combined scenario including several kinds of attacks, could have disastrous consequences for the European Member States' region economies and social wellbeing in general.

Therefore, there is a need of tools and methodologies that will meet the expectation needs of the CI operators in addressing these security challenges. Towards this end, the PRAETORIAN H2020 EU funded project, proposes an integrated and scalable toolset for CI operators that will allow a cooperative communication and effective preventive and mitigation actions among interrelated CIs, before and during emergencies, thus succeeding in their mission of protecting the EU CIs belonging to different strategic sectors (transport, energy and healthcare) [2].

PRAETORIAN consists of 23 partners from 7 EU countries (Figure 1). It includes 3 pilot sites in 4 EU countries (Croatia, Austria France and Spain). The total budget is 9M Euros. The project started on June 2021 and it will end on May 2023.

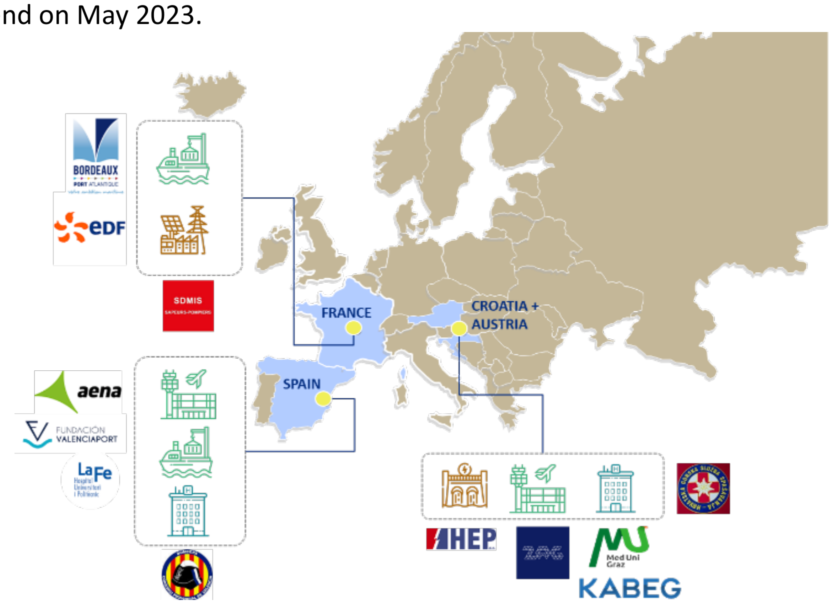

Figure 1.: The PRAETORIAN consortium.

2. PRAETORIAN METHODOLOGY

Figure 2 shows an overview of the PRAETORIAN architecture. The strategic goal of the PRAETORIAN project is to increase the security and resilience of European CIs, facilitating the coordinated protection of interrelated CIs against combined physical and cyber threats.

One of the project main objectives is to evaluate the hazards and minimize their level of risk by assessing the vulnerabilities of the targeting sectors and designing adequate security measures. Two important concepts in PRAETORIAN are the combined scenarios and the cascading effects. The PRAETORIAN pilot scenarios combine both physical and cyber threads. Also, the PRAETORIAN investigates the cascading effects of physical and cyber threads. For example, an attack in the physical domain may have impact on the cyber domain and vice versa. Additionally, an impact on a CI may cause cascading effects on another CI. Therefore, PRAETORIAN investigates the concept of cascading effects at different levels.

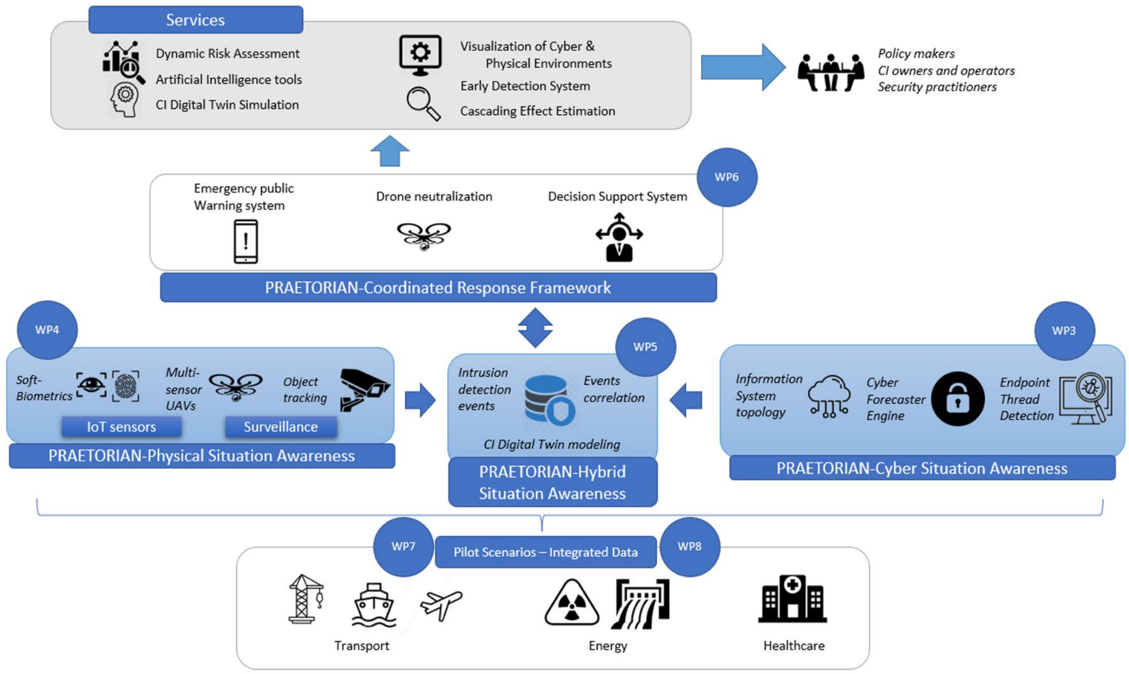

Figure 2.: Overview of the PRAETORIAN system.

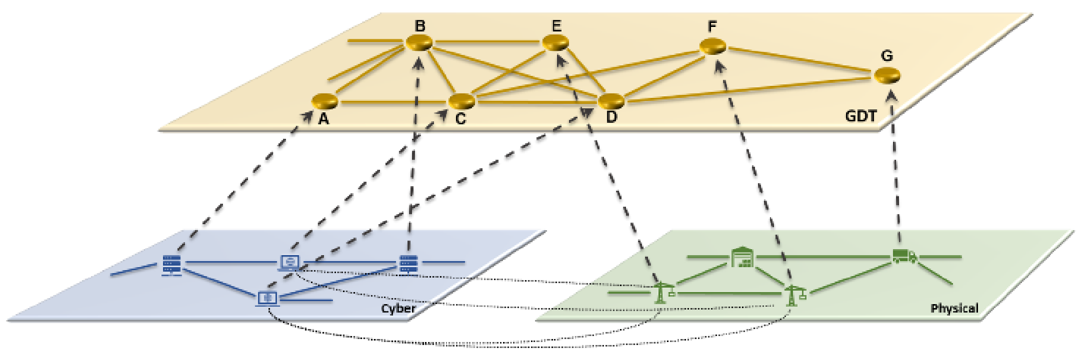

Figure 3.: A representation of the HSA digital twin. The assets (components) of the cyber domain and of the physical domain are displayed at the bottom. The edges indicate relationships between specific assets. There are also relationships between a physical and a cyber component, which means that impact (e.g. a threat) on a specific cyber component affects a physical one. The cyber and physical domains can be instantiated using a generic digital twin (top), which is used to analyze cascading effects.

PRAETORIAN aims at improving the understanding of any physical and cyber thread. Its architecture, as depicted in Figure 2, consists of the Physical Situation Awareness module (CSA), the Cyber Situation Awareness module (CSA), the Hybrid Situation Awareness module (HSA) and the Coordinated Response Framework (CR).

The role of the PSA is to model the legacy sensor systems of the CIs and include additional sensors not currently used by the CIs, but can enhance the situation awareness of the operators with regard to physical threats. The PSA system is able to predict and detect any physical intrusion and generate the corresponding alarms. The CSA provides a set of innovative tools the improve the cyber situation awareness of the operator. It provides risk and threat analysis, forecasting of cyber cascading effects of cyber-events and innovative visualization tools.

The HSA is based on a Generic Digital Twin and on a thread propagation engine, to simulate the cascading effects withing the CIs and among the CIs. In particular, the HSA combines the outcomes of the PSA and the CSA systems for ensuring the detection and visualization of the consequences of any kind of threat (either physical or cyber) that could affect EU CIs. Innovative modules are developed to model the behavior of the real CI, based on digital twins, and for calculating potential cascading effects in different parts of each CI, and also potential cascading effects on other CIs. These modules present to a security manager a global view on the threats' potential propagation independently of the nature of the threat (physical or cyber). Thus, the HSA informs the operators about subsequent targets of an attack or about unprotected areas. The HSA is further illustrated in Figure 3. Finally, the CR supports the operators of the CIs in the decision-making process when natural or man-made incidents occur. It consists of a comprehensive Decision Support System (DSS) that orchestrates the emergency plans of all the related CIs and provides automated response to the detected thread, thus helping operators of all CIs involved in an incident to have an holistic overview of the situation and control of the actions required to mitigate the potential consequences. CR integrates emergency population warning techniques, tools for automating the communication with the teams of First Responders, as well as integration with social media channels. Finally, PRAETORIAN ensure compliance of the solutions with the legal, ethical, privacy and societal principles.

3. PILOT SCENARIOS

The PRAETORIAN defined three pilot sites. The corresponding scenarios which will be used to evaluate the efficiency of the PRAETORIAN system include CIs such as power operators (EDF, HEP), hospitals (Austria, Valencia), airport operators (Valencia, Zagreb), first responders (Fire Fighting Department in Lyon, Valencia and a Rescue Service in Croatia) and ports (Bordeaux, Valencia). The pilot scenarios consider combined physical and cyber threads. The PRAETORIAN system is expected to allow effective response by the operators, considering the cascading effects of each threat on interrelated CIs.

4. CONCLUSIONS

The PRAETORIAN is a Ci-led project. Therefore, the CIs are capable to influence, develop and take-up project results that are useful and usable. It focuses on cost-efficiency and effectiveness, as it is built on top of results produced by previous projects and requires shorter and more realistic development time, as well as readiness within 24 months. The involvement of a large set of various CI owners and operators from the most attacked sectors guarantee the transferability of results to a widest group of end users. Since the PRAETORIAN considers different types of users and the design phase, it develops a flexible and customizable system, which is conceived to accommodate the needs of various kinds of CIs. Finally, it focuses on comprehensible in situ demonstrations, to evaluate the seamless integration of the PRAETORIAN technologies and the readiness to protect the European CIs.

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STUDYING THE TOXIC AND THERMAL RADIATION THREAT FROM HYPOTHETICAL INDUSTRIAL ACCIDENTS

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ABSTRACT
Petroleum crude oil poses fire risk when liquid leaks from industrial tanks, causing further releases of toxic gases and smoke. Such accidents can occur due to problems in process design, equipment malfunction or human errors, and can lead to human casualties, severe environmental pollution and large economic losses. Therefore, fire risk assessment is a necessary procedure to overcome environmental hazards from industrial facilities. This work aims to study hypothetical flammable-liquid releases and crude oil pool fires, using the industrial zone located 3 km east of the town of New Karvali and 12 km east of the city of Kavala in Northern Greece as a case-study. For this purpose, two scenarios corresponding to the warm and cold season were considered, using the Areal Locations of Hazardous Atmospheres (ALOHA) model. ALOHA is a popular atmospheric dispersion model for evaluating releases of hazardous chemical vapors and studying fire and explosion scenarios. In our study, the worst-case toxic threat occurred in warm season with sligthly stable atmospheric conditions, while the maximun thermal radiation threat was almost the same for both scenarios. Although the accidents studied here were hypothetical and were assessed for research purposes exclusively, the simulations provided essential information on the prevention and control of leakage accidents and can be used for safety and emergency planning objectives.

Keywords: Air hazard modeling, industrial accidents, crude oil, pool fire, ALOHA software.

1. INTRODUCTION

Accidents in oil or gas storage and transportation procedures may lead to disruptions in industrial activities, million-dollar property losses, adverse effects on human health and well-being, even human fatalities [1]. Accidents in chemical processes, fluid leakages and emissions from process equipment, such as tanks, vessels and pipelines, can occur for different reasons, with the human factor being the most common cause of catastrophic accidents [2].

Fire accidents are a major threat in the petroleum industry [3]. Many flammable petroleum products are stored at oil depots, such as oil terminals or gas stations. Crude oil is a liquid hazardous material that behaves mainly as a nontoxic flammable chemical. Once the fuel-air mixture or stored fuel is ignited, a large fire or explosion accident may break out [4].

The Areal Locations of Hazardous Atmospheres (ALOHA) model is a stand-alone software application which provides estimates of human health hazards associated with inhalation of toxic chemical vapors, thermal radiation from chemical fires and the effects of pressure waves from vapor-cloud explosions [5]. In order to assess the potential of a large crude oil storage tank fire outbreak, two hypothetical industrial accident scenarios were studied, concerning a crude oil leakage from an oil tank and the subsequent break-out of a pool fire inside the tank-dike, soon after the puddle formation. The industrial zone located east of the coastal city of Kavala in Northern Greece was selected as a case-study. The simulations were run for different meteorological conditions which correspond to the warm and cold season, using the ALOHA model. The distance of the toxic vapor cloud (in case of crude oil puddle evaporation) as well as the thermal radiation threat from a pool fire were investigated for each scenario. It is stressed that these are hypothetical scenarios which are highly unlikely to happen and are studied here for research purposes exclusively.

2. MATERIALS AND METHODS

2.1. Study area

The ENERGEAN OIL & GAS S.A. of Kavala in Northern Greece which covers an area of 204,059 m^2 and employs 253 workers was used as a case-study. The industry is located at a distance of 3 km east from the town of New Karvali and 12 km east from the city of Kavala (Figure 1), where 2,244 and 58,663 people live, respectively. The mean monthly temperature in the region is recorded from 5.5 °C (January) to 25.9 °C (July), with an annual average of 15.1 °C. The mean monthly relative humidity shows values from 75.3% in November to 57.5% in July, with an average annual value of 68.6%. The amount of rainfall shows its maximum value during the winter period and especially in November (68.1 mm) and December (62.9 mm), while the minimum rainfall heights are observed during the summer period and especially in August (13.9 mm).

Figure 1. Location and topography of the study area

2.2. Production plants and facilities

Crude oil is stored in three vertical cylinder tanks (TK-704 A/B/C). The TK-704 C tank is the biggest of all, with a capacity of 250,000 barrels (34,581 tn) and a total volume of 41,735 m^3. A dike surrounds each tank, providing the ease of visual leak detection. The volume of the TK-704 C tank-dike is 41,735 m^3, with a capacity of 34,850 tn.

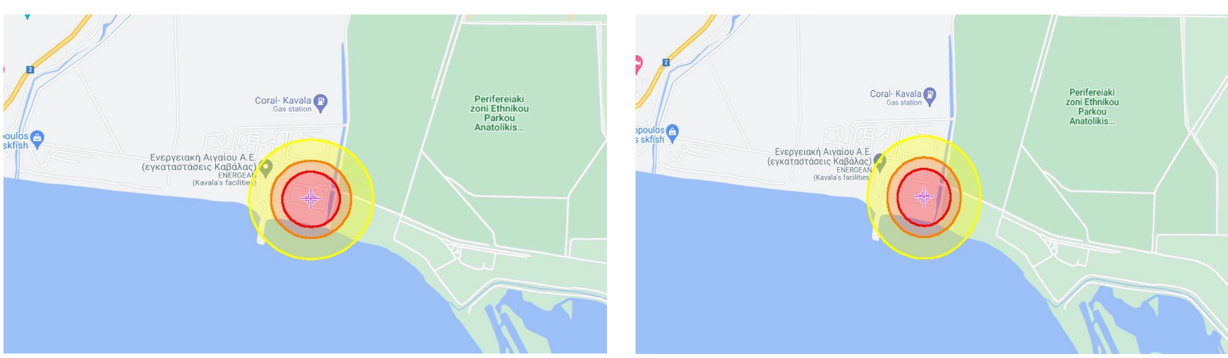
2.3. Simulation of initial conditions

For this study, the main hypothetical industrial accident scenario included a pool fire inside the TK-704 C tank-dike and it was studied with the ALOHA model. Specifically, it was assumed that crude oil leaked from a 6-inch circular hole located 10 inches above the bottom of the TK-704 C tank and flowed onto the

tank-dike area. The crude oil formed a puddle (puddle diameter up to 200 meters) and a pool fire started in the tank-dike.
The first accident scenario (warm season) was assumed to occur on July 20, 2016, at 15:30 LST. The temperature on-scene was 33 °C and the wind blew from the southeast at 3 m/s (measured at a height of 10 m by a fixed meteorological tower at the site). The cloud cover was less than 4 oktas and the relative humidity was about 25%. There were no low-level inversion conditions. Such a combination of weather patterns corresponds to sligthly stable atmospheric conditions (Pasquill-Gifford stability category E).
The second scenario (cold season) was assumed to occur on January 20, 2016, at 20:30 LST. The temperature on-scene was 8 °C and the wind blew from the norteast at 4 m/s. The cloud cover was more than 4 oktas and the relative humidity was about 75%. No low-level inversion was assumed. This combination represents conditions of neutral atmospheric stability (Pasquill-Gifford stability category D).

3. RESULTS

At first, we assumed that the crude oil did not burn and formed an evaporating puddle onto the dike area. As the puddle evaporated (the amount of vapor released at any time was 2.9 kg/min), a vapor cloud formed. The release of vapor into the atmosphere lasted for about 60 minutes. The toxic area threat zone was estimated using the Emergency Response Planning Guidelines (ERPGs) as Level of Concern (LOC). Then, we assumed that a pool fire occurred, soon after the puddle formed. According to the ALOHA estimations, the puddle burned for about 1 h, the maximum burn rate was 18 kg/min and the amount of burned oil was 1 tn, for both scenarios.
In warm season, the maximum toxic threat zone (red zone) extended to 989 m downwind. Within this zone, the ground-level crude oil concentrations exceeded the ERPG-3 level. At concentrations above the ERPG-3 level, people can experience serious health effects or find their ability to escape to be impaired (in case they are exposed for about 1 h). Unlike the toxic threat, the thermal radiation threat extended in all directions simultaneously, when the crude oil puddle formed a pool fire. The worst-case thermal radiation threat (red zone) was predicted to extend to roughly 149 m in all directions - slightly farther in the downwind direction (Figure 2a).
In cold season, the red toxic threat zone (the worst hazard level) extended primarily towards the downwind direction for about 377 m. The worst-case thermal radiation threat (red zone) was predicted to extend to roughly 151 m in all directions - slightly farther in the downwind direction (Figure 2b).



(**a**) (**b**)

Figure 2. (**a**) Thermal radiation threat zone for warm season, (**b**) Thermal radiation threat zone for cold season

4. CONCLUSION

In this work, the risk of cruid oil releases resulting from a hypothetical tank leakage at the ENERGEAN OIL & GAS S.A. of Kavala in Northern Greece were simulated under different meteorological conditions, representnig the warm and the cold season, using ALOHA. The simulations confirmed that wind direction plays a kye-role in both scenarios. The toxic threat was confined primarily to the area downwind of the release. Although the thermal radiation threat occured in all directions, it also shifted downwind from the source. Comparing the toxic threat zones, it is clear that in warm season (sligthly stable atmospheric conditions) the extension is bigger compared to cold season (neutral atmospheric stability conditions). The obtained results can be used for safety and emergency planning reasons and highlight the importance of local sources and meteorology during industrial accidents.

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