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Search & Rescue

Emerging technologies for the Early location of Entrapped victims under Collapsed Structures & Advanced Wearables for risk assessment and First Responders Safety in SAR operations

D1.2 Report on the functional specifications of S&R

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Executive Summary

The purpose of this deliverable is to define the end-user requirements in order to prepare the configuration of the chemical sensors technologies (portable or wearable) that will be developed inside SnR in terms of ergonomic, power supply, size, weight, user interface characteristics.

The operational requirements input from D1.2, combined with the results of D1.1 (referring to the task "State-of-the-art review on existing SAR technologies for the early location of entrapped victims") will be used for the design and development of the RESCUE MIMS prototype; the S&R artificial sniffing tool will be developed, capable of measuring critical volatiles in the field, either for the early detection of toxic environments or for the localisation of entrapped victims and for ensuring the chemical protection of the First Responder.

From this perspective, the technical and functional characteristics were analysed and proposed for:

- Portable Membrane Inlet Mass Spectrometer (MIMS);
- Rescue MIMS on Robotics;
- Six Gas HAZMAT Monitor with VOC Detection that can be attached to the uniform of the first responder (see **Figure 0-1**).

As seen in **Figure 0-1**, the Six Gas HAZMAT Monitor with VOC Detection is one of the equipment that ensures the security of the First Responder, contributing to its transformation into a Smart First Responder.

Figure 0-1 How S&R envisions the equipment of a first responder

Tools other than the above-mentioned chemical sensors, which are part of the First Respond equipment, are:

- **Smart glasses**: Create and send geo-tagged pictures / video from the field with notes, including option to stream live video/audio;

- **GPS Tracker**: GPS tracking will run even when there is loss of network connectivity (and synchronises logged GPS track data when re-connected).
- **Smartwatch** with a dedicated emergency communication app that integrates through Bluetooth on the smartphone and provides messaging, heart rate monitoring and alerting functions (standalone Android Wear compatible smartwatches can also be used for messaging, heart rate monitoring/alerting and GPS tracking).
    - Vibration on the wrist allows instant awareness of incoming messages while keeping hands free.
    - Alerts (Call for Assistance / Panic Button) provides monitoring centre and/or Command with visual and audible alarm showing location of the alert on map.
- **Smart-phone / Tough-phone** including emergency notification service for alerting civilians to evacuate an area pointing them to an appropriate gathering and exit point and an emergency communication App for locating victims trapped under collapsed buildings.

The usefulness of these solutions was analysed, including from the perspective of limitations and gaps manifested in the operation of devices with chemical sensors on the market (see D1.1 deliverable).

The needs to improve these chemical sensors expressed by users were also taken into account to optimise the use of these devices taking into account the specificities of S&R actions in the case of people trapped under rubble.

The concrete proposals on the technical and functional characteristics of the above-mentioned devices have highlighted only the essential aspects for their design and manufacture, within maximum and minimum flexible limits, in order to facilitate their realisation, testing and, finally, their operationalisation.

Deliverable D1.2 does not yet address the issue of technical and operational requirements of robot or UAV platforms on which chemical sensors may be mounted. However, sub-chapter 2.2.2 will mention the ability of robots under study and operational development to support the MIMS payload. Due to its complexity, the issue of Rescue MIMS on UAV (unmanned aerial vehicle) will be analysed at a later stage. The proposals of chemical sensors for UAV platform will be made in the final version of the deliverable. A gap analysis regarding community resilience was designed for strategic purposes, consolidating the idea that citizens and local communities are the centre of the S&R crisis management process. Through an analysis of the case studies several challenges were identified, as well as advantages and lessons learnt. While there are still many challenges S&R organisations face on different levels, there are also lessons learnt and improvements developed.

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1 Introduction

The overarching goal for this work is to develop a research roadmap that establishes the scientific and the technical bases to achieve what is being called Smart First Responders.

The vision for First Responders involves the following:

- Saving lives and minimising injuries to community members located in disaster areas;
- Improving First Responders occupational health and safety;
- Enhancing the overall operational efficiency of the First Responders service and the effectiveness of disaster prevention and protection;
- Minimising property loss from natural disasters and industries accidents;
- Minimising business interruption and loss of mission continuity due to natural disasters.

The First Responders activities include all areas of prevention and protection engineering and service emergency response, in order to address resilience across all disaster phases (i.e., pre-incident, during an incident, and post-incident).

An evolving range of databases and sensor networks will be tapped to create, store, exchange, analyse, and integrate information into critical knowledge to empower the purpose of Smart First Responder.

Engineering, developing, and deploying these systems will require new measurement tools and standards, among other technology developments.

This roadmap identifies and addresses high-priority measurement science research challenges, technical barriers, and related research and development gaps that hinder widespread application of Smart First Responder technologies and systems to enhance community protection against catastrophic events.

1.1 Purpose and Scope

The main objective of this document is to gather end-user requirements in order to prepare the configuration of the chemical sensors technologies (portable or wearable) that will be developed inside SnR in terms of ergonomic, power supply, size, weight, end-user interface characteristics and prepare the S&R Use case trials.

This task is part of the Definition Phase of the project for the purpose of specifying the requirements and specification of the S&R platform and how it complies with current European societal values, fundamental rights and applicable legislation, including in the area of privacy, personal data protection and free movement of people.

The chemical sensors technologies (portable or wearable) will help the first responder to be more efficient through:

- Optimal conditions for intense focus on finding and saving people;
- A sense of control over the situation;
- A feeling that time (or temporality) has not been changed or distorted, due to receiving data in almost real time.

A gap analysis regarding community resilience will be conducted with the strategic goal of consolidating the idea that citizen and local communities are the centre of the S&R crisis management process.

This type of analysis compares S&R management efforts, according to the resources used, with the desired performance at the local level. The analysis may include the examination of past operational situations in which mistakes have been made or where a need was identified to increase the quality of the managerial act. An important aspect is the existence of periodic self-assessments of the evolution over time of community resilience over time, to identify gaps and bottlenecks that may arise and solutions to improve the situation, taking into account limited local resources.

Collaboration, as a form of interaction, between professionals and volunteers at community level is highlighted as one of the solutions to increase the resilience of a community. This collaboration must assure volunteers that their desire to help can be manifested safely and to assume appropriate operational duties.

1.2 Structure of the Document

The structure of this document is as follows:

- Section 1 is an introduction to the document.
- Section 2 focuses on the requirements of the chemical sensor technologies that will be developed by the SnR project in terms of ergonomic, power supply, size, weight, end-user interface and maintenance characteristics and provides relevant suggestions.
- Section 3 exposes the outcomes of the Gap Analysis for Community Resilience, being conducted under task T1.3. In this regard it frames the scope and objective the gap analysis, outlines the timeline of the work and provides the necessary definitions. Additionally, it details the methodology employed, outlining the methodological tools used within its frame, i.e. expert consultation/focus groups, literature review, case studies and an appropriately designed survey. Section 3 further presents the actual literature review outcomes, while also addressing legislative/regulatory/standardisation issues with potential influence on the issue at hand. Last but not least, it summarises the case study findings, exposes the preliminary structure of GAP analysis and identifies next steps.
- Annex I cites the relevant bibliography and references.
- Annexes II and III provide the case studies collection templates (general overview and specific case templates) along with the partners' responses to those.
- Annexes IV and V present respectively the literature review collection and summary templates.

1.3 High-level User Requirements Identification

The questionnaires sent to end-users and project partners revealed the limitations, shortcomings and future needs for future improvement of the existing S&R technology (see Table 1-1).

The study of these questionnaires allowed us to know the limitations and gaps specific to the chemical sensor technology currently used, including the future needs of end users to improve the technique of chemical sensors (the purpose of this deliverable).

Table 1-1 Questionnaires for end-users and partners about limitation, gaps and future needs for existing S&R technologies

No	Company	Evaluator	Product name
1	CERTH- HIT	Ioannis Symeonidis	3D Mixed Reality Command Centre
2	CERTH- HIT	Ioannis Symeonidis	Emergency response health condition monitoring device
3	German Research Centre for Artificial Intelligence	Nikolas Müller	Rescue Robots & Autonomous vehicles
4	Johanniter Österreich Ausbildung und Forschung gemeinnützige GmbH	Sabrina Scheuer	Savox Searchcam 3000
5	Johanniter Österreich Ausbildung und Forschung gemeinnützige GmbH	Sabrina Scheuer	Sewerin Aquaphon A100
6	Johanniter Österreich Ausbildung und Forschung gemeinnützige GmbH	Sabrina Scheuer	Haberkron Emergency rescue set
7	Johanniter Österreich Ausbildung und Forschung gemeinnützige GmbH	Sabrina Scheuer	Motorola MTP3550
8	Johanniter Österreich Ausbildung und Forschung gemeinnützige GmbH	Pia Ferner	PAUL the 'WaterBackpack'
9	Johanniter Österreich Ausbildung und Forschung gemeinnützige GmbH	Pia Ferner	Clip CO detector
10	Johanniter Österreich Ausbildung und Forschung gemeinnützige GmbH	Pia Ferner	Motorola MTH 800
11	Johanniter Österreich Ausbildung und Forschung gemeinnützige GmbH	Pia Ferner	Motorola 1400/1600
12	Microsoft	Andrei-Madalin OANCA	Smart glasses and AR helmets HoloLens 2
13	National Technical University of Athens	Sofia Karma, Nick Panagiotou, Stamatis Giannoukos	Chemical sensors
14	National Technical University of Athens	Sofia Karma, Nick Panagiotou, Stamatis Giannoukos	Mass Spectrometry
15	Oculus	Andrei-Madalin OANCA	Smart glasses and AR helmets Oculus Quest
16	PUI FRANCE	Philippe BESSON	LEADER SCAN
17	PUI FRANCE	Philippe BESSON	Thermal technique
18	PUI FRANCE	Philippe BESSON	Acoustic technique
19	PUI FRANCE	Philippe BESSON	Optical technique
20	PUI FRANCE	Philippe BESSON	Pneumatic powered tools
21	PUI FRANCE	Philippe BESSON	Hydraulic powered tools
22	PUI FRANCE	Philippe BESSON	Gasoline power tools

24	PUI FRANCE	Philippe BESSON	Electrical power tools
25	PUI FRANCE	Philippe BESSON	Heavy Rigging
26	PUI FRANCE	Philippe BESSON	Technical rope
27	PUI FRANCE	Philippe BESSON	Hand tools
28	PUI FRANCE	Philippe BESSON	Canine search equipment
29	PUI FRANCE	Philippe BESSON	Drone (UAV)
30	PUI FRANCE	Philippe BESSON	Emergency response health condition monitoring device
31	PUI FRANCE	Philippe BESSON	Detection equipment
32	PUI FRANCE	Philippe BESSON	Radiation equipment
33	PUI FRANCE	Philippe BESSON	Personal First Responders protective equipment
34	PUI FRANCE	Philippe BESSON	Decontamination technique
35	PUI FRANCE	Philippe BESSON	Chemical sensors
36	PUI FRANCE	Philippe BESSON	Communications technique
37	JOHANNITER DEUTSCHLAND	Svenja Bertram	Half-shell helmet
38	Romanian Inspectorate for Emergency Situations	Cosma Robin	BioRadar BR 402
39	Romanian Inspectorate for Emergency Situations	Cristi Rotariu	FLIR Griffin GC/MS G510
40	Stimpex	Stimpex	Hazmat technique Detection equipment Wireless, portable multi-threat monitor for radiation and chemical detection
41	Stimpex	Stimpex	Hazmat technique Detection equipment ChemPro100i
42	Stimpex	Stimpex	RAE System
43	Uhasselt	IMOB / Uhasselt	Multipurpose UAVs (drones)
44	UNIFI	Laura Giraldi, Marta Maini	Fire crossing suit
45	UNIFI	Laura Giraldi, Marta Maini	GAS-TIGHT NBC WATERPROOF SUIT
46	UNIFI	Laura Giraldi, Marta Maini	LENZING FR SUIT
47	UNIFI	Laura Giraldi, Marta Maini	TEXPORT GARMENTS
48	UNIFI	Laura Giraldi, Marta Maini	LION PROTECTS
49	UNIFI	Laura Giraldi, Marta Maini	VALLFIREST
50	UNIFI	Laura Giraldi, Marta Maini	HYDROCOSTUME WRS Polar Zipered ATP CE
51	UNIFI	Laura Giraldi, Marta Maini	OUTSHELL FIRE SERVICE
52	UNIFI	Laura Giraldi, Marta Maini	FIRE MAX 3
53	UNIFI	Laura Giraldi, Marta Maini	FIREFIGHTER CLOTHING Drager

54	UNIFI	Laura Giraldi, Marta Maini	CPS 5800
55	UNIFI	Laura Giraldi, Marta Maini	CPS 7800
56	UNIFI	Laura Giraldi, Marta Maini	Smart textile professional uniform
57	University of Cagliari	Piero Cosseddu	Wearable Strain sensors
58	University of Cagliari (Italy)	Danilo Pani, Annalisa Bonfigli	Wearable device for ECG and respiration monitoring
59	ELLINIKI OMADA DIASOSIS SOMATEIO (HRT)	Iosif Vourvachis	Acoustic technique
60	ELLINIKI OMADA DIASOSIS SOMATEIO (HRT)	Iosif Vourvachis	Optical technique
61	ELLINIKI OMADA DIASOSIS SOMATEIO (HRT)	Iosif Vourvachis	Thermal technique
62	ELLINIKI OMADA DIASOSIS SOMATEIO (HRT)	Iosif Vourvachis	Pneumatic powered tools
63	ELLINIKI OMADA DIASOSIS SOMATEIO (HRT)	Iosif Vourvachis	Hydraulic powered tools
64	ELLINIKI OMADA DIASOSIS SOMATEIO (HRT)	Iosif Vourvachis	Gasoline power tools
65	ELLINIKI OMADA DIASOSIS SOMATEIO (HRT)	Iosif Vourvachis	Electrical power tools
66	ELLINIKI OMADA DIASOSIS SOMATEIO (HRT)	Iosif Vourvachis	Technical rope
67	ELLINIKI OMADA DIASOSIS SOMATEIO (HRT)	Iosif Vourvachis	Hand tools
68	ELLINIKI OMADA DIASOSIS SOMATEIO (HRT)	Iosif Vourvachis	Emergency response health condition monitoring device
69	ELLINIKI OMADA DIASOSIS SOMATEIO (HRT)	Iosif Vourvachis	Communications technique
70	Direccio Generale de Protecion Civil de Catalunia	Rosa Mata Frances	Acoustic technique
71	Direccio Generale de Protecion Civil de Catalunia	Rosa Mata Frances	Optical technique
72	Direccio Generale de Protecion Civil de Catalunia	Rosa Mata Frances	Thermal technique
73	Direccio Generale de Protecion Civil de Catalunia	Rosa Mata Frances	Pneumatic powered tools
74	Direccio Generale de Protecion Civil de Catalunia	Rosa Mata Frances	Hydraulic powered tools
75	Direccio Generale de Protecion Civil de Catalunia	Rosa Mata Frances	Gasoline power tools
76	Direccio Generale de Protecion Civil de Catalunia	Rosa Mata Frances	Electrical power tools
77	Direccio Generale de Protecion Civil de Catalunia	Rosa Mata Frances	Heavy Rigging
78	Direccio Generale de Protecion Civil de Catalunia	Rosa Mata Frances	Communications technique
79	SOFTWARE IMAGINATION & VISION S.R.L (SIMAVI)	Gabriela Panzariuc	Smart glasses and AR helmets (HoloLens 2)

80	SOFTWARE IMAGINATION & VISION S.R.L (SIMAVI)	Gabriela Panzariuc	Smart glasses and AR helmets (Oculus Quest)
81	AIDEAS OÜ (AIDEAS)	Patrick Karlsson	Rescue drones
82	UCSC	Andrea Gaggioli, Alice Chirico, Elena Gianotti	Biosensors for stress detection
83	KT	Rosanna Babagiannou, Iosif Sklavidis, Ioannis Karalis	Smartwatches

The information obtained from the questionnaires received from end users and S&R project partners allowed us to make operational technical recommendations for the design, development and testing of MIMS rescue, including the evaluation and testing of MIMS rescue over robots and drones.

These qualitative performance indicators are summarised below (not in prioritised order), regarding end-user's' requirements in order to prepare the configuration of the chemical sensors technologies (portable or wearable) that will be developed inside S&R:

- Production of smaller, lighter rescue tools with increased effectiveness in confined spaces; early detection of toxic environments for the first responders and K-9 dogs;
- Response time; it is the most critical parameter in the recovery of live victims in collapsed building environments. Reducing the response time significantly improves success rates of victim recovery.

The systems proposed by S&R directly operate under this realm; the chemical technologies proposed complementary to the canine dogs, supports early search and rescue of unconscious victims, or people with disabilities (e.g. hearing or speech impairment) that could not be easily located with conventional rescue tools or technologies e.g. geophones.

- The ability to accurately and non-invasively locate survivors following structural collapse – the ability to "see" through walls, smoke, debris, and obstacles;
- Lighter, more efficient power sources (batteries, fuel cells, or other technologies able to power multiple systems for longer periods of time);
- Improved monitoring systems (i.e., atmospheric, biomedical, personnel accountability, etc.) real-time, portable, multi-function devices that expand on existing detection capabilities;
- Reliable non-human, non-canine search and rescue systems - robust systems that combine enhanced canine/human search and rescue capabilities without existing weaknesses (i.e., robots),
- information about type of emergency, time of deployment, status of hardware devices etc.

2 Chemical S&R TOOLS

In essence, a chemical sensor is an independent analytical device that can provide information about the chemical composition of the environment with which it is in contact, which can be a liquid or a gaseous phase. The chemical information may originate from a chemical reaction by a biomaterial, chemical compound, or a combination of both attached onto the surface of a physical transducer toward bay analyse.

The subject of chemical sensors are an emerging discipline formed by the multidisciplinary study among chemistry, biology, electricity, optics, mechanics, acoustics, thermology, semiconductor technology, microelectronics technology and membrane technology.

Chemical sensors have gained increasing interest for application in environmental monitoring, industrial process monitoring, gas composition analysis, medicine, national and public security and on-site emergency (including S&R operations), disposal owing to its many excellent properties such as small size, satisfactory sensitivity, larger dynamic range, low cost and easy to realise automatic measurement [1].

The chemical sensor subject in an emerging discipline formed by the multidisciplinary study among chemistry, biology, electricity, optics, mechanics, acoustics, thermology, semiconductor technology, microelectronics technology and membrane technology.

Chemical sensors have been increasingly used in applications for environmental monitoring, industrial process monitoring, gas composition analysis, medicine, national and public security and on-site emergency (including S&R operations), disposal owing to its many excellent properties such as small size, satisfactory sensitivity, larger dynamic range, low cost and easy to realise automatic measurement and online or in situ [1]. Hence, the chemical sensor becomes one of the most active and effective directions of modern sensor technology.

A comparative assessment of existing state-of-the-art technologies for the detection of chemicals can be seen in Table 2-1.

Table 2-1 Benchmarking of existing state-of-the art technologies for detecting chemicals

Technique	Advantages	Limitations
EN (electronic noses)	1. Simplicity 2. Fast response times 3. Portability 4. Inexpensive	1. Unstable results 2. Specificity issues
MS (mass spectrometers)	1. High sensitivity (low LODs) 2. High specificity 3. High mass range 4. High resolution 5. Real time measurements 6. Measurements' stability 7. Accuracy 8. Portability 9. Fast analysis times (s)	1. Relatively high costs (purchase and maintenance)

	10. Qualitative and quantitative analysis 11. No sample preparation 12. Ability for MS/MS or MS^n (extra confirmation steps and elimination of false alarms)	
IMS (ion mobility spectrometry)	1. Instrumental simplicity 2. Small size 3. Light weight 4. Robustness 5. Low-power consumption 6. Fast response times 7. High sensitivity	1. False positive alarms 2. Potential compounds' adsorption onto the IMS surfaces 3. Limited selectivity 4. Lack of performance in highly contaminated environments 5. Humidity, temperature, and composition of the sample may affect detector's response 6. Bureaucracy due to the integrated radioactive sources
GC (gas chromatography)	1. Accuracy 2. Couples with other analytical techniques	1. Long analysis times
IR (infrared spectroscopy)	1. Reliable and repeatable results 2. Qualitative analysis 3. Quantitative analysis 4. Non-invasive technique	1. Lack of flexibility 2. Indoor use
CRDS (cavity ring-down spectroscopy)	1. Real-time measurements 2. High sensitivity	1. Lack of selectivity
LIBS (laser-induced breakdown spectroscopy)	1. Direct analysis 2. Sensitivity 3. Non-destructive real time analysis No sample preparation	1. False positive alarms 2. Plasma conditions vary with the environmental conditions
Raman (spectroscopy)	1. No sample preparation requirements 2. Sensitive to homo-nuclear molecular bonds 3. Fully integrated threat libraries 4. Portability 5. Non-destructive 6. Fast response times 7. Analysis through glass and polymer packaging	1. Cannot be used for metals or alloys 2. Fluorescence of the sample background may lead to false negative alarms
THz spectroscopy	1. Penetrates though materials 2. Non-destructive 3. Many non-metallic or non-polar materials are transparent to THz	1. Limited penetration in high-water content or metal objects 2. Distance limitations
Fluorescence	1. Excellent signal-to-noise ratio	1. Limit due to linear intensity
Instruments based on various sensors (e.g. chemical, electrochemical, immunochemical, colorimetric, etc.)	1. Portability 2. Sensitivity 3. Reliability 4. Easy operation 5. Low LODs 6. Fast response times	
Flame spectrophotometry	1. Sensitivity	1. Small number of excited atoms 2. Sample interferences 3. Reproducibility
Nanotechnology	1. Extreme sensitivity 2. Rapid analysis 3. Selectivity 4. Small size 5. Accuracy	
TLC (thin-layer chromatography)	1. Simplicity 2. Sensitivity (high) 3. Low cost 4. Fast separation	1. Humidity and temperature effects on the sample

Enzyme based sensors	1. Simplicity 2. Specificity 3. Sensitivity 4. Low false positive or negative alarms 5. Speed of analysis	1. Lack of stand-off detection

Field chemical analysis is the technique of sampling and analysing on-site and in time chemical compounds; it is the practice of measuring:

- The change in types of compounds;
- Concentration variations of compounds in space and time

The term "field" applies for space and/or time domains. Spatial measurements can be carried out in different directions, horizontally or vertically. Temporal measurements are generated by monitoring in fixed points (a point source, a stack) or when in motion and are discrete or continuous. Field Chemical Analysis applications have some common characteristics:

1. They usually have very fast evolving phenomena or events;
2. They have very strict and low time constraints;
3. They exhibit very broad concentration ranges and types of compounds;
4. Even if they have periodicity in events or processes, they have irregular periods;
5. They are influenced by the physical layout and environmental conditions;
6. They involve trained but not necessary specialists for operation.

Field analytical instruments are generally categorised based on (a) their principle of their operation, (b) their performance as a function of distance; stand-off and point devices; stand-off devices operate at a distance from the sample, while point devices operate close to the sample (c) their size, weight and portability in the field; they are divided into Portable Instruments, Mobile Labs and Wearable Instruments.

Portable analytical instruments are designed to be moved from one place to another in the field, in order to enable detection of compounds. The categories of portable instruments include hand-held devices, portable devices in the back (back-packed devices) and portable suitcases (luggage carried). In general, their main characteristics are:

- Weight <10 kg;
- Safety during use;
- Operation with battery or with direct current 24V, minim 6 working hours;
- Built-in sampling system;
- Possibility of self-control, self-correction and/or self-calibration
- Ability to process results on site and display them;
- Possibility of remote control.

However, depending on the application, field applications occasionally pose safety and health hazards for operators as well as safety and contamination risks for instruments; this is the case of S&R operations.

In case of a natural or man-made disaster first responders are confronted with a very demanding situation; e.g. harsh environment due to dust, smoke, high temperatures; people entrapped under the ruins; casualties in the disaster scene; unstable conditions for operating.

The possibility of further collapses in the strength of a structure already affected by the disaster reveals a persistent vulnerability and emphasises the importance of better integrating the collective response to such emergencies [2].

Disaster impacts are especially high in urban areas as they affect large, densely populated regions, often involving high, extended building blocks with complicated street patterns, socially diverse populations with ethnic, religious and linguistic issues[3]; therefore, urban S&R operations are considered time-consuming and technically demanding.

Searching under the ruins of collapsed buildings for alive people is actually a fight against time, as time is strongly associated with the chances of survival of the entrapped victims [4].

Canine searching is ideal for screening purposes covering large areas in short time-periods. Rescue dogs can detect unconscious victims and potentially dead bodies (cadaver dogs).

Nevertheless, the number of rescue dogs is limited, their performance varies and present short working time frames followed by rest times. Moreover, they can easily get saturated and frustrated (especially in the presence of dead bodies).

It is true that no chemical sensor can catch the sensitivity of canines; however, since they are exposed to many toxicological hazards and risks [5], investigating a technology that could possibly mimic dog-sniffing could be very important; though very demanding and ambitious since as a method is based on the detection of biogenic volatile organic compounds (VOCs), released continuously or periodically, from human tissues (e.g., skin, lungs) and biological fluids (e.g., sweat, urine) forming the human scent chemical profile [6].

During S&R operations in collapsed structures there is a possibility of toxic or explosive gases release, e.g. due to destruction of pipelines or explosion of gas cylinders under pressure that might be under the ruins, or fire spots that can be generated due to short circuits; there is a need to be capable of detecting on-site and on-line of such hazardous environments and in a safe distance from the source in order to protect the fire-fighters and generally the first responders and their canine dogs.

This can be achieved through state-of-the art field chemical sensors (portable instruments, hand-held, mobile units, roving systems, wearable sensors).

Ergonomic, power supply, size, weight and cost are some of the core characteristics of those sensors that need to be compatible with the end-users' requirements; major importance play the power supply, the ergonomics and the logistics; meteorological conditions during sampling should also be considered for obtaining reliable and accurate results; temperature, barometric pressure, wind speed, wind direction, humidity.

Summarising the data presented above information obtained by the chemical S&R tools (e.g. Rescue MIMS that will be developed inside the S&R) could help the First Responders in terms of their safety; chemical devices onboard fire-vehicles or robots could serve as early warning systems. Moreover, chemical tools could provide indications of vital signs of entrapped victims; this information combined with other data e.g. number of entrapped people under the ruins, possible position according to witnesses, could facilitate the S&R operations;

The challenge when using field analytical instruments in S&R operations is to measure with accuracy and minimum false alarms (cross sensitivities), as well as cope with the dynamic condition changes of

concentration gradients in space and time, the so-called transient phenomena and the "heavy" environment e.g. dust, high relative humidity etc. that are encountered under the ruins.

Robots are also believed to have great potential in assisting rescue workers locate and help entrapped victims. Robots have not been widely used yet in real-life disaster situations, However valuable information has been gained in the few cases where they have been deployed; e.g. chemical sensors have been tested as payloads on board unmanned platforms in S&R operations. Some of the areas where mobile platforms (robots) have been implemented to aid in SAR efforts are [7]:

- Mapping and manoeuvring of disaster areas after natural calamities, terror attacks, accidents, explosions, etc;
- Robots as assistance to firefighters worldwide;
- Bomb squads are using AI to aid in defusing and disposal missions;
- AI has been developed to detect signs of life, such as heart beats and breathing, of victims trapped in the aftermath of natural disasters;
- Drones been used to distribute water, food, medicines and other supplies.

2.1 **Portable Membrane Inlet Mass Spectrometer (MIMS)**

Mass Spectrometry is generally an instrumental method for chemical analysis used for measuring masses of atoms and molecules in gaseous, liquid or solid state. Membrane Inlet Mass Spectrometry (MIMIS) works by creating ions from neutral atoms and molecules and separating them according to their mass-to-charge ratios.

MIMS offers high sensitivity (low ppt), fast and accurate analysis, minimising the false alarms and without sample preparation requirements; it can be used for both simple and multicomponent mixtures simultaneously. Also compared to other MS techniques (e.g. PTRMS and SIFT-MS), MIMS offers lower size, weight, and cost which make it ideal for the field.

Moreover, MIMS is capable of air and aqueous analysis (detection and monitoring) of volatile organic compounds (VOCs), semi volatile Organic Compounds (SVOCs) and a number of permanent gases, such as ammonia (NH3), H2S etc. VOCs can be classified in anthropogenic and biogenic according to their origin. Anthropogenic VOCs derive mainly from manmade activities, such as industrial processes; e.g. benzene, toluene, nitrobenzene, styrene etc. These are classified as exogenous VOCs [8],[9].

MIMS is a specific and sensitive method of analysis of VOCs based on the separation of volatile organic analytes from an aqueous or gaseous sample by a thin membrane, which is installed between the sample and the ion source of a mass spectrometer.

Another advantage of the MIMS technology is that it is characterised by its simplicity in use, accuracy and fast chemical analysis (within seconds). MIMS instruments have demonstrated their largest commercial successes in the environmental and security fields. Apart from these fields it is also highly relevant for search and rescue operations [10]. There are already several offers of portable instruments based on mass spectrometry on the market (see Error! Reference source not found.).

Table 2-2 Summarises mass spectrometry based on portable instruments benchmarking

Supplier	Model	Mass analyser	Mass range (m/z)	Power (W)	Weight (kg)
INFICON	HAPSITE® ER Chemical Identification System	Quadrupole	41-300	N/A	34
FLIR Systems Inc.	Griffin™ 824	Cylindrical ion trap	N/A	N/A	22.7
FLIR Systems Inc.	Griffin™ 844	Cylindrical ion trap	N/A	110-240 VAC	20
Purdue University	Mini 12	Rectilinear ion trap	N/A-900	50	15
Torion Technologies (recently acquired by PerkinElmer)	TRIDION™-9 GC-MS	Toroidal ion trap	45-500	80	14.5
University of Liverpool	SNIFFLES pre-prototype	Non-scanning linear ion trap	50-500	34	14
Torion Technologies (recently acquired by PerkinElmer)	GUARDION™-7 GC-MS	Toroidal ion trap	50-500	75	13
Purdue University	Mini S	Rectilinear ion trap	N/A-925	65	12
Purdue University	Mini 10	Rectilinear ion trap	N/A-550	70	10
BaySpec Inc.	Portability™	Linear ion trap	40-650	65	9.9
1st Detect	MMS-100™	Cylindrical ion trap	15-625	N/A	8
Purdue University	Mini 11	Rectilinear ion trap	N/A-2000	30	5
908devices	M908 ™	Microscale ion traps	55-400	N/A	2
Samyang Chemical Corp	Palm portable (without pump)	Quadrupole ion trap	45-300	5	1.5

As an example, such a MIMS - Mini 2000 -[11] was made by integrating with the dimensions of 38 cm _ 23 cm _ 34 cm (length _ width _ height), with a tablet computer for system control. The whole system is powered by an adapter with a power consumption of 200 watts in total.

The main VOSs identified by MIMS - Mini 2000- are acetone, isoprene, propanoic acid and lactic acid.

An outside high-voltage interface (HVI) is available, providing a high DC voltage (0~_5000 V) that could be used for ionisation sources.

Using a cable connected with the HVI, the high voltage could be easily applied to the ionisation sources.

A tablet computer (X5, TECLAST, Guangzhou, China) is used as the control terminal, which could communicate with instrument control electronics by a wireless method (wireless fidelity, WIFI) or a cable based on the TCP/IP network protocol.

The overall instrument is 13 kg, and power-supplied by an adapter with a power consumption of 200 watts in total.

The main VOCs identified by MIMS - Mini 2000- are acetone, isoprene, propanoic acid, lactic acid, tetrachloroethene and trichlorobenzene.

The membrane material used in the TCAT inlet is 0.125 mm thick.

Another result of the research [12], led to the development of a hand-held membrane inlet mass spectrometer (MIMS) in the qualitative determination (for both detection and screening) and quantitative analysis of organohalogen chemical analytes in the gaseous phase, lightweight (11 kg).

In conclusion, we can say that using MS techniques provides an additional level of information not offered by other technologies, being able to detect levels of individual constituents and the ability to distinguish between different constituents' types.

2.1.1 Required efficiency and comfort in the working environment

The location of the victims trapped under the rubble is the first phase of maximum emergency of S&R operations (specialty literature is unanimous in considering the chances of survival of people trapped under debris being about 80% on the first day, less than 10% on the second day and about 1% after the third day from the date of the disaster).

The result is the need for the first responders to make optimal use of the best performing means of detection.

The means of detecting people trapped under rubble most commonly used today have limitations and gaps in operation, which has given rise to the use of other search devices to cover the weaknesses of the means of detection that have become classic.

The use of RESCUE MIMS complements and does not replace the activity of conventional means of detection.

In order to more precisely define the future needs of end-users regarding the use of RESCUE MIMS, we need to analyse the limitations and gaps specific to classical means of detection.

The classic means of detection currently can be classified as follows:

A. Dogs specially trained for S&R (K-9);
B. Hearing aids;
C. Thermal detection equipment;
D. Fibre optic detection equipment.
E. Scanning technique (radar)

A. Dogs specially trained for S&R (K-9)

Dogs specially trained for S&R (K-9) use their natural sniffing abilities and are used for screening large areas to detect victims, regardless of their physical and mental condition.

As a rule, K-9 dogs should be directed to any gaps, vents, cracks in walls, holes, sewers, i.e. where there are drafts.

Although the use of K-9 dogs remains a paradigm of S&R actions, their use has revealed a number of operational limitations, among which we mention the most important ones [13]:

- The limited number of K-9s compared to the operational needs of the multitude and complexity of the disaster typology;
- Difficulty in transportation (customs requirements for int. missions etc.)

- Physiologically, K-9 dogs show a limited capacity for resistance to fatigue and nervous tension, which leads to a reduction in the ability to sniff after more than an hour of searching;
- The accommodation and feeding conditions of K-9 dogs require at least a separate room from that of humans;
- Depending on the danger of collapse of some construction elements, K-9 dogs must be kept on a leash, which diminishes their operational capabilities;
- When a K-9 dog emits a false alarm to identify an incarcerated person, the search must be resumed from the beginning with another K-9 dog;
- K-9 dogs are sensitive to the weather conditions in which they operate (relatively high humidity, low temperatures, dust, etc.);
- K-9 dogs show a very high vulnerability to non-human VOC emissions and toxic gases generated by a disaster, especially to changes in the dynamic conditions of the space and time concentration gradients of the factors mentioned above. K-9 dogs are vulnerable to diffuse emissions from leaks / losses in equipment in disaster-damaged facilities (fugitive emissions) or to evaporation losses resulting from damage to storage/storage of hazardous toxic substances and petroleum products.

B. Hearing aids

This acoustic technique is used to determine weak noises or vibrations produced by people trapped under the rubble.

Despite all the improvements made, the degree of probability of issuing false alarms remains significant.

These false alarms may be due to:

- Post-disaster cracking of construction structure materials due to structural defects;
- Background noise in the intervention area;
- Inability to detect unconscious victims or limiting the likelihood of locating entrapped persons with disabilities (speech, hearing, etc.).

C. Thermal detection equipment

Thermal chambers are used to detect the heat signatures of the bodies of living victims.

The limits of using such thermal detection devices are given by the sensitivity to smoke, dust and the existence of another heat source in the area.

Similarly, the thermal detection equipment is sensitive, being able to give false alarms, to high ambient temperatures, exposure to chemicals, but to the direct action of sunlight.

One of the weaknesses of such devices is the poor contrast quality when used at high outside temperature

It should be noted that this type of technique requires high maintenance costs.

D. Fibre optic detection equipment

The use of fibre optic detectors has a high sensitivity to smoke, fog and moisture.

In the same vein, the introduction of fibre optics through the rubble does not provide a satisfactory coverage of the areas affected by the disaster and the visualisation of all the spaces where it could find survivors.

One of the weaknesses of such devices is the poor picture quality.

It should be noted that such a technique involves a high cost, especially in terms of its maintenance.

E. Scanning technique (radar)

The equipment transmitted radar waves, which are reflected by all things in front of it, received back and evaluated by the BioRadar [14]. By this way all body movement, also breathing and heartbeat can be detected and evaluated.

This type of technique generally uses sensors using Ultra-Wide Band (UWB) technology allowing the scanning of the rubble surface in order to search for movements of conscious or unconscious victims up to 30 m. in free field, to detect up to 7 living people buried.

The amount of radiation used by this equipment is considered fully harmless for all creatures because of its low power.

The weak points of using this type of technique are:

- Parts of metal (steel in concrete) may cause a loss of sensitivity of the BioRadar;
- Lack of wireless connection or weak WIFI signal quality;
- Lack of ease of use 12V power supply;
- No automatic shutdown of the device after 5 minutes of inactivity;
- Random results with false positives;
- Influence of movements of moving materials (wind);
- Risk of detection of other stakeholders;
- Weight between 16 – 18 kg.

Summarising the above, it highlights the need for a technology that adds value to S&R actions, complementing the action of traditional means of detection to overcome existing shortcomings.

In this regard advanced field chemical tools could be used for the early detection of a hazardous environment in terms of toxicity or explosively are vital for the safety of the first responders who are the ones to be exposed at certain risks when approaching the disaster scene and during the SAR operation; remote sensing, hazard analysis and decision making for the operational managers.

These chemical tools could be also used complementarily to conventional methods for the detection of entrapped victims; e.g. thermal cameras can be used to detect body heat signatures of living victims, as well as for inspection of large, dark areas, even under smoke and dust; however, if other heat sources are present e.g. fire spot under ruins, it creates false-alarms; acoustic technologies, could also potentially locate the victim position and/or identify faint noise/vibrations; however significant false alarms, such as further cracking of the structural materials after secondary earthquakes (structural failures), or background noise in general may dampen the data received. It has to be noted that acoustic

technologies are limited for location of people with disabilities, such as speech or hearing impairment and unable to detect unconscious victims.

Information obtained by the chemical S&R tools (e.g. Rescue MIMS that will be developed inside the S&R) could help the first responders in terms of their safety; chemical devices onboard fire-vehicles or robots could serve as early warning systems. Moreover, chemical tools could provide with indications of vital signs of entrapped victims; this information combined with other data e.g. number of entrapped people under the ruins, possible position according to witnesses, could facilitate the SAR operations.

Such a technological solution can be represented by MIMS, as argued in the next subchapter.

Last but not least, this technique must also provide increased First Responder protection against the action of industrial toxic gases, which was provided protection in a minimal or no way by the already existing technique.

2.1.2 Core characteristics required: power supply, size, weight, user interface characteristics

The portable Rescue MIMS that will be developed inside the S&R will be designed to be used both as luggage carried device or back-pack. It will be tested as a payload for the robotics (see subchapter 2.2) that will be used inside the S&R project (e.g. Coyote III) for recording chemical signs in the outer space of the collapsed structure or inside the voids, depending on the pilot scenario.

Based on the first responders needs and requirements it will ensure "light-weighted", "easy to deploy" and "simple to use", inclusive provide a better decision making; compared with existing solutions it will provide with high accuracy and ultra-low detection limits (low ppb levels) without pre-concentration, as well as minimum false alarms and background interferences, capable of measuring under dynamic changes of concentration gradients in space and time and with the capability of auto-protection in harsh environments, such as dust, increased RH% etc.

These chemical signs will be related either to First Responders and K-9 dogs Safety (early warning system of a toxic environment during the SAR operation), or for measuring chemical signs of life of entrapped people.

Human chemical signatures (HCS), which basically refer to the characteristic human body odour signals, are an innovative and upcoming research field. Both human expired air compounds with human skin and sweat scent compose and declare an individual's characteristic door or, in other words a person's unique and distinctive chemical "odour print" that is analogous to a fingerprint[15][16].

Volatile organic compound (VOC) emissions from human exhaled breath, sweat, skin, and other biological excretes have been used for a wide range of applications including diagnostic purposes in medicine, search and rescue operations, forensic and toxicological analysis [17].

Human exhaled air is a complex mixture of both inorganic gases and traces of VOCs and its composition depends on several factors, which are found in the daily life habits (diet, smoking [or not], exercise, medication, etc.), ethnic background, gender, age, living and working environments, etc. [18]); most of the VOCs in breath have typical concentration ranges at ppb or ppt concentration levels and are responsible for human breath door. Monitoring of human chemical signatures using membrane inlet mass spectrometry has been achieved [19].

In the scientific research specific to the analysed field [20], the advantages of using a portable mass spectrometer compared to other techniques used in artificial sniffing were relevant to:

- High sensitivity (low LODs);
- High specificity;
- High mass range;
- High resolution;
- Real time measurements;
- Measurements 'stability;
- Accuracy;
- Portability;
- Fast analysis time(s).

The membrane inlet version of mass spectrometer (MIMS) not only capitalises the advantages listed above but can improve the limitations of this type of technique in terms of:

- Size and weight;
- Power consumption;
- High costs (purchase and maintenance).

However, the main limitation of the method is possible selectivity issues for some permanent gases; e.g. using selective masses like 28 can be attributed to both CO and N2 gases.

This limitation can be overpassed if selective electrochemical sensor could be integrated to the system.

Taking into account the requirements of end users, the following core characteristics in terms of power supply, size, weight, user interface characteristics etc. are summarised for the RESCUE MIMS:

- Size: maximum 60 x 50 x 20 cm (Peli case);
- Weight: <10 kg (inclusive battery pack if required);
- Temperature operating range: -20°C to +50°C;
- Operating humidity: up to 90%;
- Limit of detection ≤ 10 ppb;
- Relative standard deviation RSD ≤ 5%;
- Max operating pressure: 1x10-5 Torr;
- Membrane response times in real times (analysis within seconds);
- Configuration: with probe capability;
- Integrated computer and LCD;
- 9" touch-screen;
- 9" Multicolour Touch Screen (1280 x 720 WVGA);
- Dust tight;
- Visible alarm;
- Interchangeable, rechargeable battery with over 4 hours of continuous operation or 6-AA battery pack;
- Electronics (ECU) weight: 1.25 kg ECU;
- Power consumption: 50 W<;
- Custom membrane inlet;
- Dual filament ion source;
- Dual quadrupole analyser;
- Dual detector (Faraday/multiplier) Connections: RS232/USB/Ethernet;
- Extensive I/O control;

- User ADC/DAC and vacuum interlock;
- Quadrupole mass analyser;
- Up to 300 Da mass range;
- Unit resolution;
- High sensitivity;
- Novel manufacturing;
- Portable;
- Rapid detection;
- Reliable;
- No sample preparation needed;
- Target substance identification;
- Thermally stable.

Library customisation a database to identify, at least, the following VOCs:

a) Metabolic processes in the human body: CO2, lactic acid, acetone, propanoic acid, ethanol, ammoniac, methanol, isoprene, propanol, isopropanol, butanone, 1- pentene, 1- butane, acetaldehyde etc.;
b) VOCs emitted from manmade activities such as industrial processes: benzene, toluene, nitrobenzene, trichloromethane, 1,2-dichloromethane, 1,1,1-trichloromethane, 1,1,1,2-tetrachloroethene, bromomethane, dibromomethane, chlorobromomethane, bromodichloromethane chlorodifluoromethane, trichlorofluoromethane, methyl iodide, butadiene, butanone, butyl acrylate, chlorobenzene, toluene, etylacrylate-hexane, ethylbenzene, phosphine, propylene oxide, methylacrylate, methybromide, styrene.

Regarding the cost of such a MIMS device, we consider that a cost-benefit analysis would be the best way to assess the starting price of the market.

As a guide, because most prices for MIMS devices are protected by trade secret law (from US $ 20,000-50,000 offered by Jiangsu Skyray Instrument Co., Ltd. offers MIMS between $ 20,000-50,000, we consider that that the selling price for a MIMS device with the main technical characteristics mentioned above shall not exceed € 50.000.

2.1.3 Equipment Maintenance

The maintenance rules of the MIMS equipment depend on the technical solution adopted and the result of the experimental tests.

However, several general rules for the maintenance of the MIMS equipment can be established to ensure its functionality.

These general maintenance requirements, in a specially designed room, are:

- Storage temperatures: -20 ° C to 50 ° C;
- Protection against dust or sunlight;
- Room humidity up to 95%;
- checking the functionality of the MIMS components, repairing or replaceable parts them the day after each intervention or after each training exercise simulating the effects of a disaster or every 2 months.

- In the same sense, it is useful to have a user manual in which the maintenance of the MIMS device is mentioned in a separate chapter.

2.1.4 Conclusions and proposals

Summarising the above information, we can conclude that the operational usefulness of a MIMS in the search for people trapped in the event of a disaster is absolutely necessary, because it helps to achieve 2 basic objectives of S&R actions:

- increasing the chances of identifying people trapped under the rubble by overcoming the limitations generated by the action of K-9 dogs or other technologies used in this case;
- ensuring increased protection for First Responder to VOCs action generated by industrially produced materials.

As a proposal, we consider that a Portable Membrane Inlet Mass Spectrometer (MIMS) with the main operational feature mentioned as subchapter 2.1.2 is an indispensable support for the search of people trapped under rubble.

2.2 Rescue MIMS on Robotics

The hand-held MIMS device as shown in subchapter 2.1 is a step forward in optimizing S&R actions.

First responders may be faced with operational situations where a disaster-affected area has limited access at sites where there is the possibility of the existence of people trapped under the rubble. This operational situation makes it difficult or inoperative to use the RESCUE MIMS hand-handed:

- The initial reduced number of First Responders who can access the area affected by the disaster;
- Difficult access conditions for first Responders in the intervention area;
- The existence of VOCs derive mainly from manmade activities such as industrial processes involving a high exposure of First Responders to the effects of this toxic volatile products toxic environment;
- Providing preliminary information to the S&R teams about VOCs emitted by metabolic processes in the human body to allow the judicious distribution of their forces at each point of work was to identify people trapped under the rubble.

The introduction of unmanned S&R devices can offer a valuable tool to save human lives and to speed up the search and rescue process.

Under these conditions, the use of a MIMS device mounted on a micro rover robot platform is a valuable unmanned tool.

2.2.1 Required efficiency and comfort in the working environment

The search and rescue context is extremely technology unfriendly, as robust solutions are required which can be deployed extremely quickly.

More and more robotic tools are now leaving the protected lab environment and are being deployed and integrated in the everyday life of citizens.

However, so far, robots have not been widely used in real-life disaster situations, but in a few cases valuable information has been obtained where they have been deployed, for example chemical sensors have been tested as payloads on unmanned platforms from S&R operations.

Like any technique of the future, the use of robots as a platform for search-rescue is still viewed by end users with caution, due to distrust in the accuracy of information received in harsh weather conditions, their ability to traverse an area with debris resulting from a natural or technological disaster, the accuracy of the transmitted data - especially on video images.

Similarly, there has been scepticism regarding the feasibility/applicability of deploying robots using the RESCUE MIMS device due to possible technical limitations:

- Legged wheels may become fragile on high loads;
- Limited power capacity, no long-term operation.

As a partial conclusion, the ease of use, endurance, and capabilities to collect and quickly transmit data to rescuers are also important barriers to adoption that the research community must focus on in the future.

The importance of the problem has led to solutions already being sought at EU level.

Among these EU projects we mention:

- The ViewFinder project (2006–2009) focused on the assessment phase, developing ground robotic agents operating in chemically contaminated disaster areas to establish whether the ground can be entered safely by human beings [21];
- The TRADR project (2013–2017) builds on the experience of the NIFTI project for human-robot collaboration in an urban search and rescue context, by building persistent environment models to improve team members 'understanding of how to work in the disaster area. TRADR robots were successfully deployed in order to deal with the damage assessment operations after the 2016 earthquake in Amatrice, Italy [22];
- The INACHUS project (2015–2018) aims at providing wide-area situation awareness solutions, including novel snake-like robotic agents, for the improved detection and localisation of victims trapped inside semi-demolished buildings [23].

Finally, an important aspect of existing research work is the emphasis on human-robot teams, which meets the desire of stakeholders to maintain a human in the loop during deployments in situations where priorities may change quickly [24].

Indeed, one crucial aspect must not be forgotten: the robotic tools must not have the objective to eliminate the need of human search and rescue workers or K9 dogs.

Instead, these robotic assets must be seen as yet another tool in the ample toolkit of human search and rescue workers in order to allow them to do their job better, faster, and safer.

Regarding the minimum level of preparation of First Responders user, the ideal situation would be that in which a First Responder that uses portable MIMS in hand to be trained in driving micro rover robot.

Regardless of the solution adopted, the existence of a user manual as a basis for training for driving a micro rover is necessary.

However, so far, robots have not been widely used in real-life disaster situations, but in a few cases valuable information has been obtained where they have been deployed, for example chemical sensors have been tested as payloads on unmanned platforms from SAR operations.

Like any technique of the future, the use of robots as a platform for S&R is still viewed by end-users with caution, due to distrust in the accuracy of information received in harsh weather conditions, their ability to traverse an area with debris resulting from a natural or technological disaster, the accuracy of the transmitted data - especially on video images.

When operated on a mobile platform, MIMS device instruments can track transient concentration excursions in both spatial and temporal domains that may be missed by grab sampling strategies.

For the same purpose the platform has various sensors for visual perception such as a laser range finder and a high accuracy camera and inertial measurement unit.

The advent of MIMS technology mounted on the platform of a micro rover has enabled a new framework for environmental monitoring, where it is possible to take high precision, high accuracy chemical measurements to the field.

As a partial conclusion, the ease of use, endurance, and capabilities to collect and quickly transmit data to rescuers are also important barriers to adoption that the research community must focus on in the future.

2.2.2 Core characteristics required: power supply, size, payload, user interface characteristics

In order to examine core functions of an S&R robot with a platform-mounted MIMS device we are using an existing lightweight mobile robotic system like a micro rover with high mobility performance in unstructured terrains. Equipped with its own power source, on-board sensor suite and computer it is able to perform autonomous exploration.

An example of a micro rover robot that meets the conditions listed above is the Coyote III (developed by DFKI).

Coyote III as robot platform carrier for MIMS device is compact, lightweight, agile, and can hold the required payload for the developed mass spectrometer.

Also, it already has been used in similar S&R applications with a mounted gas sensor hence it suits the use-case ideally.

It is equipped with software which includes a 3D-Mapping algorithm and semi-autonomous navigation which allows for collision-free navigation between waypoints.

A GPS tracker could be integrated on the robotic platforms.

The modular design approach allows adapting the rover structure according to specific payload requirements.

In contrast to competitor robot platforms, which use either regular wheels or tracks, it allows a stable and quick motion on all types of terrain without causing any unnecessary damage. The platform features various sensors for visual perception like a laser range finder and a high accuracy camera and inertial measurement unit.

Continuous quantification enables the capture of transient events that may be missed or under-represented by traditional grab sampling strategies.

The technical characteristics of Coyote III micro rover offer the following advantages in use:

- Robust but lightweight frame;
- Mobility on difficult terrain;
- Climb stairs and rocks;
- Modular mount for sensors and manipulator;
- Possible cooperation with other robots operating in the disaster-stricken area.

The technical details of the Coyote III, which can be considered minimal for any type of micro rover with MIMS load for S&R operations, are:

- Weighs of micro rover<12.5 kg
- Payload (referring to the MIMS device) <10 kg;
- Wireless connection: mobile access point, WIFI, Bluetooth;
- Handling opening battery compartments: battery never needs to be directly accessed;
- Ease of use main power: direct connection by cable, no docking station;
- Laser range finder: Hokuyo UST – 20LX;
- Driving sensors: Absolut Enconder;
- On-board computer: Intel Core, 1,7 GHz;
- Remote control: Bluetooth;
- Power supply: LIPo primary battery: 44,4 V; 4,5 Ah;
- Mobil access point: 2,4 GHz, 802,11n;
- Wheels: Hybrid legged-wheels (5 legs)

In the literature there are opinions according to which data presentation and interpretation is eased through the use of free Geographic Information System (GIS) applications, such as Google Earth. Using MIMS data that is both time and location-stamped, we are able to provide real-time chemical concentrations that are geospatially mapped.

In the same direction, it is considered that a global positioning system (GPS, QStarz, Model BT-Q1000XT; Taipei, Taiwan) was used for geo-location and accurate time-stamping of all collected data.

According to the majority of end-users who answered the above questionnaires (Table 1-2), it would be useful to use the cellular network card installed in the data system computer (Model M6600; Dell, Round Rock, TX, USA) to provide cloud data storage (Dropbox, San Francisco, CA, USA) and continuous data backup in the field.

From the point of view of MIMS end users, we consider that, in view of the proposed purpose, the MIMS device mounted on the micro rover platform has the same technical characteristics as described in subchapter 2.1.2.

2.2.3 Equipment Maintenance

From the point of view of the MIMS, which is mounted on the micro rover platform, its maintenance rules remain those mentioned in point 2.1.3 of the deliverable.

Regarding the maintenance of the micro rover robot, this will be done according to the provisions of its operation manual.

2.2.4 Conclusions and proposals

As proven by past successes, unmanned robotic tools have a great promise to increase the effectiveness of search and rescue operations. However, there is still a large number of bottlenecks which prevent the successful introduction of these unmanned tools on the practical terrain.

Any research project on the use of robots in search and rescue operations, including those concerning the use of RESCUE MIMS installed on their platforms, has tried to tackle some of these issues by following an approach of tight inter-relation with the end-users and of developing multi-tiered systems, i.e., making systems which are modular up to a certain degree, such that they can do multiple tasks, but not trying to do everything with one system, which would lead to an overflow of requirements [25].

It can be concluded that finding technical solutions to solve the limitations and gaps on RESCUE MIMS on Robotics would bring the following benefit with a significant impact on optimising search-and-rescue actions:

- Unmanned systems with RESCUE MIMS keep the human rescue workers and K-9 dogs out of harm. This is especially important in earthquake response scenarios, where search and rescue workers now still have to enter semi-demolished structurally unstable buildings to search for survivors, terrified by the possibility of aftershocks bringing the whole structure down.

As a proposal, we consider that the use for the S&R operation of people trapped under the rubble by using MIMS technology mounted on the platform of a micro rover with the operational characteristics proposed in subchapter 2.2.2 offers an extra adaptability to the complexity and multitude of situations generated by a disaster.

2.3 Six Gas HAZMAT Monitor with VOC detection for first responder

Multi-criteria detectors rely on multiple modalities (e.g., photoelectric, heat, carbon monoxide) to improve response times and reject false alarms from nuisance sources.

Increasing power and connectivity of computer resources including embedded computing provides opportunities for elaborate algorithms and even models to further improve performance increase value of information.

For this purpose, it is useful and necessary to use a Six Gas HAZMAT monitor with VOC detection consisting of several chemical sensors allowing for greater threat detection such as toxic gases, oxygen deficiency and carbon dioxide.

Due to the wireless nature of the instrument, real-time data transmission of instrument readings and alarms can be provided for increased safety and faster response times.

A Six Gas HAZMAT monitor with VOC detection is the optimal solution for monitoring maximum 6 gases (such as toxic gases, oxygen deficiency and carbon dioxide), for personal protection (including entering semi-enclosed or closed spaces) and for detecting possible gas leaks in the intervention area. The possibility of wireless connection offers real-time access to the instrument's indications, the alarm status in any location and a faster incident response time.

A Six Gas HAZMAT monitor with VOC detection embedded on wearable of First Responder can offer a variety of useful functions in R&D operation, as follows:

- Environmental assessment to ensure personal safety;
- Facilitation of real-time decision making by incident commanders;
- Increase of fundamental knowledge on risk factors and long-term exposure outcomes.

2.3.1 Required efficiency and comfort in the working environment

It has become a paradigm to find that natural disasters – such as earthquakes or landslides – can trigger complementary disasters, especially of a technological nature, such as spills of hazardous industrial chemical, explosions or fires.

This dynamic of the disaster cycle, also known as the ”domino effect” [26], is a factor in multiplying the destructive effects of the initial disaster on the affected communities, regions or countries.

Such destructive effects often have a predictability that is difficult to assess and can have a negative impact on the affected community over a longer period of time – including years.

One of the immediate effects of the phenomenon described above is on ensuring the physical and mental safety of First Responders and volunteers who provide field intervention.

Especially at the level of well-intentioned volunteers, risk of injury during S&R operations might be high, due to the fact that they did not pay enough attention to the impacts of complementary disasters that may overwhelm their own physical and mental limits.

The fundamental paradigm that acts in this field is ”fatigue leads to injury”. You will be valuable as a First Responder if you stay healthy.

Members of a S&R team must have at their disposal equipment and personal protective equipment to help determine the danger of approaching physical and mental limits specific to each person.

Technological progress makes available dedicated personal protection tools that offer more valid and effective solutions in cases of post-disaster interventions.

Above all, it can increase the survival rate of First Responders and volunteers, allowing for faster and more accurate interventions, thus increasing the likelihood of a successful rescue of victims.

First responders require specialised protection instrumentation, available at all times, easily accessible, that meet requirements in term of health detection accuracy, quick localisation of new threats, and reduction of false alarms (of these, the efforts to achieve wearable monitoring systems embedded in the uniform of the first responder – ECG, EMG, strain sensors, radiation sensors).

Among these protection tools, advanced field chemical tools for the early detection of a hazardous environment in terms of toxicity such as the Six Gas HAZMAT monitor with VOC detection are vital for the safety of the First Responders who are the ones to be exposed at certain risks when approaching the disaster scene and during the S&R operation,

Of these chemical tools, a Six Gas HAZMAT monitor with VOC detection with VOC on wearable of First Responder is an urgent operational need for personal protection.

This measure ensures the protection of First Responders from the negative effects of complementary disasters that generate VOCs derived mainly from manmade activities such as industrial processes and emissions of dangerous toxic gases, oxygen deficiency, carbon dioxide etc.

Using a Six Gas HAZMAT monitor with VOC detection provides First Responder the following operational features:

- use hands freely;
- detect, monitor and analyse passive and active threats and dangers in real-time incident scenes;
- to automatically transmit, due to the wireless nature of the instrument, the real-time data displayed by the reading and alarm instruments - audio and vibration - to all other First Responders involved in the intervention at the same point of work.

2.3.2 Core characteristics required*:* power supply, size, payload, user interface characteristics, durability and cost

On the market, there are a significant number of commercial portable sensors, even of a small size that are targeting first responders' safety, including detection of asphyxiates, irritants, or explosive gases and volatiles, covering a wide range of areas such as:

- Personal protection and detection of multi-gas leaks in the chemical, food, extractive and petrochemical industries, telecommunications, water treatment;
- Civil protection (which includes the S&R subdomain);
- Environmental protection;
- Identification of explosives, bombs, drugs or chemical weapons.

In this context, the portable chemical sensors usually consist of maximum 4 - 5 different channels for placing sensors on demand.

During field interventions, it was found that operational capability of the chemical sensors may be reduced in harsh environments, since there is no auto-protection against "poisoning" due to very high concentrations that can be measured in case of turbulent flows.

To date, the European ProeTEX project, which ended in 2010, has developed a prototype for fire safety, including chemical permanent gas sensors, namely CO and CO2.

Regarding VOCs detection, most of the portable photoionisation detectors are usually used for measuring the total VOCs (mainly BTX).

Nevertheless, other compounds may need to be measured on line in the disaster scene which is considered very toxic, such as dioxins that a PID (photoionisation detection) cannot measure.

To fill this gap, commercial GC-SAW or z-nose technologies can be used for that reason with high accuracy and repeatability, but mainly as mobile units or at fixed - detection point for the detection of narcotics, bombs, chemical agents (e.g., GB, GD, HD, etc.) and explosives.

At the same time they become very easily saturated in harsh environments and have limited selectivity and give potential false positive alarms usually produced by environmental or complex sample interferences.

As a partial conclusion, the use of a Six Gas HAZMAT monitor on the First Responder wearable in a flap pocket, but which can also be carried in the hand, is required as a viable solution to overcome these limitations and ensure increased security First Responder achieving indirectly an optimisation of S&R operations.

Such a Six Gas HAZMAT monitor must, as a minimum, be easy to carry in the intervention area, robust in operation, adjusted to the requirements of end users and easy to use.

From the comparison of the offer of Gas HAZMAT monitor devices existing on the market (of these, we list, at random, the following devices: QualitySpec®Trek, Gas – Pro Crowcon, Dräger X-pid® 9000/9500 Multi-Gas Detection, MULTIRAE Lite, FLIR Griffin® G510 GC/MS.), the great variety of adopted solutions was highlighted, among which we list the margin of choice for the most significant technical characteristics:

- Technology: Gas Chromatography/Mass Spectrometry with analysis by gas diffusion or with built-in suction pump;
- Size: from 4,2×13×8,4 (cm) to 33,7×33,7×40 (cm);
- Weight: from 0,333 (kg) to 16 (kg);
- Operating temperature: from – 10 +35°C to – 20 +55°C;
- Humidity: from 10%-95% RH to <95% RH;
- Language: minim 2 languages of world circulation;
- Cost: Most prices ranged from 1.500 to 2.500 €.

From the end users' point of view, a Six Gas HAZMAT monitor with VOC detection must meet, as a minimum, the following technical and operational characteristics:

- Possibility of wireless access in real time to the indications of the instrument and the alarm status from any location;
- Uses intelligent sensors that maintain calibration and can be changed at the measurement site;
- Dimensions: average 175 x 96.5 x 56 mm;
- Weight: maximum 1.5 kg;
- Sensors: Minimum 25 interchangeable sensors, including PID for VOC, NDIR for catalytic for combustible gases and NDIR for CO_2;
- Power supply: Li - ion battery or 4 x AA alkaline batteries;
- Working temperature: -20 ° to 50 °C;
- Humidity: 0% to 95% relative humidity (no condensation);
- Operating time: minimum 6 hours;
- Charging time: minimum 6 hours;
- Display: minimum monochrome graphic LCD screen (128 x 160) with backlight, automatic "flip" screen feature;
- Buttons on the keyboard: minimum 3 buttons for operation and programming (operable with gloves);

- Alarms: Audible notification (95 dB @ 30 cm), vibration and visual (flashing red LED) in real time and wireless remotely;
- Language: no less than 4 world languages;
- Warranty: minimum 1 year for sensors;
- A database to identify, at least, the following gases:
    a) VOCs derived from manmade activities such as industrial processes. From this class the most used are: benzene, toluene, nitrobenzene, trichloromethane, 1,2-dichloromethane, 1,1,1-trichloromethane, 1,1,1,2-tetrachloroethene, bromomethane, dibromomethane, chlorobromomethane, bromodichloromethane chlorodifluoromethane, trichlorofluoromethane, methyl iodide, butadiene, butanone, butyl acrylate, chlorobenzene, toluene, etylacrylate-hexane, ethylbenzene, phosphine, propylene oxide, methylacrylate-hexane, methybromide, styrene;
    b) Toxic gases: ammonia, carbon dioxide IR, carbon monoxide, chlorine, flammable, flammable IR, flammable IR, hydrogen sulphide, nitrogen dioxide, oxygen, ozone, sulphur dioxide, chlorine dioxide, nitric oxide and nitrogen dioxide.

In terms of the cost of purchasing a Six Gas HAZMAT monitor with VOC detection the price must not exceed 3,000 € to be competitive in the market.

2.3.3 Equipment Maintenance

Maintenance specifications of the Six Gas HAZMAT monitor with VOC detection equipment depend on the technical solution adopted and the result of the experimental tests.

However, several general rules for the maintenance of the Six Gas HAZMAT monitor with VOC detection equipment can be established to ensure its functionality.

These general maintenance requirements are:

- Storage temperatures: -20° C to 60 °C;
- Protection against dust or sunlight;
- Room humidity below 95%;
- Checking the functionality of the Six Gas HAZMAT monitor components and repairing them the day after each intervention or after each training exercise simulating the effects of a disaster or every 6 months.

2.3.4 Conclusions and proposals

Summarising the above information, we can conclude that the operational usefulness of a Six Gas HAZMAT monitor with VOC detection in ensuring First Responder protection represents an objective need absolutely necessary, because it helps to achieve 2 basic objectives of R & D actions:

- ensuring increased protection for First Responder from toxic gases;
- ensuring increased protection for First Responder from VOCs generated by industrially produced materials.

Finally, it is necessary to emphasise an additional measure absolutely necessary to provide efficiency and effectiveness for the chemical sensors' technologies (portable or wearable) previously analysed.

It is essentially to provide a Situational Awareness System between First responder and chemical sensors (portable or on wearable), regardless of their type, that provide data exchange (video, text, image, location) for a (Voice) Communication Interoperability framework, a 3 D Mixed Command Centre software and an S&R Decision Support System (see Table 2-3).

All the modules mentioned above must provide the underlying framework (interoperability amongst systems and equipment, training and awareness) so that responders at all levels of command (tactical, operational and strategic) have access, familiarise and evaluate how to deploy these innovative solutions.

Within the S&R project, the problem of how to distribute the information necessary for each decision-making level was studied.

In order to operationalise this goal, it is necessary to integrate them in an S&R platform that ensures, at a tactical, operational and strategic decision-making level, real-time information on the evolution of intervention actions.

Table 2-3 Summary of information for the ICT (Information and Communications Technology)

Type of existing S&R technology	Limitations	Gaps (including Human factor [low experience, not appropriate use of knowledge])	Future needs
ICT (Information and Communications Technology)	- The communication system between the First Responder, the coordination centres, robotics, UAV or the people of the community affected by the disaster, local authorities, etc. it is excessively multistore, there is no direct and fast communication link between them; - Often, parts of this system do not work either due to disaster effects (physical destruction of equipment, variations in the electromagnetic field generated by the earthquake, etc.) or exceeding the system's ability to process a large amount of calls or information.	- Lack of an application for locating the victim, indicating the route of evacuation of persons and communication between and with rescue services; - Lack of a Data Aggregation, Analysis and Decision Support to all decision levels; - Lack of a Communications Interoperability framework to all levels of operations, multiple technologies and	- Smart-phone / Tough-phone including emergency notification service for alerting civilians to evacuate an area pointing them to an appropriate gathering and exit point; - 3 D Mixed Command Centre software for situation analysis and impact assessment; - A (Voice) Communications Interoperability framework including data exchange (video, text, image, location); - An S&R Decision Support System; - A Situational Awareness Systems (Sensors and platforms).

		administrative levels; - A Command Centre software for visualisation information's from disaster scene. - A notification, warning and information system.	

Summarising the previous information, we consider that the research, manufacture and operationalisation of a Six Gas HAZMAT monitor with VOC detection represent an added value to the process of optimisation of S&R operations.

3 Gap Analysis for community resilience

3.1 Introduction & scoping

3.1.1 Scope and objective of GAP analysis

In general, GAP analysis is a method for resource management and assessment of management efforts, comparing actual with desired performance. In S&R, T1.3 of WP1 is dedicated to performing a GAP analysis for 'Community Resilience'. The objective of this task is to support the identification of end-user requirements and practical needs in the design and development of the technologies/wearables and operational procedures to be used in the S&R pilots.

However, the way 'Community Resilience' is defined can affect the way we will elicit feedback from end-users in relation to their needs, gaps and relevant technologies aiming at building community resilience.

The broader scope of T1.3 is to perform a GAP analysis for "Community Resilience". The specific scope of the case studies is to collect relevant data from organisations involved in disaster response. This data will enhance our understanding of community resilience specifically among SAR organisations and professionals, but also interaction with volunteers. These cases studies, along with the literature review, will identify critical features of SAR technologies, or lack of them, as well as best practices and lessons learnt among the SAR professional community during the response phase of a disaster. In turn, this will enable structuring the survey intended for the GAP analysis that will later guide the Pilot Use Cases.

Therefore, it is within the scope of T1.3 to build consensus on the definition that is most appropriate for the scope and objectives of the overall S&R project by considering the different stakeholders that are involved in search and rescue activities with a particular focus in the 'Response' phase of the Crisis Management cycle as S&R clearly focuses in this phase but not exclusively. Therefore, to further specify the scope of the GAP analysis, experts and end-users from participating organisations agreed in the 1st T1.3 expert meeting to the following:

- The scope of works of T1.1 and T1.2 are clearly focused in locating entrapped victims during the 'Response' phase. Therefore, the GAP analysis and its constituent methods that are part of the methodological approach in determining the domains and relevant attributes/characteristics

that will be explored with the GAP analysis, may consider all Crisis Management phases to the extent that important aspects of these may relate to the 'Response' phase, nevertheless, it will mainly focus on the 'Response' phase, hence moving from the comprehensive to the specific.

- Considering professional-volunteer interactions in search and rescue operations and in building community resilience is of major importance as per the DoA and thus, the GAP analysis will primarily focus on this. However, it will not further segregate the findings into different categories of volunteers (e.g. NGOs, individuals, social groups) as this will be within the scope of T2.3 of WP2 and foreseen for a subsequent and more in-depth step of the analysis in relation to the volunteering aspect of the operations.
- Limit the scope of our research to factors that are clearly linked to the S&R technologies and objectives.

Therefore, the methodological approach will consider the aforementioned limitations in the sourcing of relevant information and related analysis. Moreover, it is important to note that T1.3 and D1.2 do not aim to produce 'Community Resilience' measurement indicators; only to identify domains, attributes/characteristics that shape the conceptualisation of 'community' and 'community resilience' so as to guide the user requirements and pilot operationalisation in relation to these.

3.1.2 Major phases of work

The approach followed for performing a thorough gap analysis that takes into account the predominant user gaps and needs in building 'Community Resilience' with emphasis in the professional-volunteer interactions may be separated into two (2) major phases by considering the timeline for delivering the current report (M4) and its subsequent update in M16:

i. Phase A (M1-M4): consists of the GAP analysis scoping, the literature review and case study collection and processing and the preliminary structure of the survey to be performed for the GAP analysis. Phase A may be further split into three sub-phases:
    a. Literature review & case study collection: how are "Community", "Resilience" & "Community Resilience" defined; Professional-volunteer interactions?
    b. Literature review & case study results processing and presentation; preliminary focus group roundtable consultation.
    c. Compilation of literature review & report drafting including preliminary proposed survey structure for GAP analysis.

ii. Phase B (M5-M16): consists of the GAP analysis survey refinement and distribution, collection and analysis of responses for the identification of gaps and the provision of relevant recommendations. Phase B may be further split into four (4) sub-phases:
    a. Focus group consultation: refinement & finalisation of survey structure for GAP analysis.
    b. Online survey for GAP analysis by partners within their countries.
    c. Survey data processing; presentation and validation in Workshop (WS).
    d. GAP analysis, report drafting & input for T1.1 and T1.2.

Figure 3-1 depicts the aforementioned steps by providing the timeline for the interim actions.

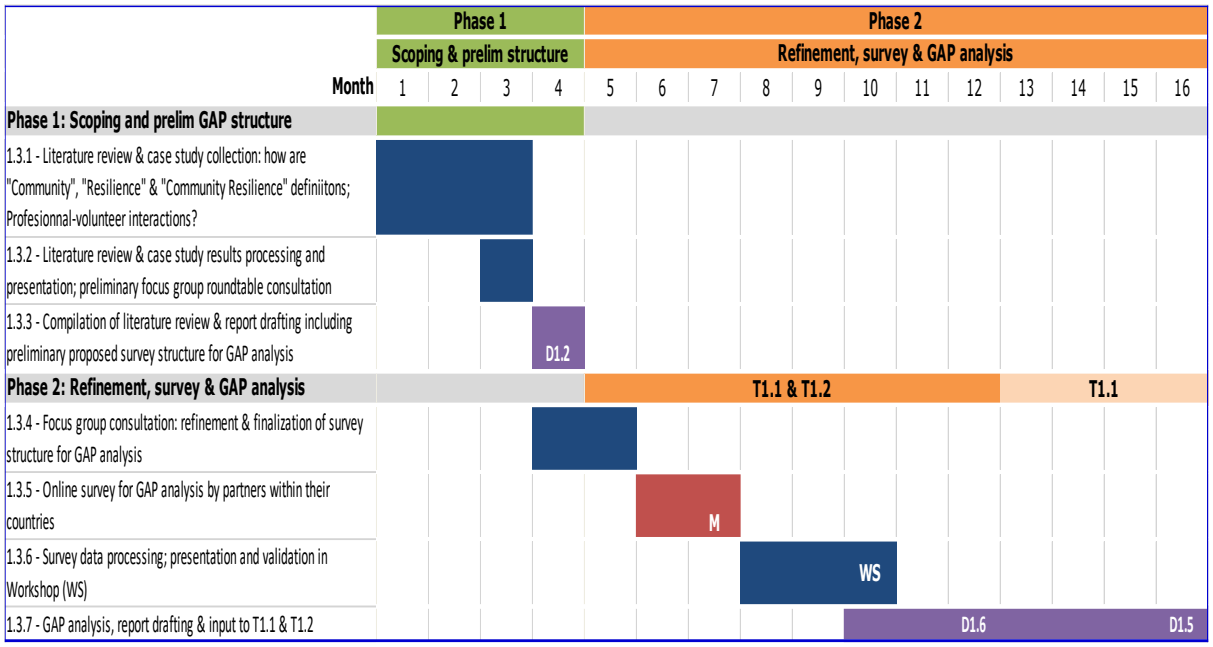

Figure 3-1 Major Phases and sub-phases for the GAP analysis

The current Chapter concerns Phase A of the works.

3.1.3 Preface on 'Community', 'Resilience' and 'Community Resilience'

A preliminary literature search was performed and subsequently informed with expert input obtained from the 1st WP1 and T1.3 expert meeting which provided the reference background for guiding our work. Next, we briefly summarise some major conclusions that arose from this expert meeting in relation to the terms 'Community', 'Resilience' and 'Community Resilience'.

3.1.3.1 'Community'

From a preliminary literature search, different notions of community may be categorised as following [28]:

- Community of practice and interest (networks of specialised and/or professional actors). The role of such networks is more prominent in the preparedness and response phases of Crisis Management.
- Interaction-based community (network of interactions between people; social groups and civil society organisations)

Its role is more visible in the response and recovery phases of Crisis Management.

- Place-based community (Individuals and social structures within a geographical location)

Its role seems to be of lesser importance to the immediate disaster response and may or not appears in in policies and practice.

The essence is that **resilience looks notably different when linked to different conceptualisations of community** [28]. In the 1st T1.3 expert meeting it was agreed that the literature review will **consider in priority** the "community of practice and interest" definition, followed by the "Interaction-based community" and the "place-based" community, if providing additional insight.

3.1.3.2 'Resilience'

There exist different conceptualisations and definitions of resilience. Some consider resilience to be a process of capacity building, others view it as an intrinsic property combined with an outcome, while there exist opinions that consider both [30].

The need to **consider the transformation/learning process** among the resilience fundamental characteristics towards sustained adaptability in order to address the need for social change and learning [29] was agreed in the 1st T1.3 expert meeting. As such a definition of resilience that incorporates the need for learning/transformation such as those reported by the following will be adopted for T1.3 work:

- The **intrinsic** ability of a system to **adjust** its functioning **prior to, during or following** changes and disturbances, so that it can **sustain** required operations **under both expected and unexpected conditions** [84]. This definition was also used in H2020 landmark project RESOLUTE (www.resolute-eu.org – [63]), completed in 2018, which produced the European Resilience Management Guidelines.
- The ability of a system, community or society exposed to hazards to **resist, absorb, accommodate, adapt to, transform and recover from** the effects of a hazard in **a timely and efficient** manner, including through the **preservation and restoration** of its essential basic structures and functions **through risk management** (UNDRR **–** [87]).

The above definitions assume that system performance is also needed for assessing its resilience. This implies the identification of system performance characteristics, aiming to produce a set of requirements for indicators and monitoring tools as a fundamental support for management and decision making. Consequently, a framework like the RAG (see Figure 3-2) proposed by [84].

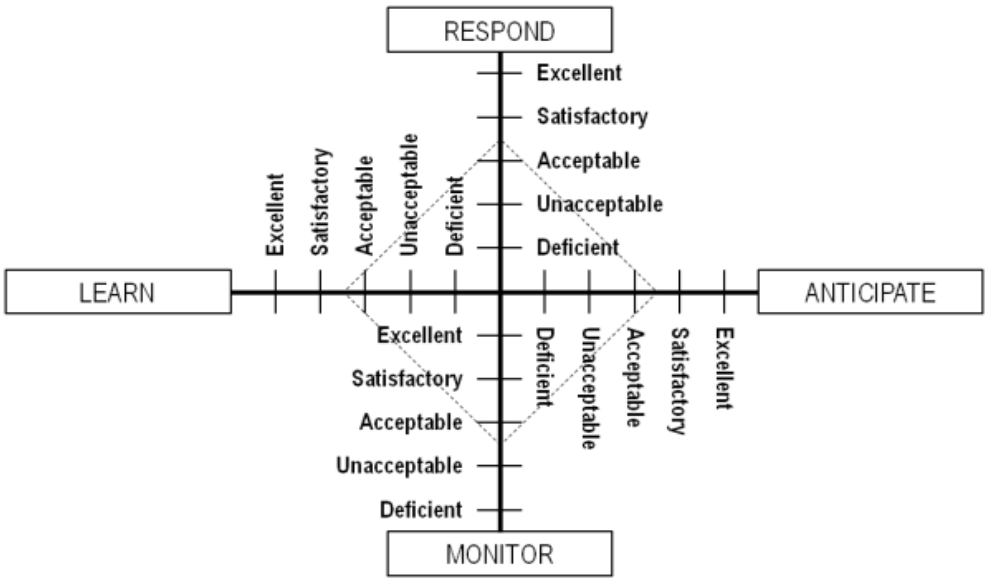

Figure 3-2 Resilience Analysis Grid

Similarly, the tabular analysis system (see Figure 3-3) proposed by [85] can be used, which aims to produce an overview of **the fundamental aspects** of the system that contribute to resilience, also **taking into account the learning process/adaptation, which better fit the purpose of our analysis**.

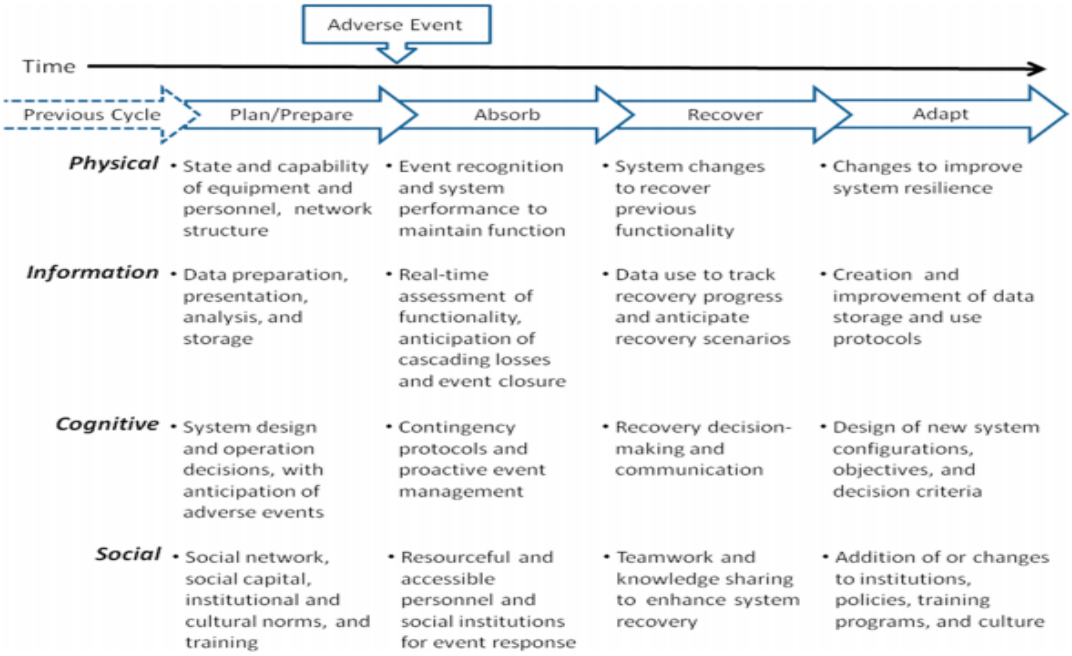

Figure 3-3 Example of GAP analysis table

3.1.3.3 'Community Resilience'

As it may easily be inferred due to the different conceptualisations of the terms "Community" and "Resilience", there also exist different conceptualisations of the term "Community Resilience" which from preliminary literature search can either be seen as an **ongoing process of adaptation**, the simple **absence of negative effects**, the presence of a **range of positive attributes**, or a **mixture of all three** [27].

As proposed by [28] *it may be easier, clearer and more useful for academics, policy-makers and responders to be explicit as to the particular elements of resilience they are focusing on in their research or interventions.*

In the 1st T1.3 expert meeting the literature review will primarily consider professional-volunteer interactions in building community resilience as per the DoA. T1.3 will not further segregate the findings into different categories of volunteers (e.g. NGOs, individuals, social groups); this will be within the scope of T2.3.

3.2 Research approach and methodology

3.2.1 Methodological approach

As aforementioned, the first step was to define the scope of works and provide guidance in relation to the terms 'Community', 'Resilience' and 'Community Resilience' that shape our work. The proposed approach and the vision were outlined in the Kick off Meeting (KoM) of the S&R project and subsequently further discussed and refined in the 1st WP1 and T1.3 meeting. In brief, our methodological approach for the current Phase A of works consists of a combination of methods that include:

- Expert meetings and focus group consultations.
- Literature search, review, critical analysis and synthesis.
- Case study collection.

The aim of Phase A work is to obtain a better understanding of important factors that may drive the development of the S&R technology/wearables to be developed and the operationalisation of the pilots in order to enhance the 'Community Resilience'. As Phase B will also include an online survey that will investigate the most important and relevant factors, it is important in Phase A to determine which are these factors and shape accordingly the structure of the GAP analysis survey template to follow. We used a combination of top-down and bottom-up approaches by performing both a literature search and a case study collection from end-users. This choice was driven from the fact that top-down approaches (i.e. literature review) facilitate the identification of general principles and enable the comparison across different scales of analysis (e.g. local, regional, state, national, or international) using standardised criteria, whereas bottom-up approaches (i.e. case studies) account for the necessary detail, knowledge and information at local level and are often more easily adopted by the local community [30].

Figure 3-4 summarises the methodological approach and methods used. The different methods are next analysed for Phase A of the works.

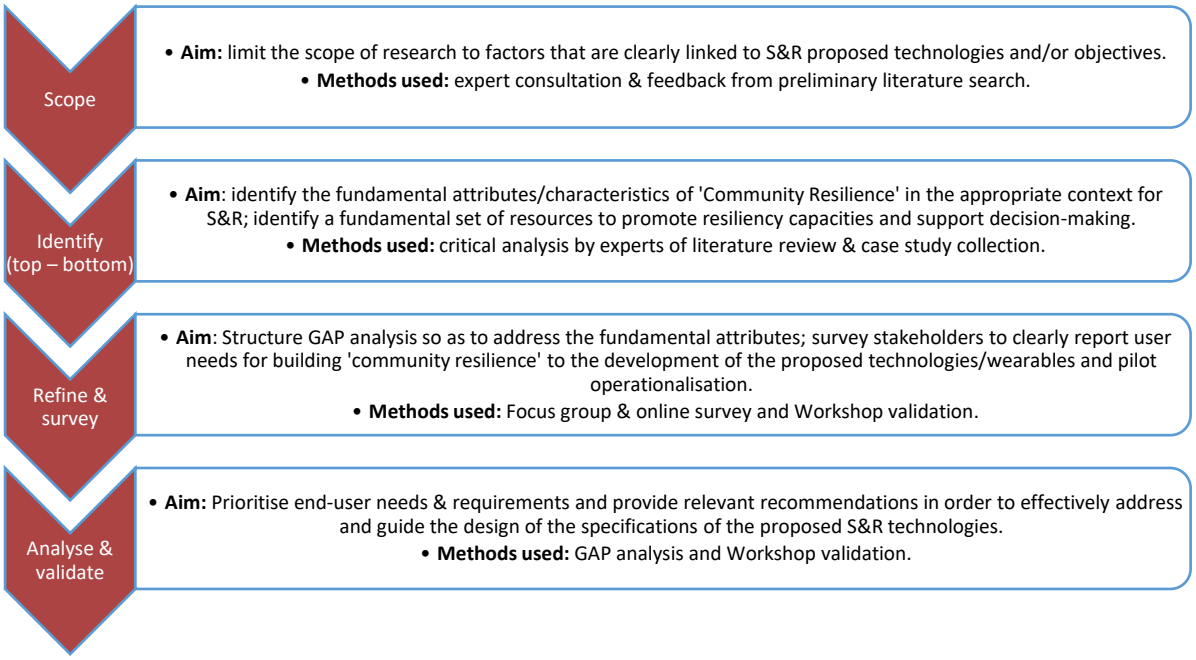

Figure 3-4 Methodological approach and methods used

3.2.2 Expert consultation / focus group roundtable

Expert consultation played an important role in the scoping of the GAP analysis and in shaping and refining the methodological approach, the literature review and case study collection processes and in structuring the preliminary survey for the GAP analysis. In Phase A of works, three (3) major meetings were held (besides the periodical plenary meetings) in which major progress was achieved:

- The S&R project Kick-off Meeting (July 22-23, 2020). In this meeting, the vision and proposed methodological approach for the GAP analysis was presented. In addition, clarification of scope and avoidance of overlaps between the different Tasks was performed.
- The 1st WP1 and T1.3 Kick-off Meeting (August 3, 2020). This was a technical meeting where a multi-disciplinary team of experts and stakeholders from different fields (e.g. resilience, communication, search and rescue professionals, volunteers) met to refine the scope and scout

potential implications of the different definitions for 'community', 'resilience' and 'community resilience'. The aforementioned scoping of works and preface on these terms resulted from this meeting. Moreover, in view of the literature search and case study collection, it was agreed that the goal is to understand the **fundamental attributes/characteristics and relevant capacities** that are needed for addressing sustained adaptability aimed at resulting in a resilient socio-technical system under study in terms of the following sets of resources as proposed by EU project RESOLUTE [63]:

- **Human/behavioural** (e.g. technical skills, expertise and competencies, as well as cognitive resources, particularly those relating to decision-making processes)
- **Technological** (e.g. infrastructure-related, UAV/robot/vehicle-related, infrastructure/traffic control, software, hardware)
- **Organisational** (hierarchical structures, formal procedures, logistics, information use and reporting, communication)

In addition to the aforementioned set of resources, the aim is to also obtain insight into the **legal/regulatory/ISO standardisation** framework (e.g. EU Directives/Regulations, ISO Standards) so that we may better understand issues that are likely to affect solution implementation and deployment, thus influencing the expected resilience (e.g. large liabilities, operating regulatory/standardisation framework/limitations).

- The 2nd WP1 and T1.3 Meeting (October 6, 2020). In this meeting the major findings from the literature review and case study collection were presented. A roundtable discussion followed the presentation in order to shape the preliminary structure of the survey for the GAP analysis and finalise the fundamental attributes/characteristics and relevant capacities to be surveyed.

Finally, input from the aforementioned experts was next sought for drafting the preliminary structure of the survey for the GAP analysis.

3.2.3 Literature review

The scope of the literature review is to collect relevant information in order to better define and agree on the specific attributes/characteristics and capacities that mainly contribute in building 'community resilience'. This, in turn, will assist in identifying the critical functions of our socio-technical system and better conceptualising the structure of the survey to be distributed for performing the GAP analysis aiming at defining the important features that the technologies to be developed within S&R should possess in order to address these needs, thus guiding the design of the Pilot Use Cases and of innovation management.

The literature review performed was structured and partners assumed clear roles. Guidance and relevant templates were provided in relation to the sought information and expected recommendations, as well as sourcing, analysing and reporting protocols.

3.2.3.1 Priority topics and expected recommendations

Table 3-1 summarises the relevant questions and expected recommendations in relation to the scope of works outlined in the previous sections. Annexes II and III include the relevant templates with the complete list of questions. Annex II template was provided for the literature review collection and Annex III template for the summary of results.

Table 3-1 Major questions for the literature review to address and expected relevant recommendations

Questions for priority topics	Expected recommendations
What are the different definitions for "Community"? How these may influence resilience and what is the most pertinent definition of Community for the scope of S&R?	Identify the different definitions for "Community", obtain insight into how these may affect "resilience" and select the definition most relevant to S&R scope of works and objectives.
What are the different definitions for "Community Resilience"	Identify the different definitions for "Community Resilience" so as to select the most appropriate for the S&R scope of works and provide context for the subsequent survey and GAP analysis.
What are the fundamental attributes and capacities that shape and influence "Community Resilience"?	Identify major factors in terms of attributes and capacities that influence "Community Resilience" with **emphasis in the Response Phase**.
What are the legislative/regulatory/standardisation issues (e.g. (limitations; legal/standardisation incentives) that are likely to influence the "Community resilience"?	Indicate legislative/ regulatory/ standardisation issues (e.g. limitations; legal/standardisation incentives) that are likely to influence the "Community resilience" in terms of: • Solution implementation and deployment • Professional-volunteer coordination and collaboration
Which are the "Community resilience" attributes and capacities that best relate to S&R objectives, UCs KPIs and proposed technologies?	Indicate which of the "Community Resilience" attributes/capacities best relate to the proposed S&R objectives, UCs KPIs and technologies as described in the Grant Agreement.
How can professional-volunteer interaction/ collaboration best contribute in building "Community resilience"?	Indicate relevant attributes / capacities that build 'Community Resilience" that are most pertinent to the professional-volunteer interactions, in particular in the Response Phase. Also provide relevant success factors/key areas/practice/tool, if possible/available and/ or major difficulties.

3.2.3.2 Sourcing, analysing and reporting protocols

Sources that provide an overview of several sources in the topic of interest are favoured and clearly preferred. A variety of sources (e.g. scientific papers, EU projects, key websites, etc.) were investigated by relevant partners.

Table 3-2 summarises the sourcing protocol for the literature review.

Table 3-2 Literature review sourcing protocol

Geographical representation	Sourcing (where from?)	Eligibility criteria	Responsible partner
- Mostly EU - However, good practices from	i. Scientific papers ii. EU fp7 & H2020 projects iii. Proposed frameworks from renowned Intl; Organisations (i.e.	- Not older than 10 years (unless it is a landmark study/framework still valid or used); prefer	i. CERTH ii. UNIFI iii. CERTH iv. UHasselt

advanced non-EU countries may be mentioned - Intl. Organisations (i.e. WHO, UNDRR)	World Bank, UNDRR, WHO, PIARC, etc.) iv. Proposed frameworks from agencies / countries advanced in Emergency Management v. Proposed frameworks by NGOs leading the involvement of volunteers. vi. DG ECHO + other key websites? vii. Legislation (Directives/Regulations & ISO Standards)	sources from last 5 years - From peer reviewed sources in priority - Quality to be assessed by subject matter expert - Use of relevant keywords (e.g. Disaster Community; Disaster AND Community Resilience AND definition or framework)	v. SAN vi. UNICA/ SAN vii. VUB

Table 3-3 summarises the analysis and reporting protocol for the literature review.

Table 3-3 Literature review analysis and reporting protocol

How are the case compared/ reported / synthesised?	QA/QC process	Responsible partner
The obtained qualitative data will be coded, either manually or by employing NVivo software if necessary. Coding will allow for sorting the material into categories such as challenges, advantages, working with volunteers, technologies, needs, gaps, etc. The categories will be then synthesised into a report.	As per D10.1. In addition: - All documentation should be retrievable & uploaded to Alfresco. - The results will be presented to the team for discussion. - Review of proposed survey structure for GAP analysis by the Advisory Board (after D1.1 & D1.2 submissions)	SAN

3.2.4 Case studies

The specific scope of the case studies is to collect relevant data from organisations involved in disaster response. This data will enhance our understanding of community resilience specifically among SAR organisations and professionals, but also interaction with volunteers. These cases studies, along with the literature review, will identify critical features of SAR technologies, or lack of them, as well as best practices and lessons learnt among the SAR professional community during the response phase of a disaster. In turn, this will enable structuring the survey intended for the GAP analysis that will later guide the Pilot Use Cases.

Similar to the literature review, the case study collection and analysis was structured, guidance and relevant templates were provided. End-user partner organisations participating in S&R were the primary targeted groups from which case studies were sought.

3.2.4.1 Priority topics and expected recommendations

Table 3-4 summarises the relevant questions and expected recommendations for general overview and Table 3-5 for specific case in relation to the scope of works outlined in the previous sections.
The case study collection templates provided in Annex III and Annex IV contain the complete list of questions.

Table 3-4 Case study collection template – general overview

Case study collection template	
Questions	**Answers**
1. What type of disasters have you responded to and what type of organisations and professionals did you cooperate with in these responses?	
2. What are the major challenges and advantages of working with other SAR organisations and professionals during the response phase?	
3. What are the major challenges and advantages of working with volunteers during the response phase?	
4. Have there been mistakes made during the response phase either by your organisation or in cooperation with others? How can this be avoided in the future?	
5. Do you experience unfulfilled needs in terms of technological resources, technical skill, logistics, communication, or reporting during response either as an organisation or in cooperation with other organisations? Could you please briefly elaborate on the most prominent?	
6. Are there legislation, hierarchal organisational structures, or complex decision-making procedures hindering your response?	
7. In terms of pre-disaster preparedness, do you cooperate with volunteers, other organisations, professionals, NGOs, or individuals from the wider community? If so, could you please briefly elaborate and list these?	

8. Are there any major lessons learnt by your organisation in how you respond to disasters: a) in order to improve its and/or the community's resilience? b) in relation to the SAR proposed technologies and/or Use Cases? Did your organisation change or adapt to address challenges over the years, and if so, how?	

Table 3-5 Case study collection templates – case-specific

Case study collection template- case - specific	
Questions	**Answers**
1. Can you briefly describe a specific disaster event and your organisation's role in it? What other organisations and professionals did you cooperate with in this response?	
2. If the case study / disaster is documented, please provide a relevant reference/link.	
3. What were the major challenges and advantages of working with other SAR organisations and professionals during the response phase of this specific disaster?	
4. What are the major challenges and advantages of working with volunteers during the response phase of this specific disaster?	
5. Have there been mistakes made during the response phase of the above disaster event, either by your organisation or in cooperation with others? How can this be avoided in the future?	
6. During your response to the disaster, did you experience unfulfilled needs in terms of technological resources, technical skills, logistics, communication, or reporting either as an organisation or in cooperation with other organisations? Could you please briefly elaborate on the most prominent?	
7. Were there legislation, hierarchal organisational structures, or complex decision-making procedures that may have hindered your response to the disaster?	

8. In terms of pre-disaster preparedness for the event you have described, did you cooperate with volunteers, other organisations, professionals, NGOs, or individuals from the wider community? If so, could you please briefly elaborate and list these?	
9. Were there any major lessons learned by your organisation in how you responded to the disaster: a) in order to improve its and/or the community's resilience? b) in relation to the SAR proposed technologies and/or Use Cases? Did your organisation change or adapt to address challenges over the years, and if so, how?	

3.2.4.2 Sourcing, analysing and reporting protocols

Table 3-6 summarises the sourcing protocol for case studies.

Table 3-6 Case study sourcing protocol

Sourcing	Proposed end-user partners	Partner responsible for template distribution and collection
- The case study template will be distributed among the nine end-user partner organisations within the project. - The general overview template (Annex I) contains eight questions which each of the nine partners is requested to answer in writing, in one or two paragraphs. - The case/disaster-specific template (Annex II) contains nine questions which T1.3 participating partners are requested to fill in with 5-10 separate cases/disasters.	The case studies are to be distributed and collected from end-user partners, i.e. first responders and organisations providing training to first responders, health specialists, defence specialist, and fire service. Below is the list of the proposed research respondents: HRT EPAYPS JUH JOAFG PUI PROECO (5-10 Use cases in addition to the general overview as per T1.3 assignment) SUMMA/SERMAS (5-10 Use cases in addition to the general overview as per T1.3 assignment) ESDP (5-10 Use cases in addition to the general overview as per T1.3 assignment) UGL (5-10 Use cases in addition to the general overview as per T1.3 assignment)	SAN

Table 3-7 summarises the analysing and reporting protocol for case studies.

Table 3-7 Community Resilience' (CR) and 'Resilience' (R) as defined by major organisations

How are the case compared/ reported / synthesised?	QA/QC process	Responsible partner
The obtained qualitative data will be coded, either manually or by employing NVivo software if necessary. Coding will allow for sorting the material into categories such as challenges, advantages, working with volunteers, technologies, needs, gaps, etc. The categories will be then synthesised into a report.	As per D10.1. In addition: - All documentation should be retrievable & uploaded to Alfresco. - The results will be presented to the team for discussion. - Review of proposed survey structure for GAP analysis by the Advisory Board (after D1.1 & D1.2 submissions)	SAN

3.2.5 Preliminary survey structure for GAP analysis

Following the understanding of the fundamental attributes and characteristics of the socio-technical system that shape 'Community Resilience', relevant questions may then be able to be formulated for a survey to be sent to stakeholders/end-users and obtain their feedback for proceeding with the GAP analysis of user needs and S&R technologies. The aim of the GAP analysis is to identify the current state versus the desired state in the variables that are examined, identify the needs and gaps for meeting the stakeholders' objectives, prioritise these and provide relevant recommendations.

An example of a table for the GAP analysis is provided in Figure 3-5.

Focus Level/Area	Parameter	Desired Goal in Future	Current State	Needs (= objectives for desired goals)	Compliance/Condition Status	Identified Gaps	Importance / Priority (essential, secondary, auxiliary)	Key Target Group (Stakeholder)	Comments	Recommended Actions
A	Technical									
A1										
A2										
B	Legal									
B1										
B2										
C	Organizational									
C1										
C2										
D	Behavioral									
D1										
D2										

Figure 3-5 Example of GAP analysis table

3.3 Community resilience – literature review findings

An extensive literature search was performed following the protocols for the literature review collection. Sixty-six sources were eventually retained and analysed by using the literature review collection (Annex II) and literature review (Annex III) templates. Sources included scientific and technical papers, Horizon 2020 and Fp7 EU-funded projects, reports from NGOs and International Organisations (e.g. UN, WHO) and websites. In addition, 44 relevant international agreements, directives, regulations and standards were summarised for a total of 110 sources considered.

Figure 3-6 shows the source distribution for the non-legislative/regulatory/standardisation sources.

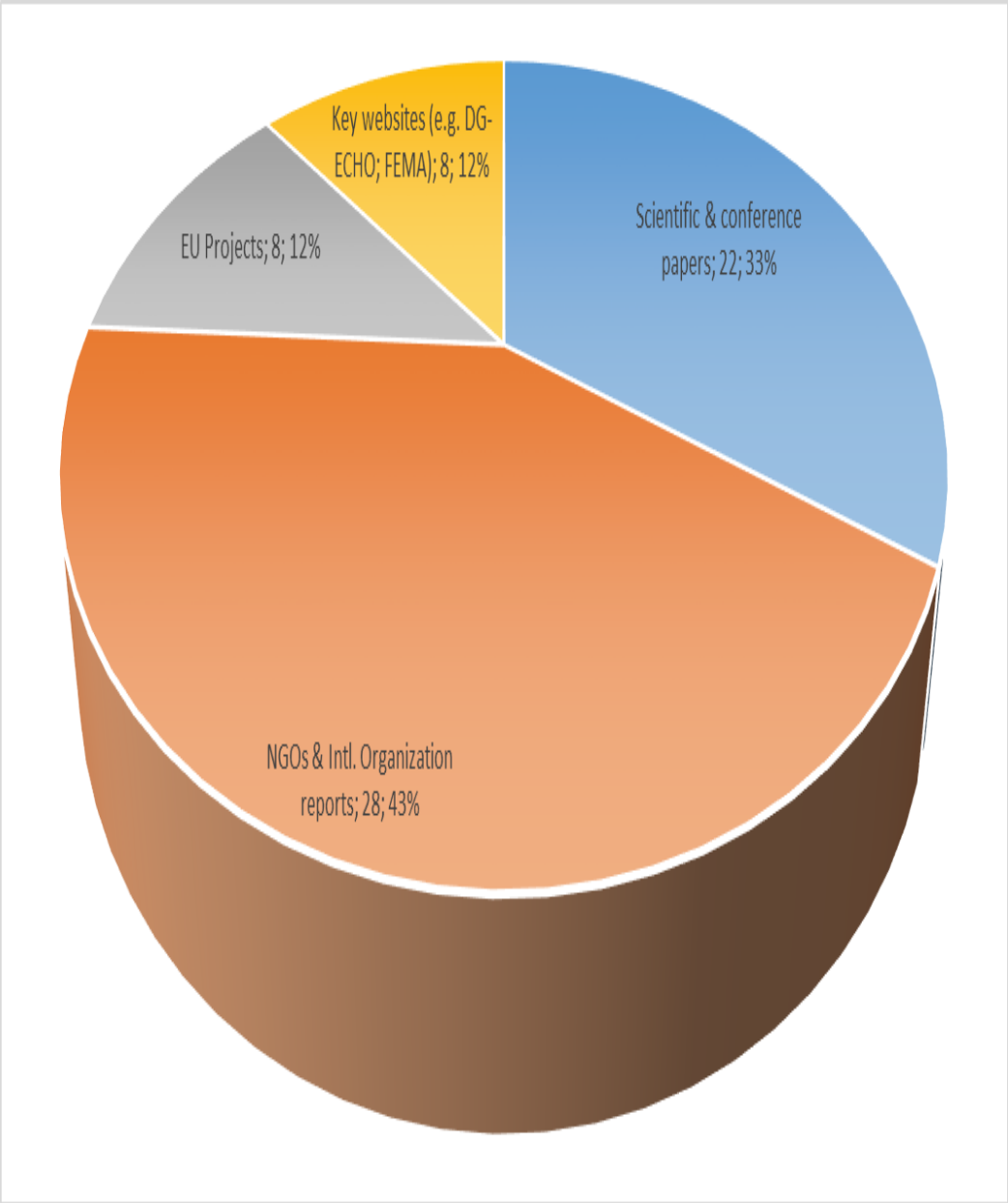

Figure 3-6 Literature review source distribution

The analysis will next follow the structure of the literature review summary template for summarizing the main findings

3.3.1 Definitions overview

3.3.1.1 'Community'

The literature search confirmed that different notions of community exist in the literature. Several studies that have performed comprehensive reviews on the topic of community resilience in crisis situations concur to this [27-31, 34].

The multidimensional aspect of the community is also noted [36-38, 59] by the International Federation of Red Cross and Red Crescent Societies (IFRC) that define: "*Community is a group of people who may or may not live within the same area, village or neighbourhood, share a similar culture, habits and resources. Communities are groups of people also exposed to the same threats and risks such as disease, political and economic issues and natural disasters.*"

Unavoidably, there exist studies [32, 33] that focus in place-based communities and social structures within a geographical location. Such is often the case in NGO reports [44-52]. The 11 NGO organisations that were reviewed are IFRC, Cordaid, Concern Worldwide, Peaceboat Disaster Relief, International Medical Corps UK, Victorian Council of Social Service, Australian Institute for Disaster Resilience, GOAL, German Red Cross Disaster Services, Oxfam, and World Vision. The vast majority of these organisations (9 out of 11) referred to the place-based community, and to a lesser extent interaction-based (7 out of 11), and practice-based communities (6 out of 10). This, however, could be, at least in part, attributed to the scope of their work which concerns working with local populations.

Sometimes reports from International Organisations (e.g. UNDP, UNDRR, FAO, UN) [13-19] and Civil Protection websites (e.g. DG-ECHO [50]; Italian Civil Protection [77]) also use the place-based definitions for community, ranging in scale from individual to regional/global with local (in the geographical sense) communities mostly being the focus of attention often also due to their interest in relieving the **vulnerable populations** that are often mostly affected by disasters.

Nevertheless, the most recent publications [54, 55, 57, 83] and key websites such the Federal Emergency Management Agency (FEMA) [46], the Global Network of Civil Society Organisations for Disaster Reduction (GDNR) [48], the Search and Rescue Assistance in Disasters (SARAID) [49] and Habitat for Humanity (HfH) [47], also support the impression that community is a **multi-faceted concept** which is **dynamic over space and time**. Therefore, the **categorisation** of community types proposed by [28] (i.e. **community of practice and interest; Interaction-based community; place-based community**) as presented **in Section 3.1.3.1** seems to be **relevant** and hold. A different variant of this multi-faceted community is provided by [31] as: i) place-based community, ii) virtual (communicative) community of individuals that is mediated by the use of communication technologies and iii) imagined community (e.g. transnational diaspora – members that may never have contact with each other.

From the above, the **Community of practice and interest** seems to be the most applicable for the purposes of the S&R project. This community may be further decomposed according to the timing of intervention of the different actors into two or three sub-categories. We consider the following decomposition for the purposes of the S&R project with the respective major actors:

- **First responders** (e.g. Fire and rescue brigade, Emergency medical services, Civil protection, police-law enforcement personnel, Coast guard / Border security, by-stander individuals);
- **Early responders and sustained support** (e.g. Emergency Coordination Centres, Critical infrastructures and infrastructure operators; hospitals, registered national and international

voluntary organisations active in disaster & spontaneous volunteers; utility companies, primary care organisations, public authorities, UAV/robots/vehicle manufacturers, infrastructure manufacturers, support aid manufacturers)

Nevertheless, the **interaction** of this community with the other two types of community, in particular with interaction-based **civil society volunteering organisations and social groups** that may also be place-based **during the response and recovery** phases of Crisis Management **is important and should be duly considered**. Special importance is attributed to the protection and involvement of **vulnerable** populations (e.g. impaired persons and persons with disabilities, persons mostly exposed or with limited resources) as these persons may possess skills and/or knowledge that is different from the mainstream, for better or worse. These are not only persons that are usually the most impacted by the disaster but that may also significantly affect the speed of the response, recovery and adaptation from it.

3.3.1.2 'Resilience' and 'Community resilience'

Some consider resilience to be a process of capacity building, others view it as an intrinsic property combined with an outcome, while there exist opinions that consider both [30], but not every study includes precise definitions of 'community resilience'. Both terms incorporate an inherent vagueness [3] which may be attributed to their positive connotation [31]. Studies [28-31] conclude that the conceptualisation of community affects its resilience and there are even **suggestions against the use of the generic term** *when it obscures the importance of individual elements it may be composed of* [27]. Several studies [28-31] concur that it is important to move from 'rigid' bounce-back-to-previous-state engineering definitions of resilience towards definitions [39-41, 52, 53, 63, 57, 87] that emphasise the **'transformative'**, **'adaptive'** and **'learning'** processes that contribute to the **need of 'social change'** and **'learning'** [29], a view that is closer to the 'ecological approach' of system's resilience.

However, measuring the performance of adaptive and transformation processes also presents inherent difficulties as the period over which this is measured is an important factor. Different socio-technical systems may present different resilience characteristics over the post-disaster short term than in the post-disaster long term. Therefore, approaches that favour measurement of disaster resilience levels based on existing status of disaster resilience characteristics find it easier to come up with measurements of 'community resilience' in comparison to approaches that consider processes [35, 54, 56]. Measuring resilience 'to what?' and 'for whom?', 'where?', 'when?' and 'why?' are guiding questions [30, 40, 41]. However, as aforementioned, as the scope of our work is not to come up with composite indicators or performance measures of 'community resilience' this presumption is of little influence to this work.

Table 3-8 lists some of the most prominent definitions for 'resilience' and 'community resilience' found in the literature review from major organisations and recent EU projects. As it may be noticed, the definition for 'community resilience' is often inferred through the general definition for 'resilience', however, the terms 'community' or 'community resilience' are not always explicitly addressed.

Table 3-8 Community Resilience' (CR) and 'Resilience' (R) as defined by major organisations

Source	Definition (Community Resilience: CR) / (Resilience: R)
IFRC [10-12] (also adopted by EU project DRIVER+ [31])	*R: "The ability of individuals, **communities**, organisations or countries exposed to disasters, crises and underlying vulnerabilities to anticipate, prepare for, reduce the impact of, cope with and recover from the effects of shocks and stresses without compromising their long-term prospects."*
UNDP [13]	*R: "…an inherent as well as acquired condition achieved by managing risks over time at individual, household, **community** and societal levels in ways that minimise costs, build capacity to manage and sustain development momentum, and **maximise transformative potential**."*
DG-ECHO [50]	*R: "Resilience is the ability of an individual, a **community** or a country to cope with, adapt and recover quickly from the impact of a disaster, violence or conflict. Resilience covers all stages of disaster, from prevention (when possible) to **adaptation** (when necessary), and **includes positive transformation** that strengthens the ability of current and future generations to meet their needs and withstand crises."*
Italian Civil Protection Department [52]	*R: "The concept of resilience is expressed in the ability of a **community** to understand potential risks, manage them and respond to disasters so as to reduce the effects, both in the **short and in the long term**. This means minimizing the loss of human life and damage to tangible and intangible assets."*
FEMA [46]	CR: *"A community is considered resilient if it makes proactive investment and policy decisions, is able to communicate risk and vulnerability to all of its members, builds cross-sectoral partnerships, and resumes normal operations and recovers rapidly after hazard events."*
SARAID [49]	CR: *"Community resilience is about communities using local resources to help themselves during an emergency in a way that complements the local emergency services"*
i-REACT [32]	R: *"Resilience is the ability of a system or systems to survive and thrive in the face of a complex, uncertain and ever-changing future. It is a way of thinking about both short-term cycles and long-term trends: minimizing disruptions in the face of shocks and stresses, recovering rapidly when they do occur, and adapting steadily to become better able to thrive as conditions continue to change. Within the context of CI, the resilience process offers a cyclical, proactive and holistic extension of risk management practices."*
UNISDR [60] (also adopted by ResiStand [34] and UN's Sendai Framework for Disaster Risk Reduction [17])	R: *"The ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions."*
UNDRR [14, 15, 61] (updated definition of the aforementioned provided by the UNISDR)	R: *"The ability of a system, community or society exposed to hazards to **resist, absorb, accommodate, adapt to, transform and recover from** the effects of a hazard in **a timely and efficient** manner, including through the **preservation and restoration** of its essential basic structures and functions **through risk management."***

Australian Institute for Disaster Resilience (AIDR) [26]	CR: *"A **resilient community** has the opportunity, capacity and capability to identify and mitigate hazards and risks, absorb the effects of disruptive events, **adapt or transform** in anticipation or response to disruptive events and return to a functioning state."*
RESOLUTE [37] (adopted definition provided by [58])	R: *"The **intrinsic** ability of a system to **adjust** its functioning **prior to, during or following** changes and disturbances, so that it can **sustain** required operations **under both expected and unexpected conditions**"*
PIARC [62]	R: *"A capability to anticipate, prepare for, respond to, and recover from threats w/ minimum damage to social well-being, the economy and the environment"*
NAS [63]	R: "*The ability of a **system** to perform four functions with respect to adverse events: (i) planning and preparation, (ii) absorption, (iii) recovery, and (iv) **adaptation.**"*
Public Safety Canada [67]	R: "*Resilience is the capacity of a **system, community or society** to **adapt** to disturbances resulting from hazards by persevering, recuperating or changing to reach and maintain an acceptable level of functioning.*"
National Academy of Sciences, Engineering and Medicine (USA) [72]	CR: "*community capabilities that buffer it from or support effective responses to disasters*"
DRIVER +	The sustained ability of a community to utilise available resources to respond to, withstand, recover from and adapt to adverse situations

Given the different definitions of resilience that can be found in the examined literature, the one that sums up the variability of the term is the following: *"Community resilience was therefore found to be an amorphous concept that was understood and applied differently by different research groups. In essence, depending on one's stance, community resilience can either be seen as an ongoing process of adaptation, the simple absence of negative effects, the presence of a range of positive attributes, or a mixture of all three."* [35]

For example, the IFRC definition [36-38] does not stress the transformative and adaptive processes and relates better to the 'bounce-back' concept. Other organisation frameworks provide definition for resilience that is applicable for the community instead of precisely defining the 'community resilience' (e.g. UNDP, UNDRR, UN Sendai Framework for Disaster Risk Reduction 2015-2030 - this framework is successor instrument to the Hyogo Framework for Action and includes biological, nuclear/radiological, chemical/industrial, NATECH, i.e. natural hazards triggering technological disasters and environmental hazards which were not part of Hyogo Framework) [39-41, 43, 97]. The most recent of these is the definition provided by UNDRR [40, 41, 87] (see **Error! Reference source not found.**) and AIDR [53]. These definitions, same as the one provided by DG-ECHO [50], consider the ability to cope, the developmental [35], **adaptive and transformative nature of resilience**.

The definitions of community resilience obtained from NGOs were in most cases a combination of 'process' and 'range of attributes' definitions [45-48; 52-53]. They referred to communities' ability to absorb, learn, and adapt as well as the means to achieve that. Additionally, the developmental organisations focused on long-term well-being of all members of effected communities, **including the vulnerable and marginalised**. All of the organisations stress the **importance of multi-stakeholder collaboration** and **communication** for community resilience and this aspect is

particularly relevant for S&R scope of works [31]. Identified lack of systematic development of an operationalised model of resilience, hence, *in developing a set of measures that can serve to assess and compare levels of community resilience it is important to identify a set of variables that can be systematically tested*.

In absence of a common and widely accepted definition for community resilience, it may however be noticed, that **there are well-understood elements that are widely proposed as important for a resilient community**. A focus on these individual elements may be more productive than attempting to define and study community resilience as a distinct concept [27]. Therefore, as also proposed by [28], *it may be easier, clearer and more useful for academics, policy-makers and responders to be explicit as to the particular elements of resilience they are focusing on in their research or interventions.*

The next sections will therefore attempt to identify such elements.

3.3.2 Major factors that shape 'community resilience'

3.3.2.1 Factors and domains that contribute in building 'Community resilience'

The literature review focused in the major factors in terms of attributes[1]/capacities[2] that contribute in building 'Community Resilience' as these were applicable to the four (30) major phases of the event management cycle that a system needs to maintain in order to be resilient.

Resilience mentioned in the 2030 UN Agenda for Sustainable Development [90] call for building resilience to disasters at the system level developing "absorptive", "anticipatory" and "adaptive" capacities* (*here capacities have the meaning to attributes according to the provided definition), usually referred to as the "3As". The **transformative capacity** is also mentioned [35]. These capacities are critical in addressing system-level issues of policy coordination, cooperation and integration and important at the individual and community levels in enabling citizen mobilisation and empowerment.

Based on the Resilience Analysis Grid[81] also adopted in EU Project RESOLUTE [37] and the adaptive phases of the Resilience Matrix proposed by [89] and [85], we defined these phases by using indices A, M, R, L as following:

- A = Anticipate/Plan-prepare: address the 'potential' – lay the foundation to keep services available and assets functioning during a disruptive event.
- M = Monitor/Absorb: address the 'critical' – maintain most critical asset functions and service availability while repelling or isolating the disruption.
- R = Respond/Recover: address the 'actual' and respond to regular or irregular disruptions by adjusting functioning to existing conditions; restore all asset functions and service availability to their pre-event functionality.
- L = Learn/Adapt: address the 'factual' by learning from experiences of both successes and failures; using knowledge from the event, alter protocol, configuration of the system, personnel training or other aspects to become more resilient.

Terminology was not always consistent across references [34].

[1] Characteristic/attribute: quantities of some attribute or the simple presence or absence of things without any evaluation of quality.
[2] Capacity: evaluations of performance or quality.

The overwhelming majority of these made reference to what we have define herein as *attributes* which in turn were sometimes attributed to different domains.

The relevant findings are summarised below:

- There are many factors that influence community which may also be interconnected and this requires that these are considered and understood holistically [36-38]. Strengthening resilience is an integrating, multi-sectoral, multi-level and dynamic process [38, 39] which should be risk informed, holistic (systems-oriented), demand-driven, **people-centred** [36-39, 40-43, 94] (i.e. participatory), **inclusive** and non-discriminatory (e.g. **vulnerable persons** [36-39]; [56], [97]) which should promote prevention and account both short and long term.
- Tools and methods should be adapted to the specific cultural and community context by performing a vulnerability and capacity assessment (VCA) [36-38]. In this respect, recent EU projects and DG-ECHO [76] have produced an array of online platforms, tools and guidelines for building resilience capacity in the different phases of the event management cycle. These are reported and summarised in Section 3.3.2.2.
- Nine (9) core elements were found to be common among different definitions of community resilience: local knowledge, community networks and communication, health, governance and leadership, resources, economic investment, preparedness, and mental outlook [27].
- Residence time, awareness and learning through past disasters [27, 29, 32, 33], and warning systems were the identified thematic complexes [32, 33].
- Personnel training is an important aspect mentioned in several studies.
- Social capital may especially help disaster recovery and thus a possible way to develop DRM practices could involve a stronger acknowledgement of informal actor networks [28, 30, 32]. The resilience of local (place-based) communities may be further enhanced by the knowledge and lessons carried by new members joining the community from elsewhere. This is the concept of **'translocalism'** [32].
- **Empowerment** is considered to be very important to resilience, representing both a process and an outcome [35, 40, 41, 43]. Interinstitutional cooperation, inter-sectoral action, and **interdisciplinary and life-course approach** are also mentioned as key features of community resilience.

Besides the aforementioned factors, **different domains** (sometimes only few key attributes or principles are only mentioned) were proposed for classifying these. An indicative selection of these from key studies, national frameworks and renowned international organisations are presented below:

- A study [34] suggested that community disaster resilience may be classified in five (5) domains:
    - Social (Human Capital, Lifestyle and Community Competence, Society and Economy, Community Capital, Social and Cultural Capital, Population and Demographics Environmental, Risk Knowledge)
    - Economic (Economic Development, Society and Economy)
    - Institutional (Governance, Organised Governmental Services, Coastal Resource Management, Warning and Evacuation, Emergency Response, Disaster Recovery)
    - Physical (Physical Infrastructure, Infrastructural, Land Use and Structural Design)
    - Natural (Protection and development of Ecosystem services)

These closely resemble to the five (5) core asset categories based on the Sustainable Livelihoods Framework (SLF) for mapping the potential characteristics of resilience: financial, human (e.g. skills, knowledge, health), natural, physical (e.g. basic infrastructure) and social (social networks, institutions, governance) that were proposed by the UNDP [39].

- The EmBRACE framework (which comes from an EU research project) was proposed for community resilience [3], built from empirical evidence obtained from case studies in 5 countries (Germany, Great Britain, Italy, Switzerland, Turkey), comprising of three (3) interrelated domains that shape resilience within the community: resources and capacities, actions, and learning. These domains are embedded in two layers of extra-community processes and structures.
- UNDRR in building resilience for cities proposed three (3) major categories consisting of 10 essentials [40, 41]:
    - Governance and financial capacity (essentials 1-3, including organisational structure and processes, learning, informed decision-making, invest in resilience and develop financial contingencies like **insurance** [40-43])
    - Planning and disaster preparation (essentials 4-8, including zones and standard/codes for the built environment, natural buffers strengthening institutional and societal capacities – e.g. training, public education and awareness in DRR; social connectedness; information/communication/**awareness systems**; engagement of civil organisations and vulnerable persons; emergency response centres; adequacy and maintenance of protective and critical infrastructure).
    - Disaster response and post-disaster recovery (essentials 9-10, including detection and monitoring equipment; **early warning** [40-43, 64] and communication systems; drills; **automating SOPs**, business continuity plans; resource prioritisation for addressing the most affected; learn and build back better; cooperation).
- The above are in great agreement with the 13 Guiding Principles proposed by the Sendai Framework for Disaster Risk Reduction (DRR) [43, 96] that shape the proposed four (4) Priorities for Action for achieving the expected goals:
    - Understanding disaster risk.
    - Strengthening disaster risk governance to manage disaster risk,
    - Investing in disaster risk reduction for resilience (e.g. financial protection, insurance)
    - Enhancing disaster preparedness for effective response, and to «Build Back Better» in recovery, rehabilitation and reconstruction.

  International cooperation and support from developed countries to be tailored to the needs and priorities of the context, shared responsibility and engagement of all are also stressed as well as the need to actively engage in the Global Platform for DRR, the regional and sub-regional platforms for DRR and the thematic platforms in order to foster and forge partnerships.
- The **Canadian** emergency management framework [93] highlighted the need for all areas of society (municipalities/communities, volunteer and non-governmental organisations, academia, indigenous peoples, the private sector and individual) to work together in order to improve resilience. The contributions from areas of society should be coordinated by strong and effective

leadership from Federal/Provincial/Territorial (FTP) governments. The Framework also aligns with the Sendai Framework for Disaster Risk Reduction 2015-2030 [43] and supports other key policy frameworks, and agreements like the United Nations Sustainable Development Goals (SDGs) [90] and the 2015 COP21 Paris Agreement for Climate Change. Flexibility and adaptability are stressed. The key attributes of societal resilience in this framework are the following:

  - Evidence-based risk assessments
  - Public awareness
  - Community engagement

- The USA National Academies of Sciences, Engineering and Medicine *Building and Measuring Community Resilience Report* [98] suggested to involve citizens, organisations, communities, governments, systems in emergency management to improve preparedness and thereby resilience so as to reduce risks. It is also in great agreement with the Sendai Framework for Disaster Risk Reduction 2015-2030 [43] and suggests that measurement of 'community resilience' will contribute in its improvement. However, data availability and compatibility between systems, tools and platform make it challenging to integrate measurement across different sectors. It makes also reference to six (6) domains (called *community resilience capitals* or *community resilience dimensions*) as follows:
  - Natural (or environmental): the natural resources base or environmental conditions within communities. This includes air, land, water, mineral resources, stability and health of ecosystems, natural land cover, and/or indicators of environmental quality.
  - Built (infrastructure): the buildings and infrastructure systems within communities. This includes critical response support facilities, residential housing, schools, commercial and industrial buildings, and supporting infrastructure such as power, transportation, bridges, roads, communication, water, and waste water.
  - Financial (economic): the totality of economic assets and livelihoods in a community. This includes income levels, personal wealth, income equality, overall employment rates, sector-specific employment, and business size and diversity.
  - Human and cultural: demographic characteristics, knowledge, skills, health, and physical abilities of community members including language competencies, cultural symbols, and belief systems. Some specific examples are educational levels, age distributions, health insurance, access to medical and mental health services, food security, special needs populations, and access to transportation and communication services.
  - Social: the social networks and connectivity among groups and individuals within a community. This includes levels of trust and reciprocity, political engagement, length of residence, volunteerism, religious affiliation, and community organisations and services. Also included is the feeling of belonging to and a sense of place about the community.
  - Political (institutional or governance): access to resources and the ability/power to influence their distribution as well as the ability to engage external (to the community) entities in efforts to achieve community goals. This includes disaster insurance coverage (e.g., flood, crop), jurisdictional coordination or fragmentation, disaster

experience in response and recovery, mitigation spending, and emergency management capacities.

- In Victoria, Australia [94], the Community Resilience Framework for emergency management is also inspired by the Sendai Framework for Disaster Risk Reduction 2015-2030 [43] and **places local community to the core** of emergency management for building a collective capacity and capability to anticipate, cope and recover from disasters. It highlights the importance of planning for resilience for reducing the exposure of community to unreasonable risk. It proposes seven (33) resilience characteristics/attributes in communities that enable communities to prevent emergencies and improve the recovery process:
    - Connected, inclusive and empowered: suggests involving different structures in a community. Structures will collaborate, communicate, share and learn together.
    - Safe and well: physically and mentally healthy community.
    - Dynamic and diverse local economy
    - Sustainable built and natural environment: valued and sustainable ecosystem services.
    - Culturally rich and vibrant: Support diversity in the community.
    - Democratic and engaged: The community can participate in decision-making and in community activities.
    - Reflective and aware: The community will have access to the resources that it need to be aware and will be able to act where required and reflect the experience to improve response and future preparedness.
- Government Accountability Office (GAO) in the USA [95] created the Disaster Resilience Framework to serve as a guide for analysis of federal actions to facilitate and promote resilience to natural disasters. The proposed framework uses the geographical (place-based) definition for 'Community' and is organised around three broad overlapping principles:
    - Information: providing reliable and authoritative information that could help decision makers to identify current and future risk and determine the impact of the strategies of risk reduction.
    - Integration: integrating analysis and planning in order to help decision makers to take coherent and coordinated resilience actions.
    - Incentives: Providing **financial and non-financial incentive** is introduced as a forward looking to risk reduction. These incentives are in form of federal regulatory requirements or federal financial assistance.
- The Food and Agriculture Organisation (FAO) position paper [42], which focuses in resource-poor setting and the social protection aspect, states that the combination of social and economic impacts with access to predictable, sizeable and regular can strengthen resilience. It encompasses 3 Pillars: social assistance, social insurance and labour market regulations. It also stresses the need to focus on the most vulnerable and the need to link social protection programmes with early warning systems.
- 10 distinct variables were found to be utilised by more than 40 % of the empirical studies on community resilience [30]:
    - Social education or educational equality
    - Economic—income
    - Social capital—civic organisations
    - Social—health access
    - Institutional—mitigation plans
    - Social capital—religious ties, affiliations

- Community attributes, aspirations, goals
- Emergency management assets and functions
- Institutional—mitigation activities
- Infrastructure and buildings

3.3.2.2 Tools and methods identified from relevant recent EU projects

Table 3-9 provides a brief summary of online platforms, tools and guidelines for building resilience capacity in the different phases of the event management cycle and also includes few that are targeted to Critical Infrastructures (CIs). DG-ECHO [76] relevant guidance is also summarised.

Table 3-9 Attributes/capacities for building community resilience most relevant to the S&R project

EU Project	Platform / Tool / Guidance Description
ANTICIPATE/PLAN-PREPARE	
DG-ECHO [76]	• A core objective is to strengthen local and national capacities for resilience. It is ultimately an individual country's responsibility to progress towards meeting key development standards (e.g. for water, education, health, sanitation, social protection), more equitable access to them and to manage risks. The EU Action Plan sets out a wide scope of programmes and priorities targeted, and amended, to promote and facilitate resilience approaches across regions and countries.
DRIVER+ [57, 70]	• **Portfolio of solutions (PoS)** ○ Catalogues innovative crisis management solutions at different TRLs according to a well-structured taxonomy of crisis management functions and gaps. ○ Improves the accessibility of innovative crisis management solutions. ○ Valuable source of credible, information about existing solutions matching practitioner gaps that can help identify the current state of the art as well as potential partners in industry and academia providing particular solutions to better plan research and innovation programs.
IMPROVER [59]	• **ICI-REF framework**: management of infrastructure resilience in conjunction with the risk management process. • **IS-REF framework:** integrates resilience management of a community or society with a societal risk management. It is similar in structure to the ICI-REF however addresses a different context. • **Proposed methodologies** ○ CIRI – critical infrastructure (CI) resilience index: potential self-auditing tool for CI. ○ ISRA – societal resilience analysis: indicator-based framework for assessing societal resilience that accounts for 63 societal resilience indicators.
ResiStand [86]	• **Tools to guide final users to develop and structure standards** ○ The ResiStand Standards Catalogue (RSC): contains data about all relevant existing or planned standards as well as the earlier collected standardisation initiatives. It aims at improving the

	crisis management and resilience capabilities for different kind of disasters and to be adopted at European level. ○ The ResiStand Dynamic Roadmap (RDR): database of all running pre-standardisation initiatives containing the collected data and assessment scores based on the output of the RAF. ○ The ResiStand Assessment Framework (RAF): used as a tool in the actual assessment of standardisation initiatives. ○ The Stakeholder Management Concept: ensures the representation of all relevant stakeholders, as well as the management, coordination, and organisation of them.
RESILENS [61]	• **ERMG guidelines for Resilience management**: operational set of guidelines for the needs of the project, based on Risk Assessment, Risk Identification, Risk Analysis, Risk Evaluation and Risk Treatment. Applies also to MONITOR/ABSORB and RESPOND/REACT phases but is **targeted to the resilience of CIs and not of the Community**.
RESOLUTE [63]	• **European Resilience Management Guidelines (EMRG):** developed for complex socio-technical systems and also specified and exemplified in the case of Urban Transport Systems.
MONITOR/ABSORB	
DG-ECHO [76]	• An early priority is to develop tools and guidance to facilitate resilience approaches. Compendium examples from the EU and other organisations committed to resilience include the application of joint humanitarian/development analytical planning tools in South Sudan and in Zimbabwe.
I-REACT [58, 71]	• **I-REACT web-based tool** ○ Collects data from different sources and presents these to the control centre. ○ Meant to be used in the control room by operators and decision-makers for analysing information coming from technical service providers (e.g. forecast layers), monitoring possible and actual emergencies, and communicate with in-field agents. • **I-REACT app** ○ Collects data from the users and sends these to the control centre, and ○ Shows to the users all the information processed by the control centre, enhancing situation awareness in the surroundings.
IMPROVER [59]	• **AESOP guidelines:** communication guidelines aimed at CI operators to improve their communication practices with their end users.
Comrades [62]	• **ICT platform**: allows appropriate communication. In particular the tool aims to collect and analyse data from different sources (also unofficial channels such as social networks). •
RESPOND/RECOVER	
DG-ECHO [76]	• Includes initiatives to measure resilience to assist priority setting and to help organised post-disaster and crisis recovery planning that incorporates resilience objectives.
I-REACT [58]	• **I-REACT web-based tool** ○ Enables understanding for where to intervene in order to communicate the danger and to keep under constant control the position of the operators. • **UAV system** ○ Consists of the ASIGN and ASMIRA services of Ansur which includes separate mobile apps and servers. Ansur's Applications

	Catalogue ensures the sharing of photos and videoclips from UAVs by mobile data connection. ○ Supported by ASING Online, a in situ visualisation and interaction data platform. Its main function is to support operators in obtaining information they need from the field, and then communicating information to users in the field **(e.g.** access the camera, geo-text messages to the server. ○ Uses Augmented Reality technology including Smart Glasses, which will allow first responders to send real-time geo-location status reports, get situational assessments and receive communications from the centre's operator • **The wearable device for first responders** ○ Provides the control team precise positioning of first responders and environment monitoring with toxic gas presence.
IMPROVER [59]	• **Proposed methodology** ○ ITRA – technological resilience analysis methodology: accounts for different time scales in the aftermath of an incident as well as the recovery phase for infrastructure. Requires specialist knowledge to implement and is hazard dependent.
RESOLUTE [63]	• **Collaborative Resilience Assessment and Management Support System (CRAMSS):** eDSS that operationalises the ERMG guidelines procedures to be followed to facilitate and support response and recovery mechanisms. • **Emergency Support Smart Mobile app** ○ to track users' movement & behaviour and thus, provide the eDSS with relevant data ○ to provide users with personalised information, aiming to support self-rescue or to divert passenger flow in the UTS in case of a disruption, or to provide guidance to other citizens in need of help.
LEARN/ADAPT	
DG-ECHO [76]	• The EU has developed training modules for resilience, stand-alone and integrated with other materials, as well as resilience guidance. ECHO has recently introduced a «resilience marker» into project appraisal forms to prompt resilience considerations.
DRIVER+ [57]	• **DRIVER+ Test-bed**. It comprises of four components: ○ The Trial Guidance Methodology (TGM): is a practitioner-centred and systematic approach to assess crisis management solutions in a realistic (simulated) context through trials. ○ The Trial Guidance Tool, to guide users through the process of designing, executing and evaluating a Trial. ○ The Test-bed Technical Infrastructure (TTI): connects solutions and simulates a crisis environment. ○ The Training Module: to familiarise practitioners with the different tools. The tool focused on the learning and training of the first responders and volunteers. • **Centres of Expertise (CoE) network**: ○ Supports organisations in their capability development and innovation management using the DRIVER+ products. ○ Collects and shares lessons learned, and, if necessary, adapts the respective DRIVER+ outcomes to organisation- al and/or national contexts.

	• **Crisis Management Innovation Network Europe (CMINE) online platform** o Enhances the shared understanding of crisis management in Europe. It is a virtual place where crisis management professionals connect and exchange on the most pressing topics related to the field. Advanced group features have been developed to host crisis management organisations, networks and research projects.
I-REACT [58]	• **Web-Based Tool application** o Provides a map where citizens can interact and send data in real-time through gamification tools, in order to learn information and feel comfortable and helpful during a disaster.
IMPROVER [59]	• **Proposed methodology** o IORA – organisational resilience analysis: Experience-based method for understanding past events in terms of resilience.
RESILENS [61] (mostly applicable to CIs)	• **Hub e-learning**: provides further guidance and training on CI resilience. • **ReMMAT, Resilience Management Matrix and Audit Toolkit:** enables a resilience score to be attached to an individual CI, organisation (e.g. CI provider) and at different spatial scales (urban, regional, national and transboundary) which can then be iteratively used to direct users to resilience measures that will increase their benchmarked future score.
RESOLUTE [63]	• **Game theory-based training tool**: fits the circumstances resulting from the implementation of the EMRG guidelines and the DSS.

3.3.2.3 Selection of factors relevant to the SnR project

Next, we attempted to classify the identified attributes/capacities into the three (3) fundamental sets of resources proposed by EU project RESOLUTE as aforementioned in Section 3.2.2: Human/Behavioural, Technological, and Organisational. The phases of the event management cycle that the attribute/capacity was most pertinent to was also indicated when possible. Although useful, this exercise proved to be challenging as identified attributes often pertained to several phases. In addition, the different propositions of domain clusters for the different attributes/capacities made their classification even more challenging. Therefore, we relied upon expert judgment for selecting among the identified attributes/capacities the ones that are very relevant (VR) and most relevant (MR) to the Use Cases KPIs, proposed technologies and objectives of S&R.

Table 3-10 lists the selected factors and attempts to classify these to the Human/Behavioural, Technological, and Organisational fundamental set of resources when possible.

- **Human/behavioural** (e.g. technical skills, expertise and competencies, as well as cognitive resources, particularly those relating to decision-making processes)
- **Technological** (e.g. infrastructure-related, UAV/robot/vehicle-related, infrastructure/traffic control, software, hardware)
- **Organisational** (hierarchical structures, formal procedures, logistics, information use and reporting, communication)

Table 3-10 Attributes/capacities for building community resilience most relevant to the S&R project

Attribute / Capacity	MR	VR	Hum./ Beh.	Tech.	Org.
• Knowledge and local knowledge/learning [27,29,34]: -public education & training in first aid and risk reduction; human skills; -public awareness (e.g. shelter safety) through past disasters and understanding of processes.	X X		X X		
• Community empowerment and inclusiveness (including **vulnerable populations; consider gender**) in programmes/projects/policies, infrastructure planning, monitoring and evaluation (MR).	X		X		
• Societal capacity/capital: Connectedness and engagement of civil organisations w/ mobile/tablet systems and through multiple media channels to build **trust** between first responders and the local community and for data collection. Networking and relations. [43, 94]	X3	X1	X	X	
• Health [27, 94] (VR): health services; physical and mental health		X	X		X
• Coordination and collaboration between different stakeholders; Interinstitutional cooperation cross- and inter-sectoral action; (MR)	X2	X	X		X
• Technology for effective disaster response (detection, monitoring and reporting equipment; interoperability of emergency response systems; emergency response centre w/ automating SOPs. MR)	X			X	
• Use of drone technologies for victim's localisation, situation awareness and risk assessments		X		X	
• Open-source data collection platform (e.g. CommCare designed by GOAL [49] to monitor community disaster resilience and tested in 11 countries; EU projects open data platforms).	X			X	X
• Communication / **early warning systems** with SOPs [1, 6, 7] (MR): appropriate communication infrastructure; real time crisis information collection, sharing & reporting; clear inter-organisational communication structure at country level. Consistent terminology. Communication with place-based community.	X			X	X
• First responder adequate equipment availability & access; capability to respond quickly (simulation exercises); wearable smart devices to improve technical skills, cognitive capabilities and information sharing of responders	X1	X2		X	X
• Availability & access of adequate, reliable and well maintained infrastructure and land use/zoning. Capability to respond quickly; capacity to deal w/ disaster. Shelters. Staffing capacity.	X1	X2		X	X

Attribute / Capacity	MR	VR	Hum./ Beh.	Tech.	Org.
• Expedite recovery (early action systems) and build back better (learning loops, manage local aid and funding)		X			X
• Governance / Leadership / Institutional capacity [27, 28]: effectiveness, efficiency, and capability to respond quickly; capacity to deal w/ disaster & share information.	X				X
• Resources [1,2] (VR): availability & appropriate allocation; formally consider informal actor networks and resources in DRM official policies.		X			X
• Contingency (from planning and preparedness) and public infrastructure plans and **investments** are disaster risk informed [69]; post-disaster needs assessments to promote investments.		X			X
• Standardisation of processes for a better disaster crisis management		X			X
• Establishing community emergency response teams & local volunteer management systems (Volunteer Coordination Teams)		X			X

3.3.3 Professional-volunteer interactions in building community resilience

At EU scale the professional-volunteer interaction exhibits considerable variability. National systems and civil protection frameworks also differ in this regard [50]. There are countries (e.g. Austria, Germany) that are more prone through their national framework to formalise and encourage involvement of different volunteer organisations, while in other countries the framework relies more heavily on professional organisations with auxiliary help from registered volunteer organisations in official civil protection registrars. There is no common practice in this sense in the EU. However, the tendency is to acknowledge, encourage and upgrade the involvement of the various volunteer organisations. The literature review identified areas where volunteers could benefit from professional experience, areas where professionals could benefit from volunteer's local knowledge, skills, empowerment and resource availability and there exist actions that could promote community resilience building by upgrading the professional-volunteer interaction in a horizontal way (as defined by the ISO norm 22319: individual who is not affiliated with an existing incident response organisation or voluntary organisation but who, without extensive preplanning, offers support to the response to, and recovery from, an incident).

Table 3-11 reports the relevant findings (indicative references are reported in brackets).

As it may be inferred, communication, connectedness through networks, collaboration, cooperation and situational awareness through inclusive and participatory approaches are essential in building 'community resilience'. Training, education and learning from past experiences are necessary processes. Empowering and engaging local communities and volunteers through the use of appropriate technologies may greatly contribute to the effectiveness and the efficiency of the response to and recovery from disaster situations.

Table 3-11 Key professional-volunteer interactions for building community resilience

Key professional – volunteer interactions in building 'community resilience'		
Professional <> Volunteer	**Volunteer → Professional**	**Professional → Volunteer**
Communication		
• Better, more accurate and faster communication promoting a participatory approach [44-52]. • Use of technological support and communication methods that are appropriate, effective, efficient and accessible to community members (e.g. low-tech / low cost, SMS, radio, newsletters, posters, volunteer meetings; geospatial and space-based technologies where possible) [64, 69].	• Promote communication and information sharing through informal social networks [28, 44-63].	• Incorporate relevant volunteer organisations in communication framework [63-83] • Communicate with local (place-based) communities [58, 63].
Training, learning and skills (Refs: EU projects)		
• Propagate learned experience. [30, 55]	• Use of risk management frameworks and platform for improving technical skills and cognitive capabilities. • Develop institutional capacities and build knowledge and evidence base [42]. • Connect communities to stakeholders: must introduce them to, or reinforce their knowledge of, principles, processes, systems and structures that can help them to build resilience. [38, 42, 44, 49].	• Provision of relevant training and skills in the area of disaster management and response [57, 58, 63]. • Include volunteers in regular drills and simulation exercises [40, 41].
Collaboration, cooperation and situational awareness		
• Coordinate for meeting food, shelter and staples (e.g. sanitation, clothing, bedding) needs [40, 41]. • Share disaster risk management tools and standards [57-63]. • Use of technological support: open-data risk management platforms, simulation tools, and real-time information-sharing and mapping tools	• May provide valuable local knowledge local skills and resources. [28, 56, 65] • Local volunteers may build trust in the local community. • May provide / collect relevant local data and assist to the field triage of victims (valuable information for hospitals) [56, 65].	• Cooperate through technology transfer, access to and the sharing and use of non-sensitive data and information [38, 43]. • Work with and through the formal (e.g. laws, regulations) and informal (e.g. tradition, indigenous knowledge) systems. [38, 43]

Key professional – volunteer interactions in building 'community resilience'		
Professional <> Volunteer	**Volunteer → Professional**	**Professional → Volunteer**
(e.g. maps, mobile apps) [38, 43, 57-62, 65, 67, 68, 69] • Maximise collaboration between institutions and civil-society organisations through the pursuit of specific knowledge, common vision and practical objectives [35,37] • Encourage an inclusive approach and be sensitive to issues such as vulnerability, gender equality, cultural diversity, climate change [9-37]. • Use of established networks	• Knowledge of relevant processes, frameworks and protocols [27, 28, 57-42]	• Enable and facilitate volunteers and local communities by providing the means (human and other resources) to act [38, 42]. • Refocus assistance to most vulnerable to shock [42, 43]. • Provide forecasting (prediction) • Test the knowledge management system (which enables the situation awareness with the volunteers)
Governance and decision-making		
• Use participatory and inclusive approach in decision-making by involving the 'whole Community' with relevant representatives [94]. • Empower local authorities and representative members of the community to take decisions and act on behalf of the community and be accountable for these [29, 40,41,43, 93, 94] • Promote the development of social safety nets and establish networks between professionals and volunteer organisations [38, 43]	• May provide valuable local knowledge, policy support and advice. [70, 72] • May be agents of change within their communities [62, 63, 69]	
Plans, programmes, processes and protocols		
• Establish rules and procedures early (i.e. preparedness, mitigation phase) • Promote the development of quality standards (e.g. certifications and awards) for disaster risk management by including civil society and professional organisations. [43].		

Key professional – volunteer interactions in building 'community resilience'		
Professional <> Volunteer	**Volunteer → Professional**	**Professional → Volunteer**
• Actively engage communities in the co-design process [40, 41, 43, 44-46], monitoring, implementation and evaluation of programmes, services normative frameworks, standards and plans for disaster risk reduction [30, 36, 37, 43]		

3.3.4 Summary of critical findings and conclusions

The literature review confirmed that there is no common, agreed definition of 'community resilience'. Unavoidably, the way we define and set the context for 'community' will affect its resilience to disasters, the way we attempt to measure it and enhance it [27, 28, 31]. 'Resilience for whom?' and 'resilience to what?' are the questions to be answered. [28, 30, 31, 40, 41].

To answer to the former question, we reviewed several conceptualisations of 'community' which exists in several forms as well [31]. From the proposed categorisations, the community of practice, including the first responders, early responders and sustained support seems to better fit the actors that are mainly involved in the S&R project. However, as aforementioned the interaction of this community with civil society volunteering organisations and social groups including relevant vulnerable populations and sub-groups during the response and recovery phases of Crisis Management, and not only, is important and will be duly considered [40, 41].

Hence, the answer to the latter question is enlightened by the answer to the first question which provides context [39]: as the definition of our 'community' involves an important social factor due to the identified interactions, building 'community resilience' for disaster response should consider 'community resilience' definitions that acknowledge the contribution of the adaptive and transformation processes to building 'community resilience' over the longer run as well. Building resilience takes time and addressing simultaneously the short-term and long-term resilience implications is a challenge [39]. Adaptive capacity, transformation and social learning are essential elements for this [29, 34, 38, 39, 42], nevertheless negative coping mechanisms (e.g. theft) should not be disregarded [39, 42].

To the aforementioned, it is noted that further empirical investigation is needed for the systematic accounting of learning and change in the operationalisation of proposed frameworks [34] as *an explicit description of learning and change is largely absent in the literature that characterises community resilience* [3]. Hence, we focused on individual elements (i.e. attributes and capacities) for which the literature review provides strong evidence [34] that they contribute to building 'community resilience' when these are of course also deemed applicable to our notions of 'community' and 'community resilience' as defined. In this respect the landscape of 'resilience' indicators is extremely diverse [30] and expert judgment was utilised for screening the different factors reported in the literature and identifying those that are most applicable to the S&R project. This approach has also been commended in the literature (e.g. [29], [34]). Lack of agreement in related terminology has also been reported [34] and we therefore defined our use of the terms 'attribute' and 'capacity'.

There is strong tendency to more actively involve the local community, volunteer and civil organisations in all phases of the event management cycle. In this respect, the interaction between professionals and volunteers is a crucial element in building 'community resilience' as they could both benefit and contribute in further building 'community resilience' by:

- Actively engaging communities in the co-design, monitoring, implementation and evaluation of plans, programmes standards, processes and protocols. Participatory approaches promoting inclusion of vulnerable population sub-groups are encouraged.
- Empowering and enabling local communities by providing regulatory context and resources [3].
- Training, educating and propagating learned experience to volunteers and local community.
- Connecting the 'community' by promoting the development of social safety nets and establishing networks between professionals and volunteer organisations [28, 19, 36-38, 42, 43, 47]. In small-population countries, it is essential to be active in international networks. International cooperation is crucial to enhance technology transfer, involving a process of enabling and facilitating flows of skill, knowledge, ideas, know-how and technology from developed to developing countries in the implementation of the Sendai Framework for DRR [43].
- Improving communication, collaboration, information sharing and situational awareness through appropriate technological solutions, relevant SOPs and protocols.

Below, key lessons for 'community resilience' building are reported:

- Community resilience is about a *demand driven, people-centred approach*. Collaboration among policy sectors and the full engagement of civil society and key stakeholders are key elements. [40,41,42]
- Communication and information sharing has been identified as a pivotal aspect of 'community resilience' capacity building across all phases of the event management cycle. Also, for the professional – volunteer interaction.

  In this respect, on-line platforms and tools for data collection, integration and sharing recently developed in relevant EU projects which provide interesting elements and frameworks to take into consideration for the development of respective technologies / wearables in the S&R project, the protection of First Responders and for the coordination during the response and recovery phases of crises. In most of these cases, coordination among actors involved in the operation, including volunteer organisations, is performed through formal procedures for decision-making and sharing of online platforms/platforms and tools including mobile applications. This is an important step towards the right direction as in emergency settings *data availability is often limited, staff turnover is higher, access is often constrained and insecurity makes monitoring and accountability challenging* [68]. Studies have commended the effectiveness of UAV usage in improving the situational awareness and reducing the response time [92, 95, 107, 118].
- Preparedness of the involved community (including the local, volunteers and civic organisations) is instrumental in building 'community resilience' during the response phase. For this, the 'community' must be informed and educated on the specific disaster(s) to which the area is subjected. A key aspect in this respect is the proper and timely maintenance of the critical infrastructures.

- Several experts and civil-rights associations have pointed out that measures aimed at resilience building should clearly address the questions: 'resilience for whom', 'where', 'when' and 'why'. [66, 67]
- Building and sustaining resilience requires the development of environments that are supportive of population health and well-being [35].
- Support communities in adopting risk-informed and holistic approaches [38, 39]. Common understanding of risks between the city and various utility providers and other regional and national agencies that have a role in managing infrastructure such as power, water, roads and trains is needed [40,41]. Risk-informed social protection interventions, including cash transfers and insurance, can become a critical component [40, 41]. As articulated in the Sendai Framework for Disaster Risk Reduction [43], making the business case for investments in risk reduction and resilience may drive the policy agenda, whereas the interest in indicators is driven by the return on investment of resilience-related activities.
- Asset-based approaches are also required as it has been argued that *people do not develop because of their deficits but rather on the strength of their assets and resilience capacities* [40, 41].

3.4 Legislative /regulatory /standardisation issues

3.4.1 Introduction

This section is dedicated to identify issues (e.g. limitations; legal/standardisation incentives) that are likely to influence "Community resilience". It focusses on Legal/regulatory/ISO standardisation issues that are likely to influence the "community resilience" in terms of:

- Solution implementation and deployment
- Professional-volunteer coordination and collaboration

This section is not meant to constitute a comprehensive-all-inclusive list of relevant directives/ISO standards but is an analysis which makes reference to the most representative of them in relation to their influence in shaping "community resilience", solution implementation and deployment and professional-volunteer coordination and collaboration.

3.4.2 Legislation/Regulation

3.4.2.1 International Instruments

The relevant references by order of presentation are [78-83].

a) *UN Convention on the Transboundary Effects of Industrial Accidents*[3]

The Convention on the Transboundary Effects of Industrial Accidents helps Parties to prevent industrial accidents that can have transboundary effects and to prepare for, and respond to, accidents if they occur. The Parties must take appropriate measures and cooperate to protect human beings and the environment against industrial accidents by preventing such accidents as far as possible, by reducing their frequency and severity and by mitigating their effects. To this end, preventive, preparedness and

[3] UN Convention on the Transboundary Effects of Industrial Accidents, Helsinki, 17 March 1992 as amended on 15 December 2015, https://www.unece.org/fileadmin/DAM/env/documents/2017/TEIA/Publication/ENG_ECE_CP_TEIA_33_final_Convention_publication_March_2017.pdf

response measures, including restoration measures, must be applied. By means of exchange of information, consultation and other cooperative measures and without undue delay, the Parties must develop and implement policies and strategies for reducing the risks of industrial accidents and improving preventive, preparedness and response measures, including restoration measures, taking into account, in order to avoid unnecessary duplication, efforts already made at national and international levels. The Parties must ensure that the operator is obliged to take all measures necessary for the safe performance of the hazardous activity and for the prevention of industrial accidents. To implement the provisions of this Convention, the Parties must take appropriate legislative, regulatory, administrative and financial measures for the prevention of, preparedness for and response to industrial accidents. With the aim of obtaining and transmitting industrial accident notifications containing information needed to counteract transboundary effects, the Parties must provide for the establishment and operation of compatible and efficient industrial accident notification systems at appropriate levels.

If a Party needs assistance in the event of an industrial accident, it may ask for assistance from other Parties, indicating the scope and type of assistance required. A Party to whom a request for assistance is directed shall promptly decide and inform the requesting Party whether it is in a position to render the assistance required and indicate the scope and terms of the assistance that might be rendered. In addition, the Parties must, consistent with their laws, regulations and practices, facilitate the exchange of technology for the prevention of, preparedness for and response to the effects of industrial accidents, particularly through the promotion of: (a) Exchange of available technology on various financial bases; (b) Direct industrial contacts and cooperation; (c) Exchange of information and experience; (d) Provision of technical assistance. In promoting these activities, the Parties must create favourable conditions by facilitating contacts and cooperation among appropriate organisations and individuals in both the private and the public sectors that are capable of providing technology, design and engineering services, equipment or finance.

b) UN Guidelines on the Use of Military and Civil Defence Assets in Disaster Relief[4]

The aim of the Guidelines on the Use of Military and Civil Defence Assets in Disaster Relief (the «Oslo Guidelines») is to establish the basic framework for formalizing and improving the effectiveness and efficiency of the use of foreign military and civil defence assets in international disaster relief operations. These guidelines arrange the deployment of personnel, equipment and services by foreign military, civil defence and civil protection forces when a State has been struck with disaster. Military and civil defence assets should be seen as a tool complementing existing relief mechanisms in order to provide specific support to specific requirements, in response to the acknowledged «humanitarian gap» between the disaster needs that the relief community is being asked to satisfy and the resources available to meet them. Therefore, foreign military and civil defence assets should be requested only where there is no comparable civilian alternative and only the use of military or civil defence assets can meet a critical humanitarian need. The military or civil defence asset must therefore be unique in capability and availability. However, foreign civil protection assets, when civilian in nature and respecting humanitarian principles, can provide an important direct and indirect contribution to humanitarian actions based on

[4] UN, OCHA, Guidelines on the Use of Military and Civil Defence Assets in Disaster Relief, May 1994, as updated in November 2007, "Oslo Guidelines", https://www.unocha.org/sites/unocha/files/OSLO%20Guidelines%20Rev%201.1%20-%20Nov%2007_0.pdf

humanitarian needs assessments and their possible advantages in terms of speed, specialisation, efficiency and effectiveness, especially in the early phase of relief response. The use of civil protection assets should be needs driven, complementary to and coherent with humanitarian aid operations, respecting the overall coordinating role of the UN. All disaster relief, including MCDA should be provided at the request or with the consent of the Affected State and, in principle, on the basis of an appeal for international assistance. As a general principle, UN humanitarian agencies must avoid becoming dependent on military resources and Member States are encouraged to invest in increased civilian capacity instead of the ad hoc use of military forces to support humanitarian actors.

c) INSARAG Guidelines for Urban Search and Rescue Teams[5]

The International Search and Rescue Advisory Group (INSARAG) is a network of disaster-prone and disaster-responding countries and organisations dedicated to urban search and rescue (USAR) and operational field coordination. INSARAG was established in 1991 to facilitate coordination between the international USAR teams that make themselves available for deployment to countries experiencing devastating events of structural collapse due primarily to earthquakes. Ever since, INSARAG has never stood still but constantly adapted its globally recognised and accepted quality standards and methodology to save more lives. The United Nations was chosen as the INSARAG secretariat to facilitate international participation and coordination. The Emergency Response Section (ERS), located within OCHA Geneva's Response Support Branch (RSB), functions as the INSARAG secretariat. The INSARAG Guidelines, which have been developed at the initiative of the UN, offer a framework for international search and rescue operations. More specifically, these Guidelines provides a methodology to guide countries affected by a sudden-onset disaster causing large-scale structural collapse, as well as international USAR Teams responding in the affected country. The Guidelines also outlines the role of the UN in assisting affected countries in on-site coordination. Reviewed and updated between 2018 to 2020, the INSARAG Guidelines 2020 incorporates six new areas from the 2015 version that were endorsed by the ISG; (i) IER Pre-Greening Process, (ii) INSARAG Recognised National Accreditation Process (IRNAP), (iii) USAR Coordination Cell (UCC), (iv) Information Management, (v) Classified Light Teams and (vi) Beyond the Rubble.

d) *NATO Logistics Handbook*[6]

Member States and Partnerships for Peace countries can in peace time appeal to the NATO as medium for the exchange of information, for assistance when coordinating during disasters and crises, or for the input of NATO materials and staff. For this purpose, the Euro Atlantic Disaster Response coordination centre has been introduced. The EADRCC is NATO's principal civil emergency response mechanism in the Euro-Atlantic area. The Centre functions as a clearing-house system for coordinating both requests for and offers of international assistance in case of natural and man-made disasters, crises and Article 5 situations. It is active all year round, operational on a 24/7 basis, and involves all NATO Allies and partner countries. The EADRCC's tasks are carried out in close cooperation with the

[5] INSARAG Guidelines for Urban Search and Rescue Teams endorsed by the United Nations General Assembly Resolution 57/150 of 2002, on "Strengthening the Effectiveness and Coordination of International Urban Search and Rescue Assistance", https://www.insarag.org/guidelines

[6] NATO Logistics Handbook, October 1997, Chapter 11: Civil Emergency Planning, https://www.nato.int/docu/logi-en/1997/lo-1124.htm

United Nations Office for the Coordination of Humanitarian Affairs, which retains the primary role in the coordination of international disaster relief operations.

e) *Tampere Convention on the Provision of Telecommunication Resources for Disaster Mitigation and Relief Operations*[7]

The Tampere Convention calls on States to facilitate the provision of prompt telecommunication assistance to mitigate the impact of a disaster, and covers both the installation and operation of reliable, flexible telecommunication services. Regulatory barriers that impede the use of telecommunication resources for disasters are waived. These barriers include the licensing requirements to use allocated frequencies, restrictions on the import of telecommunication equipment, as well as limitations on the movement of humanitarian teams. The Convention describes the procedures for request and provision of telecommunication assistance, recognizing the right of a State to direct, control and coordinate assistance provided under the Convention within its territory. It defines specific elements and aspects of the provision of telecommunication assistance, such as termination of assistance. It requires States to make an inventory of the resources – both human and material – available for disaster mitigation and relief, and to develop a telecommunication action plan that identifies the steps necessary to deploy those resources. The ITU, requested by the Operational Coordinator, will assist in fulfilling the objectives of the Tampere Convention. This life-saving international treaty was unanimously adopted on 18 June 1998 by the delegates of the 75 countries that attended the Intergovernmental Conference on Emergency Telecommunications (ICET-98).

f) *Principles and Rules for Red Cross and Red Crescent Disaster Relief*[8]

The National Red Cross and Red Crescent Societies (National Societies), the International Federation of Red Cross and Red Crescent Societies (International Federation) and the International Committee of the Red Cross (ICRC) together constitute the International Red Cross and Red Crescent Movement. National Societies support the public authorities in their own countries as independent auxiliaries to the government in the humanitarian field, this is referred to as the auxiliary role of National Red Cross or Red Crescent Societies. In view of the solidarity binding them together, National Societies shall help one another when faced with a situation exceeding the resources of any one Society. In the case of international assistance in such a disaster, the IFRC coordinates and directs international assistance following natural and man-made disasters in non-conflict situations. Hence, it is the lead agency in the disaster response of the Movement. As lead agency, the IFRC carries out the general direction and coordination of the international operational activities. To enable the Federation to act as the disaster information centre, National Societies shall immediately inform it of any major disaster occurring within their country, including data on the extent of the damage and on the relief measures taken at the national level to assist victims.

[7] Tampere Convention on the Provision of Telecommunication Resources for Disaster Mitigation and Relief Operations, Tampere, Finland, 18th June 1998, https://treaties.un.org/pages/ViewDetails.aspx?src=TREATY&mtdsg_no=XXV-4&chapter=25&clang=_en

[8] Principles and Rules for Red Cross and Red Crescent Disaster Relief, adopted by the XXIst International Conference of the Red Cross (Istanbul, 1969) - revised by the XXIInd, XXIIIrd, XXIVth, XXVth and XXVIth International Conferences - Tehran (1973), Bucharest (1977), Manila (1981), Geneva (1986) and Geneva (1995), https://www.ifrc.org/docs/idrl/I280EN.pdf

3.4.2.2 European Instruments

The relevant references by order of presentation are [73-84].

a) Regulation (EC) No 1257/96 concerning humanitarian aid[9]

EU humanitarian aid seeks to provide assistance, relief and protection to people affected by natural or manmade disasters and similar emergencies. The focus is on the most vulnerable victims. This regulation sets out the main goals, principles and procedures for implementing EU humanitarian aid operations. The principal objectives of the EU humanitarian aid operations are:

- to save and preserve life during emergencies and their immediate aftermath and natural disasters that have entailed major loss of life, physical, psychological or social suffering or material damage;
- to provide the necessary assistance and relief to people affected by longer-lasting crises arising, in particular, from outbreaks of fighting or wars, producing the same effects as those described in subparagraph (a), especially where their own governments prove unable to help or there is a vacuum of power;
- to help finance the transport of aid and efforts to ensure that it is accessible to those for whom it is intended, by all logistical means available, and by protecting humanitarian goods and personnel, but excluding operations with defence implications;
- to carry out short-term rehabilitation and reconstruction work, especially on infrastructure and equipment, in close association with local structures, with a view to facilitating the arrival of relief, preventing the impact of the crisis from worsening and starting to help those affected regain a minimum level of self-sufficiency, taking long-term development objectives into account where possible;
- to cope with the consequences of population movements (refugees, displaced people and returnees) caused by natural and man-made disasters and carry out schemes to assist repatriation to the country of origin and resettlement there when the conditions laid down in current international agreements are in place;
- to ensure preparedness for risks of natural disasters or comparable exceptional circumstances and use a suitable rapid early-warning and intervention system;
- to support civil operations to protect the victims of fighting or comparable emergencies, in accordance with current international agreements.

Community aid may be used to finance the purchase and delivery of any product or equipment needed for the implementation of humanitarian operations, including the construction of housing or shelter for the victims, the costs associated with the outside staff, expatriate or local, employed for those operations, the storage, international or national transport, logistics and distribution of relief and any other action aimed at facilitating or obtaining freedom of access for aid recipients. Such Community aid may also be used to finance preparatory and feasibility studies for humanitarian operations and the assessment of humanitarian projects and plans, operations to monitor humanitarian projects and plans, small-scale training schemes and general studies in the field of humanitarian operations, to be phased out gradually where funding is over several years, the cost of highlighting the Community nature of the aid, public awareness and information campaigns aimed at increasing understanding of humanitarian

[9] Council Regulation (EC) No 1257/96 of 20 June 1996 concerning humanitarian aid, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A31996R1257

issues, especially in Europe and in third countries where the Community is funding major humanitarian operations, measures to strengthen the Community's coordination with the Member States, other donor countries, international humanitarian organisations and institutions, non-governmental organisations and organisations representing them, the technical assistance necessary for the implementation of humanitarian projects, including the exchange of technical know-how and experience by European humanitarian organisations and agencies or between such bodies and those of third countries, humanitarian mine-clearance. It may also be used to finance any other expenditure directly related to the implementation of humanitarian operations.

b) *Decision No 1313/2013/EU of the European Parliament and of the Council on a Union Civil Protection Mechanism as amended by Decision (EU) 2019/420 of the European Parliament and of the Council of 13 March 2019*[10]

The Union Civil Protection Mechanism ("the Union Mechanism") aims to strengthen the cooperation between the Union and the Member States and to facilitate coordination in the field of civil protection in order to improve the effectiveness of systems for preventing, preparing for and responding to natural and man-made disasters. The protection to be ensured by the Union Mechanism primarily covers people, but also the environment and property, including cultural heritage, against all kinds of natural and man-made disasters, including the consequences of acts of terrorism, technological, radiological or environmental disasters, marine pollution, and acute health emergencies, occurring inside or outside the Union. In the case of the consequences of acts of terrorism or radiological disasters, the Union Mechanism may cover only preparedness and response actions. The Union Mechanism promotes solidarity between the Member States through practical cooperation and coordination, without prejudice to the Member States' primary responsibility to protect people, the environment, and property, including cultural heritage, on their territory against disasters and to provide their disaster-management systems with sufficient capabilities to enable them to cope adequately and in a consistent manner with disasters of a nature and magnitude that can reasonably be expected and prepared for. Concretely, civil protection assistance consists of governmental aid delivered in preparation for or immediate aftermath of a disaster in Europe and worldwide. Aid takes the form of in-kind assistance, deployment of specially-equipped teams, or experts assessing and coordinating support right in the field. When a disaster overwhelms a country’s ability to contain it, other participating states step in and provide assistance.

[10] Decision No 1313/2013/EU of the European Parliament and of the Council on a Union Civil Protection Mechanism as amended by Decision (EU) 2019/420 of the European Parliament and of the Council of 13 March 2019, consolidated version available at https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:02013D1313-20190321. See also Commission Implementing Decision of 16 October 2014 laying down rules for the implementation of Decision No 1313/2013/EU of the European Parliament and of the Council on a Union Civil Protection Mechanism and repealing Commission Decisions 2004/277/EC, Euratom and 2007/606/EC, Euratom, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2014.320.01.0001.01.ENG and Commission Implementing Decision (EU) 2019/570 of 8 April 2019 laying down rules for the implementation of Decision No 1313/2013/EU of the European Parliament and of the Council as regards rescEU capacities and amending Commission Implementing Decision 2014/762/EU, https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1555054672417&uri=CELEX:32019D0570

All EU Member States, as well as Iceland, North Macedonia, Montenegro, Norway, Serbia and Turkey are taking part in the Union Civil Protection Mechanism.

In 2019, the EU has strengthened its response capacities through the following measures:

- Establishment, in collaboration with Member States, a common European reserve of capacities to respond to disasters. Such capacities include firefighting planes, as well as other means to respond to situations such as medical emergencies or chemical biological radiological and nuclear incidents;
- Co-financing of the operational costs of rescEU capacities when used for the EU's Civil Protection Mechanism operations;
- Co-financing of the development of rescEU capacities;
- Increasement of the financial support for capacities registered in the European Civil Protection Pool, including for adaptation, repair, operational costs (inside the EU) and transport costs (outside the EU).

In addition, the EU provides support for Member States to improve their disaster risk management by:

- Establishing a simplified reporting framework, focusing on key risks of a cross-border nature and risks of low probability with high impact;
- Providing support to Member States to increase their existing measures through consultation mechanism and, deployment of expert missions and follow-up recommendations;
- Sharing knowledge and lessons through the setting up of a new EU Civil Protection Knowledge Network.

Very recently, a proposal to amend Decision No 1313/2013/EU on a Union Civil Protection Mechanism was introduced[11]. In concrete terms, the changes contained in this proposal are aimed at achieving the following objectives: a) Reinforce a cross-sectoral and societal preparedness approach to trans-boundary disaster risk management, including establishing a baseline and planning elements at a European level, taking into account how climate change affects disaster risk. b) ensure that the Commission is able to directly procure an adequate safety net of rescEU capacities; c) provide the Commission with the logistical capacity to provide multi-purpose air services in case of emergencies and to ensure timely transport and delivery of assistance; d) design a more flexible system for response to large-scale emergencies; e) enhance the Emergency Response Coordination Centre's operational coordination and monitoring role in support of the EU's swift and effective response to a broad range of crises inside and outside the Union, in complementarity with existing crisis response mechanisms and in line with existing inter-institutional arrangements; f) enable stronger investment in preparedness at Union level and further simplification of budget implementation; g) enable the implementation of recovery and resilience measures under the Union Civil Protection Mechanism through financing from the European Union Recovery Instrument, constituting external assigned revenues according to Article 21(5) of the Financial Regulation.

[11] Proposal for a Decision of the European Parliament and of the Council amending Decision No 1313/2013/EU on a Union Civil Protection Mechanism, Brussels, 2.6.2020, COM(2020) 220 final, 2020/0097 (COD), https://ec.europa.eu/echo/sites/echo-site/files/com_2020_220_en_act_v13.pdf

c) *Communication from the Commission to the European Parliament, the Council and the Committee of the Regions Strengthening EU Disaster Management: rescEU Solidarity with Responsibility Solidarity with Responsibility*[12]

RescEU is essentially a reserve of assets used when Member States can't cope with a disaster themselves and require extra EU assistance that should be delivered fast. rescEU establishes a new European reserve of resources (the 'rescEU reserve') which includes a fleet of firefighting planes and helicopters, medical evacuation planes, as well as a stockpile of medical equipment and field hospitals that can respond to health emergencies, and chemical, biological, radiological, and nuclear incidents. All costs and capacities of rescEU are fully covered by EU financing, with the Commission retaining the operational control of these assets and deciding on their deployment.

It works as follows in a crisis situation:

- A Member State decides to activate the EU Civil Protection Mechanism to request support when they are overwhelmed by a crisis (as can other countries and international organisations). To be clear: the European Commission cannot activate the Civil Protection Mechanism itself.
- The Commission's 24/7 Emergency Response and Coordination Centre, based in Brussels, monitors and manages an information sharing system that all EU Member States use to make requests for assistance and detail what support they need. Immediately when a request for assistance is received, all participating states in the Mechanism are alerted of the request.
- When capacities in the European Civil Protection Pool are insufficient to respond to a disaster, the Commission could then decide to deploy its own 'rescEU' capacities to support Member States' actions. Such capacities will be in the four areas of action; firefighting aircraft, high capacity pumping equipment for floods, urban search and rescue capacities, and field hospital and emergency medical assistance.
- Once the required support is identified, it will be dispatched to the affected country. The Commission retains operational control of rescEU assets. During the operation, the affected country would ensure that activities involving rescEU capacities are executed in accordance with the operational deployment agreed with the Commission.

d) *Regulation No 375/2014 of the European Parliament and the Council on establishing the European Voluntary Humanitarian Aid Corps ('EU Aid Volunteers initiative')*[13]

[12] Communication from the Commission to the European Parliament, the Council and the Committee of the Regions Strengthening EU Disaster Management: rescue Solidarity with Responsibility Solidarity with Responsibility, Brussels, 23.11.2017, COM(2017) 773 final, https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1516706412366&uri=CELEX:52017DC0773

[13] Regulation No 375/2014 of the European Parliament and the Council on establishing the European Voluntary Humanitarian Aid Corps ('EU Aid Volunteers initiative'), https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1420127481637&uri=CELEX:32014R0375. See also Commission Implementing Regulation (EU) No 1244/2014 of 20 November 2014 laying down rules for the implementation of Regulation (EU) No 375/2014 of the European Parliament and of the Council establishing the European Voluntary Humanitarian Aid Corps ('EU Aid Volunteers initiative'), https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32014R1244 and Commission Delegated Regulation (EU) No 1398/2014 of 24 October 2014 laying down standards regarding candidate

The EU Aid Volunteers initiative provides opportunities to European citizens and long-term residents, from a wide range of backgrounds and with a diversity of skills and professional experience, to get involved in humanitarian aid projects, support the provision of needs-based humanitarian aid in third countries and engage in volunteering opportunities, through deployment and online-volunteering.

The objective of the EU Aid Volunteers initiative is to contribute to strengthening the Union's capacity to provide needs-based humanitarian aid aimed at preserving life, preventing and alleviating human suffering, maintaining human dignity and strengthening the capacity and resilience of vulnerable or disaster-affected communities in third countries. The EU Aid Volunteers initiative aims at these objectives by means of disaster preparedness, disaster risk reduction and by enhancing the link between relief, rehabilitation and development. In its latest implementations, a particular attention has been devoted to the links between climate change adaptation and disaster preparedness and reduction. The Objective of the Initiative is pursued through the added value of joint contributions of EU Aid Volunteers, expressing the Union's values and solidarity with people in need and visibly promoting a sense of European citizenship.

Projects funded under this programme seek coherence and complementarity with other instruments and areas of Union external action and with other relevant Union policies, in particular humanitarian aid policy, development cooperation policy and the Union Civil Protection Mechanism.

The aims of the action are:

- Progress in contributing to increasing and improving the capacity of the Union to provide humanitarian aid.
- Progress towards the improvement of the skills, knowledge and competences of volunteers in the field of humanitarian aid and the terms and conditions of their engagement.
- Progress in building the capacity of hosting organisations and foster volunteering in third countries.
- Progress in communicating the Union's humanitarian aid principles agreed in the European Consensus on Humanitarian Aid.

EACEA is in charge of the complete life-cycle management of the strands/actions mentioned above. This consists of the implementation of the programme including the call for proposals, analysis of the grant requests, monitoring of projects, including visits on the spot, and the dissemination of the projects' and programme's results. EACEA works in partnership with the European Commission, DG ECHO. DG ECHO guided the design and development of the programme in close consultation with EU member states and key humanitarian stakeholders. DG ECHO holds responsibility for the development of the legal framework at the base of the EU Aid Volunteers initiative and maintains key oversight for policy, financial and operational elements of the initiative.

e) Council Regulation (EU) 2016/369 on the provision of emergency support within the Union[14]

volunteers and EU Aid Volunteers, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ%3AJOL_2014_373_R_0003.

[14] Council Regulation (EU) 2016/369 of 15 March 2016 on the provision of emergency support within the Union, consolidated text available at https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:02016R0369-20200201

This Regulation lays down the framework within which Union emergency support may be awarded through specific measures appropriate to the economic situation in the event of an ongoing or potential natural or man-made disaster. Such emergency support can only be provided where the exceptional scale and impact of the disaster is such that it gives rises to severe wide-ranging humanitarian consequences in one or more Member States and only in exceptional circumstances where no other instrument available to Member States and to the Union is sufficient. Emergency support provided under this Regulation must be in support of, and complementary to, the actions of the affected Member State. To this end, close cooperation and consultation with the affected Member State must be ensured. The help provided under the new instrument is needs-based and aimed at preserving life, preventing human suffering and maintaining human dignity. It includes food, shelter, water, medicine and other basic necessities. It is being delivered by the Commission or by partner organisations selected by the Commission in close cooperation with the Greek authorities.

f) Council Directive 2008/114/EC of 8 December 2008 on the identification and designation of European critical infrastructures and the assessment of the need to improve their protection[15]

Directive 2008/114 establishes a procedure for identifying and designating European Critical Infrastructures (ECI) in the transport and energy sectors that, were they to be disrupted or destroyed by an act of terrorism or other type of incident, would have significant cross-border impacts. The Directive also provides a common approach for assessing the need to improve the protection of designated ECI. The Directive is one pillar in the European Programme for Critical Infrastructure Protection (EPCIP).

The Directive calls for Member States to designate ECI by way of agreement with other Member States that may be significantly affected in the event that the functioning of the infrastructure is disrupted or the infrastructure itself destroyed. The owners/operators of designated ECI are obligated to develop Operator Security Plans (OSPs) for use in identifying those elements of each ECI that are particularly crucial and thus merit enhanced security measures in the interest of protection. The Directive also stipulates that Security Liaison Officers (SLOs) should be designated for each ECI. This function serves as points of contact between ECI's owners/operators and the competent authority at the Member State level on matters of security.

In 2018-19 the Directive was subject of an external evaluation. The evaluation was finalised on 23 July 2019 with the publication of a Staff Working Document[16].

- The context in which CI are operated has changed considerably since the Directive entered into force. In view of recent technological, economic, social, policy/political and environmental developments and the new and evolving challenges that they pose in protecting CI, the Directive has partial relevance;
- The Directive appears to be broadly consistent with relevant European sectoral legislation as well as policy at international level. Several complementarities and overlaps with other pieces

[15] Council Directive 2008/114/EC of 8 December 2008 on the identification and designation of European critical infrastructures and the assessment of the need to improve their protection, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L_.2008.345.01.0075.01.ENG

[16] https://ec.europa.eu/home-affairs/sites/homeaffairs/files/what-we-do/policies/european-agenda-security/20190723_swd-2019-310-commission-staff-working-document_en.pdf

of European sectoral legislation/policy documents in the energy, transport and ICT sectors exist;

- The Directive has been partially effective in achieving its stated objectives, i.e. to improve the level of protection for ECIs in the energy and transport sectors by creating a common framework for the identification and designation of ECI. Meanwhile, because the generality of some of the Directive's provisions left room for different interpretations by Member States, it has only to a limited degree achieved the objective of establishing a common approach to the assessment of the need to improve the protection of ECI. That being said, the Directive has generated certain spill-over effects (e.g. increased awareness about CIP, political momentum, national-level legislations/definitions/obligations in Member States with no pre-existing CIP framework). The evaluation was ultimately inconclusive as to the contribution of the Directive to the overall objective of an improved level of protection of CI with EU relevance;
- The evaluation found no conclusive evidence that the results attributed to the Directive have been achieved at a reasonable cost. While the extent of the costs associated with implementation of the Directive appear to be limited, a lack of available quantifiable data from the Member States and ECI owners/operators makes it difficult to carry out a sound assessment of the Directive's regulatory burden on stakeholders; stakeholders' views on the proportionality of the costs in relation to observable results is mixed. Besides certain incurred costs, a number of other factors have affected the overall efficiency of the Directive, some which stem from the nature and substance of the Directive itself (e.g. the generality of key provisions and definitions, the absence of a strong monitoring and evaluation framework) and others that are external to it (e.g. the existence/level of maturity of national-level CIP frameworks prior to the adoption of the Directive);
- The Directive generated EU added value insofar as it achieved results that national or other EU initiatives would not otherwise have achieved, or that national or other EU initiatives would have achieved anyway, albeit through longer, costlier and less well defined processes. One example is a common framework for the protection of ECI (although different Member States interpret the 'commonality' of this approach differently). On the other hand, certain specific provisions, like the Operator Security Plan, the Security Liaison Officer function and reporting requirements, proved to have limited added value for many Member States.
- Several effects generated by the Directive are likely to be long-lasting and would continue to exist in the event that the Directive was repealed and not replaced. On the other hand, some of the direct effects achieved through the implementation of the Directive (e.g. cross-border CIP discussions, reporting requirements) would likely cease to be felt.

Based on the findings of the evaluation, there is clearly room for further reflection at EU level as to how best further improve the protection of CI in Europe, including the 93 ECIs that have been designated thus far. This should include focused consideration of how the EU can most effectively provide support to the Member States and CI owners/operators that host, oversee and/or run vital infrastructure. This conclusion has been borne out through discussions with the Member States, CI operators and operator associations, as well as other partners, including international organisations and third countries that have taken place in recent years, including in the context of the evaluation.

g) The Seveso III Directive[17]

This Directive lays down rules for the prevention of major accidents which involve dangerous substances, and the limitation of their consequences for human health and the environment, with a view to ensuring a high level of protection throughout the Union in a consistent and effective manner. The Directive covers establishments where dangerous substances may be present (e.g. during processing or storage) in quantities exceeding certain threshold. Excluded from the Directive are certain industrial activities which are subject to other legislation providing a similar level of protection (e.g. nuclear establishments or the transport of dangerous substances). Depending on the amount of dangerous substances present, establishments are categorised in lower and upper tier, the latter are subject to more stringent requirements. The legal framework established by the Directive creates a continuous improvement cycle of prevention, preparedness and response to major accidents. The cycle is closed by provisions on lesson learning. Operators are obliged to take all necessary measures to prevent major accidents and to limit their consequences for human health and the environment. The requirements include:

- Notification of all concerned establishments;
- Deploying a major accident prevention policy;
- Producing a safety report for upper-tier establishments;
- Producing internal emergency plans for upper tier establishments;
- Providing information in case of accidents.

Member States need to ensure that a number of requirements are fulfilled, those include:

- Producing external emergency plans for upper tier establishments;
- Deploying land-use planning for the siting of establishments;
- Making relevant information publicly available;
- Ensuring that any necessary action is taken after an accident including emergency measures, actions to ensure that the operator takes any necessary remedial measures and informing the persons likely to the affected;
- Reporting accidents to the Commission;
- Prohibiting the unlawful use or operation of establishments;
- Conducting inspections.

Member States may maintain or adopt stricter measures than those contained in the Seveso Directive.

h) The NIS Directive[18]

Objective/Focus of Study:

The NIS Directive defines a "network and information system" as being either an electronic communications network or any device or group of interconnected or related devices, one or more of

[17] Directive 2012/18/EU of the European Parliament and of the Council of 4 July 2012 on the control of major-accident hazards involving dangerous substances, amending and subsequently repealing Council Directive 96/82/EC, https://eur-lex.europa.eu/legal-content/GA/TXT/?uri=celex:32012L0018

[18] Directive (EU) 2016/1148 of the European Parliament and of the Council of 6 July 2016 concerning measures for a high common level of security of network and information systems across the Union, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2016.194.01.0001.01.ENG&toc=OJ:L:2016:194:TOC

which, pursuant to a program, perform automatic processing of digital data including digital data stored, processed, retrieved or transmitted by these systems for the purposes of their operation, use, protection and maintenance. The security of these systems consists in their ability to resist, at a given level of confidence, any action that compromises the availability, authenticity, integrity or confidentiality of stored or transmitted or processed data or the related services offered by, or accessible via, those network and information systems. In order to fulfil its objectives, the NIS Directive establishes security and notification requirements for two different types of players which are considered being of particular critical importance: operators of essential services (OESs) and digital service providers (DSPs). Moreover, at the national level, the NIS Directive lays down obligations for Member States to adopt a national strategy as well as to designate national competent authorities, single points of contact and computer security incident response teams (CSIRTs). In addition, at European level, the NIS Directive creates a Cooperation Group (NIS Cooperation Group) with a view of fostering mutual understanding of challenges related to the implementation of key provisions of the Directive as well as to facilitate strategic cybersecurity cooperation and information sharing among Member States. In parallel, the Directive creates a CSIRTs network to build confidence between Member States and to boost operational cybersecurity cooperation.

i) The Cybersecurity Act[19]

Title III of the Regulation containing the Cybersecurity Act establishes a European cybersecurity certification framework in order to improve the conditions for the functioning of the internal market by enabling a harmonised approach to European cybersecurity certification schemes (hereafter "ECC schemes"). The aim of this framework is to attest that the ICT processes, products and services that have been evaluated in accordance with ECC schemes comply with specified security requirements. The objective of these schemes is to protect the availability, authenticity, integrity or confidentiality of stored or transmitted or processed data or the functions or services offered by, or accessible via, those products, processes, and services throughout their life cycle.

The adopted ECC schemes should be designed so as to achieve, as applicable, at least the following security objectives: to protect stored, transmitted or otherwise processed data against accidental or unauthorised storage, processing, access or disclosure and against accidental or unauthorised destruction, loss or alteration or lack of availability during the entire life cycle of the ICT product, service or process; that authorised persons, programs or machines are able only to access the data, services or functions to which their access rights refer; to identify and document known dependencies and vulnerabilities; to record which data, services or functions have been accessed, used or otherwise processed, at what times and by whom; to make it possible to check which data, services or functions have been accessed, used or otherwise processed, at what times and by whom; to verify that ICT products, ICT services and ICT processes do not contain known vulnerabilities; to restore the availability and access to data, services and functions in a timely manner in the event of a physical or technical incident; that ICT products, ICT services and ICT processes are secure by default and by design and

[19] Regulation (EU) 2019/881 of the European Parliament and of the Council of 17 April 2019 on ENISA (the European Union Agency for Cybersecurity) and on information and communications technology cybersecurity certification and repealing Regulation (EU) No 526/2013 (Cybersecurity Act), https://eur-lex.europa.eu/eli/reg/2019/881/oj

are provided with up-to-date software and hardware that do not contain publicly known vulnerabilities, and are provided with mechanisms for secure updates.

The goal of the Cybersecurity Act is to create a digital single market for ICT products, ICT services and ICT processes. Any business offering ICT products, services, or processes within the EU, whatever their size, is affected by the Cybersecurity Act and should begin monitoring the ENISA and EU websites for updates on EU cybersecurity certification schemes.

j) *The General Data Protection Regulation*[20]

The GDPR, which replaces the 20-year-old Data Protection Directive 95/46/EC, is directly applicable in all Member States since 25 May 2018. Where a processing of personal data falls within the territorial scope of the GDPR, one of the core obligations of both data controllers and data processors is to set up appropriate technical and organisational measures to ensure a level of security appropriate to the risk "to the rights and freedoms of natural persons" . When such a risk is susceptible to be high, the data controller is accountable to conduct a data protection impact assessment before he starts with the processing. Furthermore, the Regulation lays down a set of rules on personal data breaches by introducing an obligation to notify the supervisory authority at the latest within 72 hours when the data breach is likely to pose a risk to the individual's rights and freedoms. In addition, when the personal data breach is likely to result in a such high risk, it obliges to inform the person whose data is concerned by the breach.

k) EU Regulation on drones[21]

This Regulation lays down detailed provisions for the operation of unmanned aircraft systems as well as for personnel, including remote pilots and organisations involved in those operations. UAS operations shall be performed in the 'open', 'specific' or 'certified' category, subject to the following conditions:

- UAS operations in the 'open' category shall not be subject to any prior operational authorisation, nor to an operational declaration by the UAS operator before the operation takes place;
- UAS operations in the 'specific' category shall require an operational authorisation issued by the competent authority or an authorisation received, or, under some circumstances, a declaration to be made by a UAS operator;

UAS operations in the 'certified' category shall require the certification of the UAS pursuant to Delegated Regulation (EU) 2019/945 and the certification of the operator and, where applicable, the licensing of the remote pilot.

3.4.3 Standardisation

The relevant references by order of presentation are [85-107].

a) ISO/Guide 73:2009 - Risk management — Vocabulary

This Guide provides the definitions of generic terms related to risk management. It aims to encourage a mutual and consistent understanding of, and a coherent approach to, the description of activities

[20] Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation), https://eur-lex.europa.eu/eli/reg/2016/679/oj

[21] Commission Implementing Regulation (EU) 2019/947 of 24 May 2019 on the rules and procedures for the operation of unmanned aircraft, https://eur-lex.europa.eu/eli/reg_impl/2019/947/oj

relating to the management of risk, and the use of uniform risk management terminology in processes and frameworks dealing with the management of risk.

This Guide is intended to be used by:

- those engaged in managing risks,
- those who are involved in activities of ISO and IEC, and
- developers of national or sector-specific standards, guides, procedures and codes of practice relating to the management of risk.

b) ISO 22300:2012 - Societal security — Terminology

This International Standard contains terms and definitions applicable to societal security to establish a common understanding so that consistent terms are used. "Societal security" is being defined as "protection of society from, and response to, incidents, emergencies and disasters caused by intentional and unintentional human acts, natural hazards, and technical failures". "societal security framework" is defined as a "set of components that provide the foundations and organisational arrangements for designing, implementing, monitoring, reviewing and continually improving societal security". Finally, "civil protection" relates to "measures taken and systems implemented to preserve the lives and health of citizens, their properties and their environment from undesired events".

c) ISO 22301:2012 - Societal security — Business continuity management systems --- Requirements

This International Standard specifies requirements for setting up and managing an effective Business Continuity Management System (BCMS). A BCMS emphasises the importance of

- understanding the organisation's needs and the necessity for establishing business continuity management policy and objectives,
- implementing and operating controls and measures for managing an organisation's overall capability to manage disruptive incidents,
- monitoring and reviewing the performance and effectiveness of the BCMS, and
- continual improvement based on objective measurement.

Business continuity contributes to a more resilient society. The wider community and the impact of the organisation's environment on the organisation and therefore other organisations may need to be involved in the recovery process.

d) ISO 22311:2012 - Societal security — Video-surveillance — Export interoperability

This International Standard is mainly for societal security purposes and specifies a common output file format that can be extracted from the video-surveillance contents collection systems (standalone machines or large scale systems) by an exchangeable data storage media or through a network to allow end-users to access digital video-surveillance contents and perform their necessary processing. The means of exchange are not part of this International Standard. This common output file format relies on a combination of several technical standards that individually are not restrictive enough to provide the requested interoperability. These standards are formally referenced to avoid duplications or divergence. When appropriate to improve the interoperability, subsets or a limited number only of these standards are called. Since video-surveillance recording often includes taking records of citizens, requirements relating to privacy, use of the records and their disposal are also considered.

e) ISO/TR 22312:2011 - Societal security — Technological capabilities

The scope of ISO/TC 223 is defined as international standardisation in the area of societal security, aimed at increasing crisis and continuity management and capabilities through technical, human, organisation, operational, and management approaches as well as operational functionality and interoperability, as well as awareness amongst all interested parties and stakeholders. ISO/TC 223 will work towards international standardisation that provides protection from and response to risks of unintentionally, intentionally, and naturally caused crises and disasters that disrupt and have consequences on societal functions. The committee will use an all-hazards perspective covering the phases of emergency and crisis management before, during, and after a societal security incident.

f) ISO 22313:2020 - Security and resilience — Business continuity management systems — Guidance

This document gives guidance and recommendations for applying the requirements of the business continuity management system (BCMS) given in ISO 22301. The guidance and recommendations are based on good international practice.

This document is applicable to organisations that:

- implement, maintain and improve a BCMS;
- seek to ensure conformity with stated business continuity policy;
- need to be able to continue to deliver products and services at an acceptable predefined capacity during a disruption;
- seek to enhance their resilience through the effective application of the BCMS.

The guidance and recommendations are applicable to all sizes and types of organisations, including large, medium and small organisations operating in industrial, commercial, public and not-for-profit sectors. The approach adopted depends on the organisation's operating environment and complexity.

g) ISO 22315:2014 - Societal security — Mass evacuation — Guidelines for planning

This International Standard provides guidelines for mass evacuation planning in terms of establishing, implementing, monitoring, evaluating, reviewing and improving preparedness. It establishes a framework for each activity in mass evacuation planning for all identified hazards. It will help organisations to develop plans that are evidence-based and that can be evaluated for their effectiveness. This International Standard is intended for use by organisations with responsibility for, or involvement in, part or all of the planning for mass evacuation. It is applicable to all types and size s of organisations that are involved in the planning for mass evacuation, such as local, regional, and national governments; statutory bodies; international and non-governmental organisations; businesses; and public and social groups. This International Standard covers planning for mass evacuation in order to gain a more effective response during the actual evacuation. It will assist organisations to meet their obligation of saving human life and reducing suffering. This International Standard does not cover activities to stabilise the affected area after an evacuation, protect property and preserve the environment.

h) ISO 22316:2017 - Security and resilience — Organisational resilience — Principles and attributes

Organisational resilience is the ability of an organisation to absorb and adapt in a changing environment to enable it to deliver its objectives and to survive and prosper. More resilient organisations can anticipate and respond to threats and opportunities, arising from sudden or gradual changes in their internal and external context. Enhancing resilience can be a strategic organisational goal, and is the

outcome of good business practice and effectively managing risk. An organisation's resilience is influenced by a unique interaction and combination of strategic and operational factors. Organisations can only be more or less resilient; there is no absolute measure or definitive goal.

A commitment to enhanced organisational resilience contributes to:

- an improved ability to anticipate and address risks and vulnerabilities;
- increased coordination and integration of management disciplines to improve coherence and performance;
- a greater understanding of interested parties and dependencies that support strategic goals, and objectives.

There is no single approach to enhance an organisation's resilience. There are established management disciplines that contribute towards resilience but, on their own, these disciplines are insufficient to safeguard an organisation's resilience. Instead, organisational resilience is the result of the interaction of attributes and activities, and contributions made from other technical and scientific areas of expertise. These are influenced by the way in which uncertainty is addressed, decisions are made and enacted, and how people work together. This document establishes the principles for organisational resilience. It identifies the attributes and activities that support an organisation in enhancing its resilience.

This document includes:

- principles providing the foundation for enhancing an organisation's resilience;
- attributes describing the characteristics of an organisation that allow the principles to be adopted;
- activities guiding the utilisation, evaluation and enhancement of attributes.

i) ISO 22319:2017 - Security and resilience — Community resilience — Guidelines for planning the involvement of spontaneous volunteers

ISO 22319:2017 provides guidelines for planning the involvement of spontaneous volunteers (SVs) in incident response and recovery. It is intended to help organisations to establish a plan to consider whether, how and when SVs can provide relief to a coordinated response and recovery for all identified hazards. It helps identify issues to ensure the plan is risk-based and can be shown to prioritise the safety of SVs, the public they seek to assist and incident response staff. ISO 22319:2017 is intended for use by organisations with responsibility for, or involvement in, part or all of the planning for working with SVs. It is applicable to all types and size s of organisations that are involved in the planning for, and management of, SVs (e.g. local, regional, and national governments, statutory bodies, international and non-governmental organisations, businesses and public and community groups). The range of tasks performed by SVs can require only basic planning (e.g. for people who are first on the scene), or a plan that is more complex (e.g. for people who travel to the affected area to volunteer). Coordinating the participation of volunteers who are affiliated to voluntary or professional organisations to provide relief is not within the scope of this document.

j) ISO 22320:2018 - Security and resilience — Emergency management — Guidelines for incident management

This document gives guidelines for incident management, including

- principles that communicate the value and explain the purpose of incident management,
- basic components of incident management including process and structure, which focus on roles and responsibilities, tasks and management of resources, and

- working together through joint direction and cooperation.

This document is applicable to any organisation involved in responding to incidents of any type and scale. This document is applicable to any organisation with one organisational structure as well as for two or more organisations that choose to work together while continuing to use their own organisational structure or to use a combined organisational structure.

k) ISO 22322:2015 - Societal security — Emergency management — Guidelines for public warning

ISO 22322:2015 provides guidelines for developing, managing, and implementing public warning before, during, and after incidents. This International Standard is applicable to any organisation responsible for public warning. It is applicable at all levels, from local up to international. Before planning and implementing the public warning system, risks and consequences of potential hazards are assessed. This process is not part of this International Standard.

l) ISO 22324:2015 - Societal security — Emergency management — Guidelines for colour-coded alerts

This International Standard provides guidelines for the use of colour codes to inform people at risk as well as first response personnel about danger and to express the severity of a situation. It is applicable to all types of hazard in any location. This International Standard does not cover the method for displaying colour codes, detailed ergonomic considerations related with viewing displays, or safety signs covered by ISO 3864-1.

m) ISO 22325:2016 - Security and resilience — Emergency management — Guidelines for capability assessment

ISO 22325:2016 provides guidelines for an organisation in assessing its emergency management capability. It includes

- an assessment model with a hierarchy of four levels;
- eight indicators;
- an assessment process, explaining how to plan, collect, analyse and report.

ISO 22325:2016 is intended to be used by organisations responsible and accountable for emergency management. Each organisation's context can involve a mix of prevention, mitigation, preparedness, response and recovery activities.

n) ISO/TR 22351:2015 - Societal security — Emergency management — Message structure for exchange of information

ISO/TR 22351:2015 describes a message structure for the exchange of information between organisations involved in emergency management. An organisation can ingest the received information, based on the message structure, in its own operational picture. The structured message is called Emergency Management Shared Information (EMSI). ISO/TR 22351:2015 describes the message structure built in order to facilitate interoperability between existing and new information systems. The intended audience of ISO/TR 22351:2015 is control room engineers, information systems designers and decision makers in emergency management. The EMSI can be used complementary to other message protocols, as for example the common alert protocol (CAP).

o) ISO 22397:2014 - Societal security — Guidelines for establishing partnering arrangements

ISO 22397:2014 provides guidelines for establishing partnering arrangements among organisations to manage multiple relationships for events impacting on societal security. It incorporates principles and

describes the process for planning, developing, implementing and reviewing partnering arrangements. ISO 22397:2014 is applicable to all organisations regardless of type, size and nature of activity whether in or between the private, public, or not-for-profit sectors.

p) ISO 22398:2013 - Societal security — Guidelines for exercises

ISO 22398:2013 recommends good practice and guidelines for an organisation to plan, conduct, and improve its exercise projects which may be organised within an exercise programme. It is applicable to all organisations regardless of type, size or nature, whether private or public. The guidance can be adapted to the needs, objectives, resources, and constraints of the organisation. It is intended for use by anyone with responsibility for ensuring the competence of the organisation's personnel, particularly the leadership of the organisation, and those responsible for managing exercise programmes and exercise projects.

q) ISO 26000:2010 - Guidance on social responsibility

ISO 26000:2010 is intended to assist organisations in contributing to sustainable development. It is intended to encourage them to go beyond legal compliance, recognizing that compliance with law is a fundamental duty of any organisation and an essential part of their social responsibility. It is intended to promote common understanding in the field of social responsibility, and to complement other instruments and initiatives for social responsibility, not to replace them. In applying ISO 26000:2010, it is advisable that an organisation take into consideration societal, environmental, legal, cultural, political and organisational diversity, as well as differences in economic conditions, while being consistent with international norms of behaviour. ISO 26000:2010 is not a management system standard. It is not intended or appropriate for certification purposes or regulatory or contractual use. Any offer to certify, or claims to be certified, to ISO 26000 would be a misrepresentation of the intent and purpose and a misuse of ISO 26000:2010. As ISO 26000:2010 does not contain requirements, any such certification would not be a demonstration of conformity with ISO 26000:2010. ISO 26000:2010 is intended to provide organisations with guidance concerning social responsibility and can be used as part of public policy activities. However, for the purposes of the Marrakech Agreement establishing the World Trade Organisation (WTO), it is not intended to be interpreted as an "international standard", "guideline" or "recommendation", nor is it intended to provide a basis for any presumption or finding that a measure is consistent with WTO obligations. Further, it is not intended to provide a basis for legal actions, complaints, defences or other claims in any international, domestic or other proceeding, nor is it intended to be cited as evidence of the evolution of customary international law. ISO 26000:2010 is not intended to prevent the development of national standards that are more specific, more demanding, or of a different type.

r) ISO 31000:2018 - Risk management — Guidelines

ISO 31000:2018 provides guidelines on managing risk faced by organisations. The application of these guidelines can be customised to any organisation and its context. ISO 31000:2018 provides a common approach to managing any type of risk and is not industry or sector specific. ISO 31000:2018 can be used throughout the life of the organisation and can be applied to any activity, including decision-making at all levels.

s) ISO/TR 31004:2013 - Risk management — Guidance for the implementation of ISO 31000

SO/TR 31004:2013 provides guidance for organisations on managing risk effectively by implementing ISO 31000:2009. It provides:

- a structured approach for organisations to transition their risk management arrangements in order to be consistent with ISO 31000, in a manner tailored to the characteristics of the organisation;
- an explanation of the underlying concepts of ISO 31000;
- guidance on aspects of the principles and risk management framework that are described in ISO 31000.

ISO/TR 31004:2013 can be used by any public, private or community enterprise, association, group or individual. ISO/TR 31004:2013 is not specific to any industry or sector, or to any particular type of risk, and can be applied to all activities and to all parts of organisations.

t) IEC 31010:2019 Risk management — Risk assessment techniques

IEC 31010:2019 is published as a double logo standard with ISO and provides guidance on the selection and application of techniques for assessing risk in a wide range of situations. The techniques are used to assist in making decisions where there is uncertainty, to provide information about particular risks and as part of a process for managing risk. The document provides summaries of a range of techniques, with references to other documents where the techniques are described in more detail.

u) CEN/CLC/JTC 4 - Services for fire safety and security systems

This European Standard specifies minimum requirements for service providers as well as the competencies, knowledge and skills of their involved staff charged with the planning, design, installation, commissioning, verification, handover or maintenance of fire safety systems and/or security systems, regardless whether these services are provided on-site or remotely. This European Standard is applicable to services for fire safety systems and/or security systems, which are fire detection and fire alarm systems, fixed firefighting systems and alarm systems and to combinations of such systems including those parts of an alarm transmission system for which the service provider has contractually accepted responsibility. Social alarm systems and alarm receiving centres are not included. This European Standard applies regardless of project size or organisational structure or size. Fire detection and fire alarm systems include voice alarm systems. Fixed firefighting systems include such as water based and gas extinguishing systems, smoke and heat control and exhaust systems. Alarm systems include such as intruder and hold-up alarm systems, access control systems, periphery protection systems, video surveillance-systems, other monitoring and surveillance systems related to security applications.

v) ISO 22396:2020 - Security and resilience — Community resilience — Guidelines for information exchange between organisations

This document gives guidelines for information exchange. It includes principles, a framework and a process for information exchange. It identifies mechanisms for information exchange that allow a participating organisation to learn from others' experiences, mistakes and successes. It can be used to guide the maintenance of the information exchange arrangement in order to increase commitment and engagement. It provides measures that enhance the ability of participating organisations to cope with disruption risk. This document is applicable to private and public organisations that require guidance on establishing the conditions to support information exchange. This document does not apply to technical aspects but focuses on methodology issues. Legislation can differ from jurisdiction to jurisdiction. It is the user's responsibility to determine how applicable legal requirements relate to this document.

w) *ISO 22326:2018 - Security and resilience — Emergency management — Guidelines for monitoring facilities with identified hazards*

This document gives guidelines for monitoring hazards within a facility as a part of an overall emergency management and continuity programme by establishing the process for hazard monitoring at facilities with identified hazards. It includes recommendations on how to develop and operate systems for the purpose of monitoring facilities with identified hazards. It covers the entire process of monitoring facilities. This document is generic and applicable to any organisation. The application depends on the operating environment, the complexity of the organisation and the type of identified hazards.

x) *ISO 22300:2018 - Security and resilience — Vocabulary*

ISO 22300:2018 defines terms used in security and resilience standards.

y) *PD CEN/TS 17091:2018 - Crisis management. Guidance for developing a strategic capability*

This is a European technical specification giving organisations good practice guidance on how to prepare for, anticipate, respond to and recover from crisis. It can be used by any organisation, regardless of location, size , type, industry, structure or sector. It will be used by managers with strategic responsibility for delivering the organisation's crisis management capability. Specifically, it's for those who operate under the direction and within policy of top management in:

- Implementing crisis plans and structures
- Maintaining and assuring the procedures associated with this capability

z) *ISO/IEC 27002:2013 - Information technology — Security techniques — Code of practice for information security controls*

ISO/IEC 27002:2013 gives guidelines for organisational information security standards and information security management practices including the selection, implementation and management of controls taking into consideration the organisation's information security risk environment(s).It is designed to be used by organisations that intend to:

- select controls within the process of implementing an Information Security Management System based on ISO/IEC 27001;
- implement commonly accepted information security controls;
- develop their own information security management guidelines.

3.4.4 Conclusions

The aforementioned brief overview of legislations, regulations and standards that are of relevance in different aspects (e.g. training, safety, security, emergency response, resilience) of the S&R proposed activities and technologies/wearables to be developed, provides guidance in relation to issues that partners that are involved in these activities should be aware of (see Error! Reference source not found.).

It is possible that the implementation of the legislation and regulations in the EU Member-States may cause harmonisation issues.

Table 3-12 Short summary of the most prominent issues that are likely to influence the "Community resilience"

Legislation/ Regulation	Aim	Incentives	Limitations
UN Convention on the Transboundary Effects of Industrial Accidents	Cooperation between States and assistance to protect human beings and the environment against industrial accidents	• Facilitation of the exchange of technology. • Establishment of a notification system at national level	Sates must take appropriate legislative, regulatory, administrative and financial measures which not be harmonised
UN Guidelines on the Use of Military and Civil Defence Assets in Disaster Relief	Formalizing and improving the effectiveness and efficiency of the use of foreign military and civil defines assets in international disaster relief operations	Provides guidelines for the use of international military and civil defines personnel, equipment, supplies and services in support of the United Nations (UN) in pursuit of humanitarian objectives in complex emergencies	Foreign military and civil defence assets should be requested only where there is no comparable civilian alternative
INSARAG Guidelines for Urban Search and Rescue Teams	Methodology to guide countries affected by a sudden-onset disaster causing large-scale structural collapse, as well as international USAR Teams responding in the affected country	• Developing and promoting common standards for USAR assistance, coordination methodologies and tools, and mobilisation and information exchange protocols between relevant stakeholders. • Promoting cooperation and experience-sharing amongst, and in partnership with, Member States, NGOs, and national, regional and international partners.	Not identified
NATO Logistics Handbook	Defines the NATO's Civil Emergency Planning's strategy.	Countries can in peace time appeal to the NATO as medium for the exchange of information, for assistance, or for the	Not identified

		input of materials and staff.	
Tampere Convention on the Provision of Telecommunication Resources for Disaster Mitigation and Relief Operations	Cooperation among States and with non-State entities and intergovernmental organisations to facilitate the use of telecommunication resources for disaster mitigation and relief	The Convention simplifies: • the trans-border importation and use of telecoms equipment • Use of allocated frequencies • Customs duties, fees and procedures • Restrictions on movement of personnel	Weak Institutions
The European Union Civil Protection Mechanism	Establishment of a common European reserve of capacities to respond to disasters	Establishes a simplified reporting framework, focusing on key risks of a cross-border nature and risks of low probability with high impact	Flexibility issues for response to large-scale emergencies
Council Directive 2008/114/EC of 8 December 2008 on the identification and designation of European critical infrastructures and the assessment of the need to improve their protection	Establishes a procedure for identifying and designating European Critical Infrastructures (ECI) in the transport and energy sectors	Provides a common approach for assessing the need to improve the protection of designated ECI	Due to different interpretations by Member States, it has only to a limited degree achieved the objective of establishing a common approach to the assessment of the need to improve the protection of ECI
The Seveso III Directive	Lays down rules for the prevention of major accidents which involve dangerous substances	The legal framework established by the Directive creates a continuous improvement cycle of prevention, preparedness and response to major accidents	Efforts are still needed in some fields in a number of Member States, in particular with regard to the development and testing of external emergency plans and the provision of information to the public
The NIS Directive	Establishes security and notification requirements for two different types of players which are	Obligations for Member States to adopt a national strategy as well as to designate national	Harmonisation issues in the definition of OESs

	considered being of particular critical importance: operators of essential services (OESs) and digital service providers (DSPs)	competent authorities, single points of contact and computer security incident response teams (CSIRTs).	
The Cybersecurity Act	Attest that the ICT processes, products and services that have been evaluated in accordance with ECC schemes comply with specified security requirements	Creates a digital single market for ICT products, ICT services and ICT processes	No EU cybersecurity certification schemes yet
The General Data Protection Regulation	Lays down rules relating to the protection of natural persons with regard to the processing of personal data and rules relating to the free movement of personal data	protects fundamental rights and freedoms of natural persons and in particular their right to the protection of personal data	Harmonisation issues due to different implementation laws in the Member States
EU Regulation on drones	Lays down detailed provisions for the operation of unmanned aircraft systems as well as for personnel, including remote pilots and organisations involved in those operations	Contains a comprehensive set of rules ensuring safe, secure and sustainable operations of drones both, for commercial and leisure activities	Very new Regulation

Such may be also the case for the INSPIRE Directive[22] which defines the legal framework for establishing a common spatial data infrastructure for supporting environmental policies in all European Member States. While some European countries have very advanced Open Data policies in place, covering also spatial reference data (e.g. Spain, United Kingdom, the Netherlands, Denmark, Finland, etc.), others have considerably fewer [58].

It is possible that the implementation of the legislation and regulations in the EU Member-States may cause harmonisation issues. Such may be also the case for the INSPIRE Directive[23] which defines the legal framework for establishing a common spatial data infrastructure for supporting environmental policies in all European Member States. While some European countries have very advanced Open Data

[22] Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE).

[23] Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE).

policies in place, covering also spatial reference data (e.g. Spain, United Kingdom, the Netherlands, Denmark, Finland, etc.), others have considerably fewer [58].

In addition to this important information, the literature review from sources other than the ones mentioned in this section also revealed the following:

- There is currently an increasing demand by policy makers and practitioners for concrete quantitative measures of resilience [32,33].
- The impact of a past disturbance may lead to significant changes in disaster risk management, which includes the adoption of new legislation [28, 29]. However, not all types of disasters are institutionalised to the same degree [28]. The greatest responsibility often rests with local and regional authorities. Although the role of some major organisations (e.g. Red Cross) and professional rescue teams may be clearly outlined in national and place-based DRM plans, nevertheless it seems that marginal roles are assigned to informal social interactions and social capital (although the emphasis on self-preparedness has grown) and few policies are implemented to support the role of such communities.
- Communities of practice and interest are usually backed by policies in countries with relatively strong institutionalisation; however few policies are implemented to support the role of interaction-based communities in DRM, despite the importance that informal social networks may exhibit in response and recovery stages of DRM [28]. Therefore, a possible way to develop DRM practices could thus involve a stronger acknowledgement of informal actor networks and reciprocal help in official policies [28].
- There is the need of further integrating resilience qualities into existing policies aimed at preventing the creation of risk and reduction of existing risks [40-41].
- Policy and regulations should also support [36-38, 43]:
    - Communities in adopting risk-informed and holistic approaches and accessing external support networks (e.g. civil societies; public authorities).
    - The accountability of communities by having them proactively providing regular reports, feedback and information relating to programmes, services and activities; also, the assignment, as appropriate, of clear roles and tasks to community representatives within disaster risk management institutions and processes and decision-making through relevant legal frameworks [43].
    - Promotion of effective environmental regulation related to risk [36-38].
    - Empowerment of communities through regulatory and financial means to be placed at, and remain at the centre of decisions and actions that impact their future. Programmes should respond to objectives defined by the community [43].
    - *Encouraging the establishment of necessary mechanisms and incentives to ensure high levels of compliance with the existing safety-enhancing provisions of sectoral laws and regulations, including those addressing land use and urban planning, building codes, environmental and resource management and health and safety standards, and update them, where needed, to ensure an adequate focus on disaster risk management* [43].
- There is the need to promote the development of quality standards, such as certifications and awards for disaster risk management, with the participation of the private sector, civil society, professional associations, scientific organisations and the United Nations [43].

- In some cases the research community has also reported on the difficulty of using cutting-edge new technologies for risk management because, very often, existing regulations block their implementation. Such finding were also supported by EU project Driver+ where barriers to accept, uptake and apply new technologies were acknowledged [57].

3.5 Case study findings – User needs & technologies

3.5.1 Overview

The case study collection was performed based on the protocols described in sub-section 3.2.4 by using the templates provided in Annexes III and IV. Eight (8) general overviews (case study template Annex II) and twenty four (24) specific cases (case study template Annex III) were collected on which the findings are based. All cases were collected from partners of the Search and Rescue consortium. The general overviews were collected from the T1.3 participating partners UGL, ESDP, SUMMA, and PROECO, as well as non-T1.3 participating partners HRT, PUI, JUH, and JOAFG. The specific cases were collected from T1.3 participating partners UGL, ESDP, SUMMA, and PROECO, in addition to one specific case by non-T1.3 participating partner HRT.

Collectively, these organisations and the cases they referred to included natural disasters and human-made disaster within a national, regional (European), and/or international scope.

The natural disasters included:

- Earthquakes in multiple locations such as Algeria, Turkey, Haiti, Nepal.
- Floods
- Forest Fires
- Typhoons in Philippines
- Cyclones in Mozambique
- Tsunami
- Avalanche
- Mudslides
- Volcanos

The human-made Disasters included:

- Building Collapse
- CBRN (chemical, biological, radiological, and nuclear) Explosions: Beirut port, Cyprus British Base, Romania Ammonium Nitrate truck.
- Railway accidents
- Fires in urban areas.
- Terrorist attacks
- Forest and Mountain rescue

During these operations these organisations collaborated with S&R organisations, non-governmental organisations, governmental organisations, inter-governmental organisations, and volunteers. These included: Fire fighters, police, armed forces, primary health care services and medical teams, local and regional public authorities, ministries, non-governmental organisations, international organisations (ACF, ACTED, Red Cross, TSF), United Nations agencies and bodies (UNDAC, OCHA, WHO, UNICEF), local volunteers, civil protection, and local and national media (see Table 3-13).

Table 3-13 Summary of case studies (organisation, type of organisation, area of engagement specific incident disaster)

Organisation	Type of Organisation	General Area of Engagement	Specific Incidents and Disasters
Hellenic Rescue Team (HRT) - Greece	Volunteer non-profit SAR organisation involved in cases of urgent needs and massive disasters	Earthquakes, wildfires, floods, sea rescue, and mountain rescue	1. Greece: Mountain rescue mission in mount Olympus. A mountaineer was trapped with nowhere to go for 3 days, with very bad weather conditions
Innovation management on Emergency Services (UGL) – Cyprus	The main technology provider for UKeMED platform (innovative collaborative services to the healthcare community)	Natural and manmade	1 UK (1995): Ais Gill Train accident 2. London, UK (2005) Kings Cross Bombings London 3. Bangladesh (2013) Collapse of Factory Building 4. New Zealand (2011) Christchurch earthquake 5. Cyprus (2011)Evangelos Florakis Naval Base explosion 6. Greece (2010) Evacuation of a Municipality of Athens summer camp – field exercise
Johanniter Österreich Ausbildung und Forschung gemeinnützige GmbH (JOAFG) – Austria	Research on emergency management	Floods, avalanches (regional), mudslides, earthquakes (int. missions), building collapse or large-scale accidents (including CBRN) as Medical First Responders (MFR) and in its capacity as disaster relief unit	
Johanniter-Unfall-Hilfe e.V. (JUH) – Germany	Search and rescue activities, research, training for end-	Cyclone, Earthquakes, and Typhoons.	

	users and communities		
Madrid Region Health System (SUMMA) - Spain	Emergency medical services	Ordinary healthy emergency incidents, multiple victims incidents, and disasters and Catastrophes. including CBRN types	1. Spain (2017): Explosion in recycling waste factory in Arganda del Rey (20 km from Madrid). 2. Spain: Pepper gas poisoning. 12 people were poisoned at lunchtime by inhaling an irritant gas at a Social Security office in Madrid's Carabanchel district. 3. Spain (2019): Fire in a house in the outskirts of Madrid that affected 4 blocks of houses. There was also ammonia and bleach poisoning. There are 13 light and 4 moderate victims. 4. Spain (2020): Intoxication of 5 people by toluene. Workers were renovating a house and the glue fumes they used caused the poisoning. 5. Spain (2017): Sodium hypochlorite and hydrochloric acid were mixed, forming a mixture of 50 litres of volume with this solution, which caused a chlorine leak in a gaseous state (cloud) within the installations of a private swimming pool in the municipality of Mostoles. 6. Ecuador (2016) An earthquake of magnitude 7.8 with an epicentre in Pedernales, Manabí

			province, in the northwest of Ecuador. 7. Spain (2019): An explosion in a pharmaceutical industry (Química Sintética S.A) near the town Alcalá de Haneras, Madrid. 8. Spain: A suspected intended tire fire in one of the biggest illegal graveyards of wheels in Europa (over 5 million wheels, more than 90.000 tons), took place in Seseña, border community between Madrid and Toledo. The fire forced the evacuation a population of 6,000 people in El Quiñon, due to the toxic cloud.
POMPIERS DE L'URGENCE INTERNATIONALE (PUI) – France	Humanitarian organisation, first responders	Natural and accidental disasters including earthquakes, tsunamis, typhoons, storms, floods, landslides, volcanos, forest fires, accidental explosions and human disasters. Diseases, assistance to the homeless after the disaster	1. Lebanon (2020): Beirut port explosion: ammonium nitrate depot explosion in the port of Beirut.
Romanian Cluster PROECO-CBRNE (PROECO) – Romania	Promoting development of production marketing and use of techniques for	Fires in a community, Road accidents with dangerous toxic substances, railway accidents with	1. Romania (2004): Mihăilești commune, Buzău county. An explosion occurred due to the accident with a truck transporting 20 tons of ammonium nitrate.

	responding to disasters caused by chemical, biological, nuclear accidents (CBRN)	dangerous toxic substances, rain floods	2. Romania (2004): Vrancea County. A railway accident in which a train broke in two, and 3 diesel tank wagons overturned and caught fire. 3. Romania (2015): Fire in Bucharest concert due to fireworks causing injuries and fatalities 4. Romania (2016) county of Brașov: Floods to heavy rain. 5. Romania (2019): Sibiu County. 25 dry vegetation fires broke out.
Search and Rescue Dogs School (ESDP) – Spain	Search and rescue dogs	Earthquakes, floods, building collapses due to gas explosions, and search for people lost in forest areas	1. Spain (2018): Dog Unit requested to search for two disappeared persons in the collapse of a house due to a possible gas explosion in a village called Villamanta (Community of Madrid). 2. Spain (1997): Badajoz: 21 people died, washed away by massive flooding. 3. Haiti (2010): Earthquake with over 300,000 deaths. 4. Spain (2019): Person lost in the mountains. 5. Portugal: The EU exercise in the framework of the EU Civil Protection Mechanism major disaster response coordination exercises was held in Lisbon from 4 to 7 November 2019. of the European Civil Protection Mechanism.

3.5.2 Case study findings

The findings are centred on three broad themes including major challenges in managing the disaster, best practices and advantages, and lessons learned. The aforementioned themes and their respective sub-themes emerged from a coding process of the case studies using NVivo software for qualitative data analysis. The relevant findings are next summarised:

3.5.2.1 Major challenges in managing the disaster

1) Communication Technologies: The case study participants listed several challenges including the following: lack of access to communication networks to transfer data via WIFI, lack of reliable maps of the area, phone lines being saturated leaving only satellite phones as an option, the limited life of walkie-talkie and GPS batteries. Other challenges were related to S&R teams using different radio frequencies, as well as the time-consuming nature of writing down radio communicated messages. Additionally, wearing CBRN equipment can impact the smoothness of communication.

2) Communication and information sharing: Most participants listed challenges in the area of information sharing among multiple S&R teams. These included an incident of a railway accident where field staff did not know the evacuation plan until the last minute and misunderstandings occurred between the commanders and the rest of the crew. In another incident, an earthquake in Christchurch, health workers did not deploy where they were needed most due to lack of information. In a third incident in Spain there was inadequate synchronisation between health teams and the fire brigade.

3) Coordination: The case studies participants pointed to major challenges regarding coordination. One of the main difficulties was activating the resources and allocating tasks among multiple actors, taking into account their level of expertise, previous training and experience as well as their equipment - "it needs very good organisation to make everyone operational" (SUMMA 2020). In some cases, a spatial factor of operating in a vast area added a layer of difficulty. Proper distribution of tasks and avoiding the agglomeration of resources to the needs of a specific affected area was another issue. This included a dynamic aspect of relocating resources based on the current needs where teams that completed certain tasks could be relocated to tasks that were still ongoing. Establishing shared goals and objectives among different organisations involved, where "there are many decision makers, decision points and kinds of decisions" (UGL 2020) was another challenge. The case studies participants also indicated that the above coordination issues become even more complex in the international missions.

4) Procedures and Legislation: Professionals indicted that they faced a challenge with volunteers who were not always familiar with the correct procedure to follow in various incidents, and because volunteers did not participate in sufficient exercises that would familiarise them with relevant procedures. Another challenge in an international response case consisted in the government delaying the granting of permission to work thereby delaying the S&R team involvement. In an incident in Spain, the procedure for working with victims was not activated thereby hindering the identification of victims and reporting them to the coordinating centre. Additionally, procedures of airlines are not standard in relation to transporting K-9 dogs and this can lead to excessive costs.

5) Training: The case study participants pointed to the lack of training as a major challenge, concerning both professionals and volunteers. The participants expressed an opinion that there is a limited number of professionals and volunteers who are adequately trained in emergency response. There is not enough of joint training which again includes both professionals and volunteers.

Guaranteeing the qualified education and training of the volunteers to be similar to that of the professionals is a major challenge. There is also not enough training addressed for and provided to local communities.

6) Inter-organisational feedback and debriefing: The case study participants pointed to an issue of various actors involved in the response debriefing separately rather than in collaboration. The absence of inter-organisational debriefing meant that there was no opportunity to analyse the performance from different points of view which could, in turn, contribute to improved performance and coordination. The respondents expressed an opinion that sharing reports could contribute to a more complete learning process for all actors involved (firefighters, police, health personnel and volunteers).

7) Equipment and Technology Limitations: The participants indicated a lack of technologies to assist in the safety of the dogs during search operations, to reliably locate the dogs during work, to identify the route of the dog during the search of the structures, and to know where the dog has searched and where it has not. In a situation where there is a risk of a second explosion, participants pointed out that it is important to have drones and sensors that assess and identify the risks of new explosions and their scope, as well as detect chemical release as soon as possible. As for volunteers, they sometimes lack the protective equipment similar to that in possession of professionals.

3.5.2.2 Successful practices reported and added-value of volunteers

1) Combining Resources: Some of the respondents mentioned that having several actors involved, including professionals, volunteers and members of community, can make up for the lack of technologies or other resources. Diverse actors are able to complement each other's skills and expertise. Even if untrained, volunteers can support professionals by performing simpler tasks, such as decongesting the space or evacuating people. When there are many volunteers, their work can be organised in shifts.

2) Local Knowledge: Volunteers usually have a better knowledge of the disaster area. This applies to the environmental characteristics, e.g. the details of a search terrain or the topography of areas affected by fires which do not appear on maps, as well as community characteristics in terms of their needs but also skills and expertise. They can help with a correct assessment of the effects of the disaster, the scope of required intervention and locating of resources. They can explain the work of S&R teams to the affected community, and assist S&R teams in gaining the support of the local community and local authorities.

3) Networking: Networking of the parties provided additional value by combining different training and experience on S&R operations, sharing knowledge, and also by providing additional human, technological, and financial resources.

4) Preparedness (Simulation Training Exercises): The participants saw previous training, simulation and exercises as a major advantage, especially if they were joint actions of all actors involved. This allowed for linking theory and practice and creating joint procedures. Members of different organisations were more familiar with each other, they had awareness of each other's' capacity and expertise which overall made the response more effective.

5) Cost Reduction and Commitment (volunteers): Major advantages of working with volunteers are low personnel cost, strong commitment, motivation and specialist expertise from the volunteers' main jobs. Volunteers can also be a relief for full-time staff in the operational centre. Local volunteers,

as members of their communities, are the ones who are the most committed to restoring the normal functioning of infrastructure that ensures the community's well-being. Often, they are also first responders who can quickly provide the support that cannot be provided by government or external agencies. Local volunteer involvement promotes local ownership and accountability of operations.

3.5.2.3 Technologies / Tools used / missing / improvements needed

Technologies / tools used

- The participants pointed to the following technologies and tools used during disasters:
- Tetra communication system
- Mobile telephone network and internet network
- Radio equipment
- 112 system
- Various information processing systems
- Location systems (A-GPS)
- Portable and wearable sensors (CBNR suits)
- Protective gear and equipment
- Drones
- Drones video recordings

Technologies / tools missing

- Communication Technologies. The case study participants listed several challenges including the following: lack of access to communication networks to transfer data via WIFI, lack of reliable maps of the area, phone lines being saturated leaving only satellite phones as an option, the limited life of walkie-talkie and GPS batteries. Other challenges were related to S&R teams using different radio frequencies, as well as the time-consuming nature of writing down radio communicated messages. Additionally, wearing CBRN equipment can impact the smoothness of communication.
- Equipment and Technology Limitations. The participants indicated a lack of technologies to assist in the safety of the dogs during search operations, to reliably locate the dogs during work, to identify the route of the dog during the search of the structures, and to know where the dog has searched and where it has not. In a situation where there is a risk of a second explosion, participants pointed out that it is important to have drones and sensors that assess and identify the risks of new explosions and their scope, as well as detect chemical release as soon as possible. As for volunteers, they sometimes lack the protective equipment similar to that in possession of professionals.

Improvements needed

- Compatible Communication Technologies. Unification of communication systems and unification of location and data management programmes. A need for common and reliable communication systems. All actors should use the same information and communication technologies (ICTs).

- Reserving a separate radio communication frequency for the exchanges between teams, for example in order to inform the teams for a potential danger
- Compatible tracking technologies. Developing systems to combine track data from different apps and systems compatible with the volunteers' GPS. A cartographic base must be compatible with several formats.
- Improvement and compatibility of personal protective equipment for chemical substances with the other components of the suit (e.g. a chemical face mask with the waterproof glasses).
- Improvement of detection tools in terms of wearable/portable sensors, radiological meters and rapid chemical detectors.
- Improvement of mobile phone and internet networks capacity; autonomy of internet lines; powerful mobile WIFI router system
- Use of drones with more flight range, and with more thermal imaging penetration capability as well as atomic flights in areas of difficult access (e.g. canyon bottoms).
- a video streaming device for the diffusion of images from the drone live to the command post
- Use of artificial intelligence to identify a person's body or personal objects with previous description.
- Need for technologies allowing access to hot zones before the first responders.
- Thermal cameras of the drones must function correctly when the outside temperature is very high and amplitudes are low.
- Triage sheets being available via telematics.

Improvements implemented

- Development of mobile app (My 112 app) had been developed in Spain in order to facilitate the victims to contact the emergency centre call and provide their geographical location when multiple victims' incidents occur.
- Acquiring portable solar power.
- Acquiring more efficient and portable equipment in order to minimise space and transport weight
- Developing offline systems for locating and managing the positioning of the equipment
- Improvement of the mapping and equipment location system, use of open map databases, acquiring location equipment for rescue dogs and dog guides.
- Improvement of portable risk detection systems.
- Improvement of technical-material base, especially regarding the chemical, biological and nuclear intervention techniques.

3.5.2.4 Lessons learnt

1) Networking: Some participants realised the need for continuous professional information, especially from the practical experience of colleagues abroad. Others identified the need for participation in EU applied research projects to create synergies and utilise resources within the European community. Another organisation noticed the need to intensify collaboration with military forces specialised in CBRN matters. Participating in simulations and practical workshops with other emergency teams was also identified as a need for improvement. For most participants increased

collaboration and training with other organisations provides an opportunity for networking and exposure to different equipment, technologies, knowledge and practices creating opportunities for knowledge transfer.

2) Training: It is a priority to include volunteers from the local community in training programmes related to prevention and emergency situations. Some participants considered that more training is required by professionals and state forces. One organisation, ESDP, established structured training plans for dog handlers. Another area for improvement identified is cross-training programme in several emergencies that would create deeper knowledge in a variety of incidents and disasters.

3) Procedures: Internal procedures in SUMMA 112 for the response of multiple-victim incidents have been developed and disseminated and the professionals have received the related training. ESDP have modified their own procedures in line with regulations and collaborated in the development of procedures aimed at the search for victims in order to improve the efficiency and effectiveness of their work. Additionally, the need for the involving accredited volunteers in exercises prior to incidents in order to familiarise them with procedures in case of a real incident.

4) Media Exposure: PROECO saw a need for media promotion of their organisation's activities to attract human and financial resources.

5) Psychological: SUMMA has recently prepared teams of psychologists to respond to the emotional and psychological needs of various stakeholders.

6) Knowledge Retention: The need for means to retain knowledge and experience in the case of a professional, volunteer, or a group of them leaving the organisation.

7) Technological: Technological mobile app (My 112 app) had been developed in Spain in order to facilitate the victims to contact the emergency centre call and provide their geographical location when multiple-victims incidents occur.

8) Compatibility of Communication Technologies: A need for common and reliable communication systems has been identified. The need for the harmonisation and interoperability of communication systems and the unification of location and data management programmes has been reported. All actors should use the same information and communication technologies (ICTs).

3.5.3 Summary of conclusions

Through an analysis of the case studies several challenges were identified, as well as advantages and lessons learned. This report breaks down these broad categories into sub-categories and explores the main issues in disaster management and provides examples to clarify these issues. The good practices of S&R referred mostly to cooperation as well as sharing and combining resources. Among the main advantages of cooperating with volunteers was their local knowledge. As members of local communities volunteers could provide valuable information on the environmental characteristics, available resources and community needs. The challenges, on the other hand, were on the levels of technology, organisation, communication, procedures, legislation, training, and coordination.

One of the main issues during S&R missions was the lack of specific training which applied to volunteers but also, in some cases, to S&R professionals. Another challenge that many respondents identified was the incompatibility of communication technologies used by different stakeholders, both volunteers and professionals.

This seems to be an issue even when a common protocol, such as INSARAG, is used, or when different actors share the same physical space. Another important challenge that some participants discussed was the difficulty in applying advanced technologies when basic infrastructure was destroyed.

3.6 Summary of common findings and expert opinion

A summary of the major conclusions that were derived from the literature search (top-down) and the case study collection (bottom-up) from were provided in the respective sections (i.e. 3.3.4, 3.4.4, and 3) and this section will not replicate these. Instead, it will highlight common findings that this combination of top-down and bottom-up approaches resulted to.

The plethora of methods and frameworks proposed in the literature for assessing resilience and the different definitions used for the terms 'community', 'resilience' and 'community resilience', guided us in the identification of attributes and capacities that are commonly accepted as contributing in increasing 'community resilience' for subsequently (in Phase B of works) identifying the needs and gaps of stakeholders in strengthening 'community resilience' as these may be applicable to the S&R objectives, the proposed technologies and the operationalisation of the pilots. *Measuring community resilience requires a composite measure of the various characteristics that comprise community resilience so as to allow for performance measurement and systematic learning. Determining key factors, or priority characteristics, that contribute to building resilience to disaster at community level (qualitative assessment) are critical to the process of identifying the resilience impact indicators and prioritizing climate-resilient policy, planning and programming decisions by accounting for the specific context and different timeframes* [36,37,39]. As measuring resilience is out of our scope of work, we focused instead in determining the aforementioned characteristics/attributes that are of relevance to the S&R project.

By comparing the findings from both approaches two (2) major conclusions may be derived:

- All the major challenges reported from the case studies are directly related to the 18 elements (attributes/capacities) that were identified as being most relevant for the S&R project. As such, there is a good agreement between the two approaches and some indicative and interesting examples were provided from field experience. Therefore, these elements are all relevant and the focus in structuring the survey for the GAP analysis is on them:
    - Communication, information-sharing, coordination, training, use of appropriate resources (i.e. technologies, protective equipment) and procedures and were among the major issues reported.
    - Interoperability and compatibility of information and communication technologies and experienced leadership are also crucial to building resilience and highlighted by the learned lessons and by experts in the roundtable discussions, in particular during the response and recovery phases of the disaster.
- All successful practices reported from the case studies, in relation to the added-value of volunteers in the professional-volunteer interaction in disaster response have also been captured by the literature review. Sharing of information and local knowledge, provision of valuable supplementary resources in human capital, skills and expertise, collection of relevant data and connectedness for information sharing were the most prominent. An important aspect highlighted by case studies is the commitment that members of the local community and

volunteers put in recovering from the disaster. These points have also informed the survey structure for the GAP analysis.

In relation to the review on legislation / regulation / standardisation issues, there are several legal and ethical implications of working with people, technologies and information in crisis response and disaster management. In this sense, the awareness of the relevant legislative and regulatory environment in the form of a general overview of content that may be applicable and/or pertinent to different elements of 'community resilience' will support the development of the proposed technologies and their integration in the DSS platform. In addition, it will also provide context and guidance for the operationalisation of the pilots in WP8.

As it has been observed in the literature, *a framework is needed for assessing the resilience implications of policies and standards in use* [40-41], however, this is a direction for future research but not in the scope of S&R. However, legislation harmonisation issues for the interoperability of the technologies/wearables and for the operationalisation of the pilots need to be considered in the relevant WPs. Case studies have also reported on the lack of awareness of the regulatory context and procedures to follow in disaster events, which may be even more pronounced in the case of international operations.

3.7 **Proposed survey structure for GAP analysis and next steps**

Following the presentation of the literature review and the case study finding in the 2nd WP1 – T1.3 online meeting, held on 6/10/2020, with the participation of experts a draft template including the structure of the issues to be surveyed for the GAP analysis was created and circulated internally for all S&R partners to provide input.

By consolidating and integrating the input received the proposed draft survey template herein presented was created (

Table 3-14).

This template is proposed as a baseline document that considers the main factors identified from the literature review and case study collection as well as points/observations made by expert partners and end-users of S&R technologies/wearables that were found to enhance 'community resilience' for which S&R technologies/wearables stakeholders are going to be surveyed in order to identify the needs and gaps that will guide the design of the S&R proposed technologies/wearables and operationalisation of the pilots.

We would like to stress that this is only the baseline document which will undergo further refinement before being finalised and sent out to the stakeholders.

This template provides the necessary context and elements that the survey needs to focus upon and S&R partners may refer to for adjusting and calibrating the issues to be surveyed so as to best address their needs in the development of their technologies wearables in Phase B of the works (M5-M16). For finalizing the survey structure, following the submission of the current report, the following actions will be performed:

- In-depth review of relevant developed tools and/or frameworks, as necessary.
- Internal upload and circulation of the template for S&R consortium partners to provide input and feedback.

- Focus group formation consisting of partners involved in the development of S&R technologies and members from the Advisory Group to provide input and finalise the survey structure.

The finalised version will then be sent out to stakeholders for relevant input and feedback. Processing of the results will provide useful guidance for the development of the S&R proposed wearables, technologies and other services (e.g. design / content of e-learning content for first responders in WP2).

Table 3-14 Draft proposed structure for GAP analysis (to be further refined and finalised during Phase B of works)

Focus Domain / Area	Attribute / Capacity	Current State	Desired State (=Goal)	Needs (= objectives for desired goals)	Compliance/ Condition Status (1=poor; 4=v. good)	Identified Gaps	Importance / Priority (1=essential 2=secondary 3=auxiliary)	Comments / Notes	Proposed actions / solutions
A	Human / Behavioural								
A1. Knowledge, training and learning	1. S&R Training and human skills needed								
	2. Understanding/ knowledge of rescue processes								
	3. Awareness of / lessons from past disasters								
A2. Community empowerment and inclusiveness	1. Organisation empowerment in S&R								
	2. Inclusiveness of vulnerable populations								
A3. Societal capacity	1. Connectivity and engagement with civil organisations and local communities								
	2. Networking through media channels								

A4. Health Services	1. Physical and/or mental health during S&R operations (either of first responders or of victims - please specify)								
B	Technological								
B1. Technology for effective disaster response	1. Detection, monitoring and reporting equipment								
	2. Compatibility & interoperability with other S&R actors								
	3. Use of open or other data-collection and sharing platforms								
B2. Use of drone technologies (if applicable)	1. Victim's localisation, situation awareness and risk assessments								
B3. Communication & information sharing technologies	1. Appropriate communication infrastructure								
	2. Real time crisis information collection, sharing & reporting								
	3. Inter- and extra-organisational communication structure								
	4. Use of/ connection with early warning systems								

B4. First responder equipment	1. Use of smart devices to improve technical skills, cognitive capabilities and information sharing								
	2. Availability and access to appropriate equipment								
C	Organisational								
C1. Processes and procedures	1. Early action systems for expediting response/recovery								
	2. Processes standardisation								
C2. Governance / Leadership / Institutional capacity	1. Effectiveness, efficiency, and capability to respond quickly								
	2. Capacity to deal with disaster and share/manage information								
C3. Resources / logistics	1. Resource availability and appropriate allocation								
	2. Sharing of risk management tools and standards								
C4. Contingency planning	1. Business continuity plans / disaster risk management plans								

C5. Coordination and collaboration	1. Interorganisational / cross-organisational (non-volunteer related)								
	2. Interaction with local community and / or volunteer emergency response & coordination teams / use of local knowledge								
D	Legal								
D1. Legislative / regulatory issues	1. Legal / regulatory relevant limitations								
	2. Legal / regulatory harmonisation with other S&R actors or in foreign context.								

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Annex II: Case study collection template – general overview

Please provide 1-2 paragraph answer to the below questions. The template is intended for all partners (see Table 3-4).

Case study collection template	
Questions	**Answers**
1. What type of disasters have you responded to and what type of organisations and professionals did you cooperate with in these responses?	
2. What are the major challenges and advantages of working with other SAR organisations and professionals during the response phase?	
3. What are the major challenges and advantages of working with volunteers during the response phase?	
4. Have there been mistakes made during the response phase either by your organisation or in cooperation with others? How can this be avoided in the future?	
5. Do you experience unfulfilled needs in terms of technological resources, technical skill, logistics, communication, or reporting during response either as an organisation or in cooperation with other organisations? Could you please briefly elaborate on the most prominent?	
6. Are there legislation, hierarchal organisational structures, or complex decision-making procedures hindering your response?	
7. In terms of pre-disaster preparedness, do you cooperate with volunteers, other organisations, professionals, NGOs, or individuals from the wider community? If so, could you please briefly elaborate and list these?	
8. Are there any major lessons learnt by your organisation in how you respond to disasters: a) in order to improve its and/or the community's resilience? b) in relation to the S&R proposed technologies and/or Use Cases?	

Did your organisation change or adapt to address challenges over the years, and if so, how?	

ESDP

Please provide 1-2 paragraph answer to the below questions. The template is intended for all partners.

Case study collection template	
Questions	**Answers**
1. What type of disasters have you responded to and what type of organisations and professionals did you cooperate with in these responses?	The Spanish School of Rescue and Detection with Dogs (ESDP), has participated in multiple national and international disasters since 1999. The group of intervention in catastrophes of the ESDP has worked on searching and location of people buried by earthquakes: - Turkey Earthquake (1999) (2000) - El Salvador Earthquake (2001) - Algeria Earthquake (2003) - Earthquake Morocco (2004) - Haiti Earthquake (2010) - Ecuador Earthquake (2016) ESDP has collaborated in emergencies within the national territory, cooperating in the search of victims in floods, building collapses due to gas explosions and search of people lost in forest areas.
2. What are the major challenges and advantages of working with other SAR organisations and professionals during the response phase?	The advantages: - Obtain the accumulated experience from the different intervention teams, and be able to use it to improve own procedures and response protocols. - Be able to complement other teams in order to deal with any operational shortcomings. As a challenge: - Use of different communication systems, data processing and management models. - Different intervention protocols. - Differences regarding equipment technology, software and information management models.
3. What are the major challenges and advantages of working with volunteers during the response phase?	The advantages: - Increase the resilience of the population by involving civil society in the emergency. - Collaboration between organisations.

	- A more effective early response that can serve to increase the survival rate - Reach a higher organisational level in the development of the intervention. The challenges: - Lack of training in emergency intervention. - Lack of access, knowledge and updating of the materials and technology used by emergency teams.
4. Have there been mistakes made during the response phase either by your organisation or in cooperation with others? How can this be avoided in the future?	- Coordination mistakes due to the lack of a single communication channel between intervention teams. - Poor coordination due to the lack of unified protocols aimed at the different teams. Misunderstandings could be avoided by designing and developing more effective communication systems and information management processes that should include all involved teams.
5. Do you experience unfulfilled needs in terms of technological resources, technical skill, logistics, communication, or reporting during response either as an organisation or in cooperation with other organisations? Could you please briefly elaborate on the most prominent?	One of the great challenges for search teams is to have in the operational direction access to real and accurate information about aspects such as: - Actions carried out by the different participants. - Registration of the movement of the different participants (K9 and people), in order to analyse the implemented strategy and establish an index of priorities for the search. - Carry out a post-emergency analysis to optimise future actions.
6. Are there legislation, hierarchal organisational structures, or complex decision-making procedures hindering your response?	There is legislation aimed at regulating the intervention in local, regional, national and international emergencies. In some cases, due to their complexity, it causes slowness in the response of emergency teams, not only in the mobilisation but also in the coordination of the First Responder teams.
7. In terms of pre-disaster preparedness, do you cooperate with volunteers, other organisations, professionals, NGOs, or individuals from the wider community? If so, could you please briefly elaborate and list these?	The ESDP is an NGO that actively collaborates with local, regional and national authorities and emergency services too. At an international level, we respond to emergencies integrated in ERICAM (Emergency and Immediate Response of the Autonomous Community of Madrid); as a medium USAR team certified by INSARAG.

8. Are there any major lessons learnt by your organisation in how you respond to disasters: **a) in order to improve its and/or the community's resilience?** **b) in relation to the SAR proposed technologies and/or Use Cases?** **Did your organisation change or adapt to address challenges over the years, and if so, how?**	The ESDP has modified its own procedures to adapt them to the regulations and to improve the effectiveness and efficiency of our work. - Participating in simulations and practical workshops with other emergency teams. - Establishing structured training plans for dog handlers. - Collaborating in the development of procedures aimed at the search for victims. - Collaborating with public and private organisations to improve the training of their own workers.

HRT

Please provide 1-2 paragraph answer to the below questions. The template is intended for all partners.

Case study collection template	
Questions	**Answers**
1. What type of disasters have you responded to and what type of organisations and professionals did you cooperate with in these responses?	Earthquakes, wildfires, floods, sea rescue, mountain rescue
2. What are the major challenges and advantages of working with other SAR organisations and professionals during the response phase?	Challenges: Level of competence, procedures, language (glossary), coordination Advantages: More people with skills to address the event Allocation of work to more people Easier allocation of areas
3. What are the major challenges and advantages of working with volunteers during the response phase?	Challenges: Level of competence, procedures, language (glossary), coordination, unknown number of volunteers, different equipment, unknown training Advantages: More people with skills to address the event Allocation of work to more people Easier allocation of areas

4. Have there been mistakes made during the response phase either by your organisation or in cooperation with others? How can this be avoided in the future?	Mistakes have been made in the involvement of our volunteers especially in the early stages of an event. This can be avoided by incorporating the use of volunteers in an overall response mechanism
5. Do you experience unfulfilled needs in terms of technological resources, technical skill, logistics, communication, or reporting during response either as an organisation or in cooperation with other organisations? Could you please briefly elaborate on the most prominent?	Yes - Affordable new technologies that can enhance resource capabilities an resource management - Integration of new technologies for training - As volunteers we do not often train with authorities to establish common understanding, operational procedures, etc
6. Are there legislation, hierarchal organisational structures, or complex decision-making procedures hindering your response?	Yes. As a volunteer group we are always required to work under the government authorities and only when we are allowed to do so.
7. In terms of pre-disaster preparedness, do you cooperate with volunteers, other organisations, professionals, NGOs, or individuals from the wider community? If so, could you please briefly elaborate and list these?	As a volunteer organisation we work together with the authorities and where we sometimes participate in common training exercises.
8. Are there any major lessons learnt by your organisation in how you respond to disasters: **a) in order to improve its and/or the community's resilience?** **b) in relation to the SAR proposed technologies and/or Use Cases?** **Did your organisation change or adapt to address challenges over the years, and if so, how?**	As a volunteer organisation we value and depend on the role and support of the community. a) Enhancement of local communities participation in training and prevention activities.

JOAFG

Please provide 1-2 paragraph answer to the below questions. The template is intended for all partners.

Case study collection template	
Questions	Answers

1. What type of disasters have you responded to and what type of organisations and professionals did you cooperate with in these responses?	Johanniter Austria have responded to flood incidents, avalanches (regional), mudslides, earthquakes (int. missions), building collapse or large-scale accidents (including CBRN) as Medical First Responders (MFR) and in its capacity as disaster relief unit. Cooperation is oftentimes with other FR organisations such as other MFR, fire fighters, police or armed forces. Further, we collaborate with the governmental crisis and disaster management unit (ger.: SKKM) of the ministry of interior and local and regional governmental bodies, depending on the respective context of the crisis response. Cross-border collaboration often involves the German THW and other FR organisations across Europe for international operations.
2. What are the major challenges and advantages of working with other SAR organisations and professionals during the response phase?	Among some of the challenges are a lack of unified guidelines and common terminology of response organisations. Many organisations operate according to own specific guidelines and terminology that is not always easily understood by others. Integration of different types of organisations with different organisational cultures in one command structure is a particular challenge. In addition, differing logistics systems can become a challenge for joint operations as well, not being interoperable. The more organisations that are trying to collaborate, the harder it becomes to coordinate between FR units and to establish effective information sharing and communication across organisations. Regarding international missions, varying standards in K9 certification and toll procedures of third countries can hinder response and effective collaboration. Among main advantages of collaboration are the possibility of exchange of information and a complementary usage of resources and greater manpower in operation which ideally can increase the efficiency of response and shorten the response time. Collaboration can also lead to knowledge transfer between organisations, exposure to new/more efficient practices or technologies.

3. What are the major challenges and advantages of working with volunteers during the response phase?	When working with volunteers it has to be distinguished whether volunteers are skilled/trained or 'ad-hoc'. Major benefit is having a large pool of people at disposal at low cost. Working with trained volunteers requires adequate preparation and training (on a rolling basis) and one needs to build commitment across the volunteer group in order to be able to rely on these volunteers in times of crisis. However, if well prepared, they represent a valuable resource. Major challenge of working with volunteers can be their availability. Ad-hoc volunteers can also become a logistical challenge in terms of how to best fit them into the operations structure, keeping them and other people safe during the emergency without being an extra burden to the operations management. From another angle, ad-hoc volunteers that are not needed but show up at the scene anyway or in-kind donations that are not needed at the time can similarly become burdensome.
4. Have there been mistakes made during the response phase either by your organisation or in cooperation with others? How can this be avoided in the future?	Mistakes can happen due to a number of reasons, such as a lack of information at the time of decision making. This could potentially be avoided through more detailed or earlier availability of relevant data. Stress (being on high alert, operating in a constantly changing and evolving environment) is another factor which can render people prone to making mistakes. Training is key to familiarise people with such situations and become more resilient in coping with emergency situations. Deployment without adequate command and lack of communication can become an additional risk for an operation. It is also important to keep an overview of the emergency situation and not lose sight in the details. This could lead to a neglect of important factors influencing the situation.
5. Do you experience unfulfilled needs in terms of technological resources, technical skill, logistics, communication, or reporting during response either as an organisation or in cooperation with other organisations? Could you please briefly elaborate on the most prominent?	In terms of communication, documentation and reporting the EMS/relief unit is in need of a system/software for operational support for large-scale ambulance services – a digital patient guidance system. Furthermore, the response unit needs equipment to manage self-sufficiency in an operation, such as water and food supply, fuel, etc.

6. Are there legislation, hierarchal organisational structures, or complex decision-making procedures hindering your response?	In preparation of the UEFA Euro in Austria 2008 an attempt was made to test and introduce a common command and control system used by all national emergency response organisations. However, while technical solutions would be already readily available, it was not possible yet to convince organisations to agree on the usage of one common system. Concerning international missions, legislation can become a barrier. Toll regulations of third countries, especially for the rescue dog unit, can significantly slow down the response time. In some cases you run the risk of equipment being confiscated etc.
7. In terms of pre-disaster preparedness, do you cooperate with volunteers, other organisations, professionals, NGOs, or individuals from the wider community? If so, could you please briefly elaborate and list these?	We are always concerned with the training of volunteers, also in the form of large-scale simulation exercises. Such exercises are sometimes held with other emergency response organisations such as other FR units (Red Cross, Samaritans, Maltese Austria), armed forces or the fire brigade. We also collaborate with ÖBB, the Austrian federal railways, for trainings regarding train evacuations etc.
8. Are there any major lessons learnt by your organisation in how you respond to disasters: a) in order to improve its and/or the community's resilience? b) in relation to the SAR proposed technologies and/or Use Cases? c) Did your organisation change or adapt to address challenges over the years, and if so, how?	A.I. Trainings are a crucial aspect in resilience building and in strengthening response capacities A.II. Strengthening resilience through interactive community engagement, including awareness raising through games etc. at neighbourhood festivals/events etc. A.III. We do have lessons learnt, but for us one of the main challenges is knowledge management which is currently not sufficiently organised to successfully retain knowledge and learnings within our own organisation. With each person leaving the organisation, part of the experience/knowledge is lost. B. Increased collaboration and training with other organisations provides an opportunity for networking and exposure to different equipment, technologies, knowledge and practices creating opportunities for knowledge transfer. C. For us, major learnings and a change of thinking evolved from the refugee crisis in Europe, triggered in 2015. It led to a restructuring process of the disaster relief unit from a volunteer-based unit to a mixed structure consisting of staff and volunteers. Full-time positions were created especially for the leadership of the unit to ensure readiness for action and that staff is adequately trained for their missions.

JUH

Please provide 1-2 paragraph answer to the below questions. The template is intended for all partners.

Case study collection template

Questions	Answers
1. What type of disasters have you responded to and what type of organisations and professionals did you cooperate with in these responses?	Project Assessment Team Beirut, Lebanon (COVID-19 2020) Project Assessment Team Beira, Mozambique (Zyklon 2019) EMT Type 1 fixed Mozambique (Zyklon 2019) EMT Type 1 mobile Nepal (Earthquake 2015) EMT Type 1 mobile Philippines (Typhon 2013) EMT Type 1 fixed Haiti (Earthquake 2010) […] Primary health care service; no entrapped victims
2. What are the major challenges and advantages of working with other SAR organisations and professionals during the response phase?	A challenge may be a different understanding of execution of processes and performance requirements (mindset) towards a team consisting of volunteers.
3. What are the major challenges and advantages of working with volunteers during the response phase?	Major challenges are the availability of volunteers and the exemption by their employers, extended response time, no sufficient pre-deployment preparation, lack of understanding or experience of personal role, lack of teamwork, drop-out of team during or after bad mission experience. Major advantages by working with volunteers are low personnel costs and claims, strong commitment, motivated mindset and specialist expertise from the volunteers major job, volunteers can be a relief for full-time staff in the operational centre as well.
4. Have there been mistakes made during the response phase either by your organisation or in cooperation with others? How can this be avoided in the future?	The following means have been identified for improvement: Definition of an explicit mission goal, optimisation of alert mechanism, optimisation of handover process to a following team, new definition of psychosocial care, new definition of material carried by the team, revision and restriction of equipment and the revision of communication lines.
5. Do you experience unfulfilled needs in terms of technological resources, technical skill, logistics, communication, or reporting during response either as an organisation or in cooperation with other organisations? Could you please briefly elaborate on the most prominent?	Sending a small project assessment team before deploying a complete EMT e.g. to Mozambique has been a major advantage. Colleagues on-site were able to attend relevant meetings with the LogCluster, EMTCC and local representatives; had therefore an information head start and were able to brief our EMT properly.

6. Are there legislation, hierarchal organisational structures, or complex decision-making procedures hindering your response?	After request for assistance by Mozambique 2019, receiving an official entry permit has been a major effort by a project assessment team on-site.
7. In terms of pre-disaster preparedness, do you cooperate with volunteers, other organisations, professionals, NGOs, or individuals from the wider community? If so, could you please briefly elaborate and list these?	Robert Koch Institute (RKI) which is EMT National Focal Point for Germany – regular organised meetings and provides a platform to exchange mission experience and gaining from each other's knowledge. Johanniter therefore is in closed cooperation with other German NGO running an EMT. Johanniter made its SOP available to other NGO in preparation for their WHO classification processes and organised joint field exercises, e.g. with ASB. Furthermore Johanniter is a member of Aktion Deutschland Hilft (ADH).
8. Are there any major lessons learnt by your organisation in how you respond to disasters: a) in order to improve its and/or the community's resilience? b) in relation to the SAR proposed technologies and/or Use Cases? Did your organisation change or adapt to address challenges over the years, and if so, how?	Johanniter has more than 10 years of disaster response experience (Haiti, Nepal, Philippines, and Mozambique etc.) Johanniter EMT has been classified as the first Type 1 mobile by WHO in 2017. In order to improve processes and community resilience the following the following measures have been undertaken within the past years: Personnel and organisational restructuring at administrative and management level, additional procurement and restructuring of equipment, involving volunteers in the revision process of the SOP and make use of experienced volunteers as trainers, and thus appreciate their expertise (win for new unexperienced volunteers).

PROECO

Please provide 1-2 paragraph answer to the below questions. The template is intended for all partners.

Case study collection template	
Questions	**Answers**
1. What type of disasters have you responded to and what type of organisations and professionals did you cooperate with in these responses?	1. Types of disasters involved: - Fires in a community; - Road accidents with dangerous toxic substances; - Railway accidents with dangerous toxic substances; - Rain floods. 2. During the intervention we collaborated with: - Training of local community volunteers;

	- Local public authorities (mayor, deputy mayor) - S&R military formations of the County Inspectorate for Emergency Situations; - S&R specialists of the "Service for preparation for intervention and resilience of communities" within the County Inspectorate for Emergency Situations; - The commander of the intervention (officer from the County Inspectorate for Emergency Situations); - Local and national media.
2. What are the major challenges and advantages of working with other SAR organisations and professionals during the response phase?	1. The major challenges of the volunteer's collaboration with other SAR organisations and the professionals within the County Inspectorate for Emergency Situations are: - The use of volunteers according to the competence class obtained within the accreditation courses organised at local level by the County Inspectorate for Emergency Situations[1]; - Establishing areas of responsibility and communication system between R&D teams regardless of their affiliation; - Supporting volunteers by the local public administration with logistical resources specific to the type of R&D action; - Correct and timely media coverage of the contribution made by volunteers in actions to limit the destructive effects generated by a disaster. 2. The major advantages are: - The collaboration of the parties brought added value to the optimisation of S&R operations; - Making the most of the resilience of the community affected by a type of disaster; - Volunteers often know the geography of the affected area and the typology of interpersonal relationships specific to the disaster-stricken community; - optimizing the action of volunteers based on specialised expertise provided by other SAR organisations or professionals.
3. What are the major challenges and advantages of working with volunteers during the response phase?	1. The major challenges in the relationship between volunteers from outside the community and volunteers from the Community Voluntary Service for Emergency Situations are: - Differences in training, skills and professional experience; - Misperception of external volunteers on issues specific to the affected community; - The degree of tolerance and mutual trust in carrying out S&R actions 2. The major advantages are: - Existence of a common training base in emergency management; - Exchanges of experience organised at Community, regional and national level through specialised competitions; - Absence, almost total, of prejudices of religion, culture, sex or race.

4. Have there been mistakes made during the response phase either by your organisation or in cooperation with others? How can this be avoided in the future?	1. The mistakes made were due to the fact that PROECO volunteers did not take into account all aspects of operational situation assessments, at the community level, made by the main actors (S&R teams of the County Inspectorate for Emergency Situations, local administration, volunteer emergency service of community). 2. This mistake can be remedied by the participation of a PROECO volunteer at the forward command point organised by the County Inspectorate for Emergency Situations in the affected area, to coordinate the intervention of all forces and means involved.
5. Do you experience unfulfilled needs in terms of technological resources, technical skill, logistics, communication, or reporting during response either as an organisation or in cooperation with other organisations? Could you please briefly elaborate on the most prominent?	The most prominent unmet needs that have manifested themselves, over time, in the response phase are: - Failure to update the technical parameters of the endowment technology due to the limitation of financial funds, so that the reaction time and the return on the performance of R&D actions did not progress; - The communication technique has not been modernised, being physically and morally worn out; - At the level of a volunteer's technical skills, his level of competence has not increased to the level of the specific requirements of the local community, as there are no refresher courses of technical and operational knowledge, except for the head of the volunteer emergency service; - Gaps in the information transmission system between all actors involved in R&D actions in the affected area, especially at the beginning of the intervention, until a common frequency is established (basic and reserve).
6. Are there legislation, hierarchal organisational structures, or complex decision-making procedures hindering your response?	The legislation in the field has been updated, both proactively and reactively[2], so that administrative barriers that would delay decision-making and its implementation have been reduced. The execution of the intervention at the community level was decentralised. Directly, our response does not reach the required level of optimisation because, at the legislative level, impact and feasibility studies that support the promotion of laws are not correlated, in the short and medium term, with the real situation of available resources at a community level.
7. In terms of pre-disaster preparedness, do you cooperate with volunteers, other organisations, professionals, NGOs, or individuals from the wider community? If so, could you please briefly elaborate and list these?	At the community level, the principle of "resilience through early education" applies. According to the legislation in force[3], training is carried out in the field of youth emergencies. The practical verification of this training is organised through competitions at community, regional and national level[4]. PROECO volunteers, as accredited trainers, participate in these forms of training or in NGOs according to their competencies in the field.

8. Are there any major lessons learnt by your organisation in how you respond to disasters: **a) in order to improve its and/or the community's resilience?** **b) in relation to the SAR proposed technologies and/or Use Cases?** **Did your organisation change or adapt to address challenges over the years, and if so, how?**	1. The major lessons learned by PROECO members in how to respond to disasters are: a) In order to improve the community's resilience: - participation with priority, with trainers, in the training program of volunteers from the local (community) voluntary service for emergency situations. b) In relation to the SAR proposed technologies and/or Use Cases: - The need for continuous professional information, especially from the practical experience of colleagues from abroad; - Participation in EU applied research projects, to use the synergistic effect of optimal capitalisation of resources in the European community; - The need for media promotion of PROECO activities to attract human and financial resources. 2. The organisation has changed in recent years, both quantitatively and qualitatively, in an attempt to adapt to new economic and social developments, but not only. PROECO's participation in this project is proof of this.

PUI

Please provide 1-2 paragraph answer to the below questions. The template is intended for all partners.

Case study collection template	
Questions	Answers
1. What type of disasters have you responded to and what type of organisations and professionals did you cooperate with in these responses?	We are specialist in all natural and accidental disasters: earthquakes, tsunamis, typhoons, storms, floods, landslides, volcanos, forest fires, accidental explosion and human disasters: diseases, assistant to the homeless after the disaster. As an INSARAG classified team, we cooperate with military organisations, police departments, medical teams, search and rescue organisations, governmental, non-governmental and international organisations (UNICEF, ACF, ACTED, RED CROSS, TSF…); Last but not least, we closely collaborate with the United Nations, UNDAC, OCHA, WHO etc…
2. What are the major challenges and advantages of working with other SAR organisations and professionals during the response phase?	The major challenge of working with other SAR organisations is that we speak the same technical language and we have the same goal: to save lives; we must work together and be complementary, in terms of equipment, staff and leadership. The advantages are to share effort and have the capability of working more and more efficiently.

3. What are the major challenges and advantages of working with volunteers during the response phase?	The challenge of working with volunteer is to make them follow the minimum disciplinary procedures; we are experienced, working in the same team since many years and as professional rescuers we have different procedures; the volunteers have to respect the working conditions according to precise procedures. But, the advantages of volunteers, particularly in the country affected, are that people are members of different communities with many contacts; it is easier to speak, explain our work and have the support from the local people or administration, with local volunteers.
4. Have there been mistakes made during the response phase either by your organisation or in cooperation with others? How can this be avoided in the future?	A mistake already corrected is that during the response phase, we should be in contact with the people in charge of the district, villages or religion because they have a very good network and are generally appreciated; The mistake was that we underestimated their role as they can bring a lot of success during a mission by facilitating deployment and contacts with the local population. Collaborating with a team that does not have the same INSARAG (UN) standardisation as ours can also have difficulties; so we avoid this unless we know the USAR team well.
5. Do you experience unfulfilled needs in terms of technological resources, technical skill, logistics, communication, or reporting during response either as an organisation or in cooperation with other organisations? Could you please briefly elaborate on the most prominent?	The most important needs for us are those which have to do with saving lives: reliable tools for detecting and locating trapped victims are very important to save time in searches and have the biggest chance of saving people; the rubble search scanner used is not reliable enough and requires too much interpretation; it is however light, wireless including a tablet allowing to locate a victim, but the results are often wrong, something which is prohibited as we deal with human lives. In terms of communication, the most prominent are compact, light, reliable, resistant and long range communication radios; devices compatible with other systems by common radio frequencies would also be interesting.

6. Are there legislation, hierarchal organisational structures, or complex decision-making procedures hindering your response?	As a non-governmental team, we are independent and we can organise our response by ourselves; on the other hand, the procedures with the airlines are not standard and we sometimes have to pay exorbitant prices for the air tickets, as the air tickets paid for our search dogs can be twice more expensive than for a human; often disaster-stricken countries facilitate the response of international rescue teams, but this is not always the case.
7. In terms of pre-disaster preparedness, do you cooperate with volunteers, other organisations, professionals, NGOs, or individuals from the wider community? If so, could you please briefly elaborate and list these?	In the field of preparation, we collaborate with several partners: USAR teams from other European countries (Spain, Greece, Italy) in order to share techniques, experiences and collaborate during the simulation exercises. We are also working with private partners from our region for the development of new equipment such as specific drones, robots, radars etc. (example AQUIDRONE) and finally we are working with local teams from large institutions such as the Red Cross through the form of a cooperation agreement to, for example, share supply facilities for drugs (or medic) or equipment for our team.
8. Are there any major lessons learnt by your organisation in how you respond to disasters: a) in order to improve its and/or the community's resilience? b) in relation to the SAR proposed technologies and/or Use Cases? Did your organisation change or adapt to address challenges over the years, and if so, how?	a / We invest a lot in training: training of our team in order to be ready to face all situations, which allows us to prepare better and overcome the difficulties with more serenity; we also share this training abroad, with community teams or communities in order to prepare them for future disasters; we believe that training is an essential tool in resilience. b / We have noticed that the professional network we now have, allows us to share experience with other USAR teams and also learn from them; we are always trying to develop this network which also facilitates the deployment of teams in order to have precise and realistic information before anyone else. c / We always wish to help: we try to upgrade our equipment regularly, to be open to new technologies and to find ways to be more effective with innovative methods and materials; we take into account the experiences of others, as we did for COVID in the case of a collapsed building in China: we have collected the experience of the Chinese team in this operation in order to be inspired and ready to face a similar case. We are also seeking to have our equipment evacuated in order to adapt to new risks such as pandemics, or global warming.

SUMMA

Please provide 1-2 paragraph answer to the below questions. The template is intended for all partners.

Case study collection template

Questions	**Answers**
1. What type of disasters have you responded to and what type of organisations and professionals did you cooperate with in these responses?	SUMMA 112 is the public Emergency Medical Service in Madrid´s Community and responds to: 1.- Ordinary healthy emergency incidents. 2.- Multiple victims incidents. 3.- Disasters and Catastrophes. including CBRN types. SUMMA 112 may respond itself using ordinary or specific protocols or may be activated collaborating with other organisations as example bellows: 1. Ordinary incidents: SUMMA 112, Civil Protections (which includes a local emergency medical service called SAMUR-PC), Red Cross, Fire Fighters, Security Forces, Forestry. 2. Biological Risk Sanitary Transport: specific group of SUMMA 112 with qualified training and formation in biological risk assessment. 3. ERICAM: composed by SUMMA 112 health care workers and firefighters from the Community of Madrid and three NGOs of search and guide dogs. Responds to both, missions related with natural disasters in the community, as well as international catastrophes. ERICAM is the first Spanish Team available behind the rules of INSARAG. It was formed in 1991, as a cooperative effort by countries that are either prone to earthquakes or disasters that may cause structural collapse, or countries and organisations that are providers of international USAR assistance, the UN, and other international responders. SUMMA112 functions under the legal framework of the PLATERCAM, which corresponds to the Civil Protection Territorial Plan of Madrid Community and is developed to deal with emergency risks, including natural disasters and catastrophes. 1. Types of disasters involved: - Terrorism attacks: national (ETA) and international (jihadism). - Earthquakes. - International humanitarian emergencies (Haiti earthquake in 2010, Mozambique cyclone 2019). - Fires and floods. - Rail, air and road accidents. - CBRN (chemical, biological, radiological, nuclear) incidents. 2. During the intervention we collaborated with: - Training of local volunteers and professional health care workers (SAMUR-PC). - State security forces (Police, Civil Guard...). -Firefighters and rescue services. -Civil protection or local volunteers. and professionals: SAMUR-PC - Spanish Red Cross.

	- In major incidents military army (UME: emergency military unit) and mayor or president of the Community. - Local and national media. - Recently incorporated in SUMMA 112: teams of psychologists.
2. What are the major challenges and advantages of working with other SAR organisations and professionals during the response phase?	- PLATERCAM is the legal framework of the Community of Madrid in which there is an exhaustive defined action plan protocol, based on the severity of the incident, for each organisation and institution involved according to the type of risk and damage suffered. All the Emergency, Rescue and State Security Services, volunteers and political leaders are governed by this territorial plan where they have their functions described. - The greatest challenge is to ensure quickness and a multi-level coordinated response for which an adequate training of all the organisations involved and a deep knowledge of the PLATERCAM should be guaranteed prior to the incidents. -Volunteers and local civil protection help considerably in the triage of minor patients. -Another area for improvement would be communications between different organisations.
3. What are the major challenges and advantages of working with volunteers during the response phase?	-The main challenge is guaranteeing the qualified education and training of the volunteers to be similar to that of the professionals. -The main advantage is to have a team in charge of the triage chain for minor injuries and the evacuation wheel. -Sometimes there are volunteers and on the day of the incident they are not available.
4. Have there been mistakes made during the response phase either by your organisation or in cooperation with others? How can this be avoided in the future?	-Every incident can be improved. The main errors arise in communication failures between different organisations. Having a global law (PLATERCAM) that protects all the organisations involved is important to avoid errors. Proposals to improve errors: - Joint training among all organisations (firemen, local and national police, civil guard, volunteers...) at least twice a year simulating a multiple victim incident. - Adequate training and coaching of volunteers. - Adequate records of patient entry and exit at an advanced medical post. - Proceed to put on personal protective equipment according to the type of disaster. - Improving the way of communication between all stakeholders involved in the catastrophe.
5. Do you experience unfulfilled needs in terms of technological resources, technical skill, logistics, communication, or reporting during response either as an organisation or in cooperation	1. On a technological level, SUMMA 112 has only one carbon monoxide detector. It would be important to have other detectors or chemical sensors to prevent risks in the interventions. 2. Debriefing is done in each organisation but not between them. It would be good if there were people in charge of each

with other organisations? Could you please briefly elaborate on the most prominent?	organisation (health, fire, security forces...) who also commented on the failures in coordination between them. 3. CBRN incidents are unusual and there is poor handling in the out of hospital emergency medical services. Better formation should be provided to all professionals.
6. Are there legislation, hierarchical organisational structures, or complex decision-making procedures hindering your response?	Since the incident of 11 March 2004 (the Atocha train bombing), many laws have been drafted concerning multiple victim incidents. PLATERCAM is the main law that speeds up, coordinates, and improves the intervention in disasters in the Community.
7. In terms of pre-disaster preparedness, do you cooperate with volunteers, other organisations, professionals, NGOs, or individuals from the wider community? If so, could you please briefly elaborate and list these?	In the Summa 112: - At a local, regional and national level there are rapid response teams for disasters that work together with the fire brigade, the army, state security forces and civil protection (volunteers and rescue dogs). - At the international level, there is an international disaster action group that works with INSARAG (International Search and Rescue Advisory Group) regulations belonging to the UN which, in addition to the teams mentioned at the national level, also carries out practices with rapid response working groups from other countries (USAR teams)
8. Are there any major lessons learnt by your organisation in how you respond to disasters: **a) in order to improve its and/or the community's resilience?** **b) in relation to the SAR proposed technologies and/or Use Cases?** **Did your organisation change or adapt to address challenges over the years, and if so, how?**	a) 1. The emotional and psychological impact between the stakeholders involved. Prepared teams of psychologists have been recently added in the respond to these incidents. 2. Install multiple victims' mortuaries, in order to gather the families of the deceased and give them physiological support to start a complicated grief process. 3. Take advantage of buildings not initially designated for sanitary purposes and arrange them as field hospitals as we have seen in the actual COVID-19 pandemic. In Madrid, the named IFEMA hospital. b) 1. Technological mobile apps (My 112 app) have been developed in order to facilitate the victims to contact the emergency centre call and provide their geographical location when multiple victims incidents occur. 2. Internal procedures in SUMMA 112 for the response of multiple victim's incidents have been developed, spread and trained between professionals. 3. Intensify collaboration with military forces specialised in CBRN matters. 4. The Department of Catastrophes of SUMMA 112 has acquired, concerning these lessons learnt: --personal

	protective equipment such as chemical face masks and ventilated biohazard personal protective suit. -- diphoterine for chemical substances. -- RM21 as a decontamination product specially acquired for bacillus anthracis (anthrax). -- a new sanitary decontamination station (added to two individual stations). -- oxygen distributors in case of multiple oxygen requirements.

UGL

Please provide 1-2 paragraph answer to the below questions. The template is intended for all partners.

Case study collection	
Questions	**Answers**
1. What type of disasters have you responded to and what type of organisations and professionals did you cooperate with in these responses?	Types of – natural or not – disasters (case studies) involved, either directly or indirectly: 1. Ais Gill Train accident – UK (1995) 2. Kings Cross Bombings London – UK (2005) 3. Collapse of Factory Building – Bangladesh (2013) 4. Christchurch earthquake – NZ (2011) 5. Evangelos Florakis Naval Base explosion – Cyprus (2011) 6. Evacuation of a Municipality of Athens summer camp – GR – field exercise (2010) During the disasters we collaborated with: - NHS professional health care workers - Police - Firefighters - Rescue services - Other State security forces - Civil protection - Municipality of Athens - Neighbouring municipalities - Municipality volunteers team - Local and national media
2. What are the major challenges and advantages of working with other SAR organisations and professionals during the response phase?	Major challenges working with other SAR organisations and professionals during the response phase: 1. One of the greatest challenges working with SAR organisations, is fast access to accurate information and cross communication between the emergency responders i.e. state forces/ civil protection/ volunteers etc. that get involved to

	encounter an emergency situation that just occurred. 2. Secondly, is the quick response of multi-level emergency services and prioritisation of first responders. 3. Another area for improvement would be a cross-training programme in order to improve collaboration between different organisations in several emergencies, which will create a deep knowledge of the multileveled training and response each organisation has on different incidents. Major advantages: 1. The collaboration of the parties involved add value by combining different training and experience on S&R operations.
3. What are the major challenges and advantages of working with volunteers during the response phase?	Major challenges working with volunteers during the response phase: 1. Communicate efficiently between organisations and volunteers 2. Classify and use of volunteers/volunteer teams according to their background emergency response training 3. A need for improvement would be on the participation of accredited volunteers with organisations, in exercises, prior to an incident, in order to get more familiar with the procedures that have to be followed in a real situation 4. Support volunteers by the local public administration with proper equipment and logistical resources Major advantages: 1. Volunteers often create a strong community 2. Local volunteers usually have a better knowledge of the area and paths 3. Past training of volunteers in state forces is very useful.
4. Have there been mistakes made during the response phase either by your organisation or in cooperation with others? How can this be avoided in the future?	Main issues occurred in several incidents during the response phase, where mainly caused by poor communication. These types of miscommunication and delays of passing information can be avoided by organising cross-training programmes and several joint-exercises based on common cross-functional operational emergency plans.
5. Do you experience unfulfilled needs in terms of technological resources, technical skill, logistics, communication, or reporting during response either as an organisation or in	One of the most important needs an organisation has, is the proper tools, in order to respond accordingly to an emergency. Not always, access to the latest and most advanced technological resources is there. At the same time, technical skills vary from organisation to organisation, and creates delays at a communication level.

cooperation with other organisations? Could you please briefly elaborate on the most prominent?	
6. Are there legislation, hierarchal organisational structures, or complex decision-making procedures hindering your response?	Because of complex decision-making procedures, the legislation gets updated constantly. This tries to solve the hierarchy in complicated organisational structures where is times of crisis there might be conflicts. At the same time, operational plans are being updated, in order to comply with those legislations.
7. In terms of pre-disaster preparedness, do you cooperate with volunteers, other organisations, professionals, NGOs, or individuals from the wider community? If so, could you please briefly elaborate and list these?	This is not applicable to our company, because our role was to only conduct interviews after the incident
8. Are there any major lessons learnt by your organisation in how you respond to disasters: **a) in order to improve its and/or the community's resilience?** **b) in relation to the SAR proposed technologies and/or Use Cases?** **Did your organisation change or adapt to address challenges over the years, and if so, how?**	Major lessons learned in how to respond to disasters are: a)1. More training is required, mostly by professionals and state forces a)2. Communicating the need of volunteers and creating awareness regarding Health and Safety, which will reduce the risk of an incident, but if and when that occurs, communities will respond in an organised manner and appropriately b)1. More knowledge and communication of what types of SAR technologies exist is needed b)2. More professionals can help in the training of volunteers on those technologies The organisation has changed in many levels. With regards to experience, many field exercises took place, which created experience on how to respond more quickly and with more confidence. Prior to that, appropriate training took place, in order to prepare personnel and volunteers. Based on that, the operational plans were improved and adjusted.

Annex III: Case study collection template – case-specific

This template is only intended for T1.3 participating partners and T1.3 non-participating partners only if they wish to as per Table 3-5. Please provide 1-2 paragraph answer to the below questions. Please provide 5-10 case studies of disaster events you participated in or know of. Please fill out a separate template for each case study.

Case study collection template	
Questions	**Answers**
1. Can you briefly describe a specific disaster event and your organisation's role in it? What other organisations and professionals did you cooperate with in this response?	
2. If the case study / disaster is documented, please provide a relevant reference/link.	
3. What were the major challenges and advantages of working with other SAR organisations and professionals during the response phase of this specific disaster?	
4. What are the major challenges and advantages of working with volunteers during the response phase of this specific disaster?	
5. Have there been mistakes made during the response phase of the above disaster event, either by your organisation or in cooperation with others? How can this be avoided in the future?	
6. During your response to the disaster, did you experience unfulfilled needs in terms of technological resources, technical skills, logistics, communication, or reporting either as an organisation or in cooperation with other organisations? Could you please briefly elaborate on the most prominent?	
7. Were there legislation, hierarchal organisational structures, or complex decision-making procedures that may have hindered your response to the disaster?	
8. In terms of pre-disaster preparedness for the event you have described, did you cooperate with volunteers, other organisations, professionals, NGOs, or individuals from the wider community? If so, could you please briefly elaborate and list these?	
9. Were there any major lessons learned by your organisation in how you responded to the disaster: a) in order to improve its and/or the community's resilience? b) in relation to the SAR proposed technologies and/or Use Cases?	

Did your organisation change or adapt to address challenges over the years, and if so, how?	

ESDP

Case study: Gas explosion in building	
Questions	**Answers**
1. Can you briefly describe a specific disaster event and your organisation's role in it? What other organisations and professionals did you cooperate with in this response?	 **Case description:** April 18th , 2018 at 11:10 p.m. A call from the 112 (emergency number) was received on the ESDP emergency phone. It was requested the presence of Dog Unit to search for two disappeared in the collapse of a house due to a possible gas explosion in a village called Villamanta (Community of Madrid). The mission of the K9 teams was to locate possible survivors and / or their remains under the rubble. **Organisations involved** -Local Police -SUMMA 112 -Firefighters (Community of Madrid) - Civil protection **Procedure:** The 112 called by phone to the ESDP principal who was on duty. 2 on duty teams and the principal person travelled to the emergency scene. The Fire Chief informs to the K9 Chief about the situation: a) Causes of collapse b) Detected risks c) Actions carried out so far. d). High priority search areas

2. If the case study / disaster is documented, please provide a relevant reference/link.	https://www.publico.es/videos/664349/angustioso-rescate-de-siete-horas-de-una-anciana-tras-una-explosion-de-gas-en-villamanta-en-madrid
3. What were the major challenges and advantages of working with other SAR organisations and professionals during the response phase of this specific disaster?	**Challenges** Achieve a good coordination between all involved teams. **Advantage** Put in practice the operational procedures that were learned as theory. 
4. What are the major challenges and advantages of working with volunteers during the response phase of this specific disaster?	ESDP is a team of volunteers. We are currently fully integrated into the disaster response system of the Community of Madrid, through activation and action procedures.
5. Have there been mistakes made during the response phase of the above disaster event, either by your organisation or in cooperation with others? How can this be avoided in the future?	Notable mistakes were not observed.
6. During your response to the disaster, did you experience unfulfilled needs in terms of technological resources, technical skills, logistics, communication, or reporting either as an organisation or in cooperation with other organisations? Could you please briefly elaborate on the most prominent?	It should be underlined the absence of a briefing to analyse the performance from different points of view in order to achieve aspects of improvement.

7. Were there legislation, hierarchal organisational structures, or complex decision-making procedures that may have hindered your response to the disaster?	There were no deficiencies from the legislative point of view. Regarding organisational structures or decision-making issues deficiencies were not reported.
8. In terms of pre-disaster preparedness for the event you have described, did you cooperate with volunteers, other organisations, professionals, NGOs, or individuals from the wider community? If so, could you please briefly elaborate and list these?	As it was said, ESPD is an NGO. In this emergency situation, we did not collaborate with any civil organisation.
9. Were there any major lessons learned by your organisation in how you responded to the disaster: **a) in order to improve its and/or the community's resilience?** **b) in relation to the SAR proposed technologies and/or Use Cases?** **Did your organisation change or adapt to address challenges over the years, and if so, how?**	

Case study: Haití Earthquake	
Questions	**Answers**
1. Can you briefly describe a specific disaster event and your organisation's role in it? What other organisations and professionals did you cooperate with in this response?	Haití Earthquake 

2. If the case study / disaster is documented, please provide a relevant reference/link.	https://www.britannica.com/event/2010-Haiti-earthquake
3. What were the major challenges and advantages of working with other SAR organisations and professionals during the response phase of this specific disaster?	 **Challenges** Language barriers. Difference in operating procedures between teams. Lack of resources for an effective communication. **Advantage** The possibility of receiving the support of other work teams helped to fill in the gaps and problems arose during the intervention.
4. What are the major challenges and advantages of working with volunteers during the response phase of this specific disaster?	**Challenges** Training, operational, and material resources deficiencies were the most frequent challenges to solve. **Advantage** Local volunteer teams usually know the terrain very well. They provides us valuable information about the environment and the possibilities of obtaining certain materials and accessories that cannot be transferred from the rescuers' countries of origin.

5. Have there been mistakes made during the response phase of the above disaster event, either by your organisation or in cooperation with others? How can this be avoided in the future?	 In this case, there was a long delay in mobilisation. The lack of access to communication networks (use of data via Wi-Fi, for example), and not having reliable maps of the area, were a major problem for the correct development of searching tasks. The lack of adequate computer support (both software and hardware) to help us to establish key stations for logistical and planning aspects affected the work efficiency too.
6. During your response to the disaster, did you experience unfulfilled needs in terms of technological resources, technical skills, logistics, communication, or reporting either as an organisation or in cooperation with other organisations? Could you please briefly elaborate on the most prominent?	There were great shortcomings to make possible the communication between the different teams in order to achieve an efficient coordination. There was no possibility of accessing data networks until several days after the disaster. Phone lines were saturated and only the satellite phone could be used. The very limited duration of the walkie-talkies and GPS batteries obliged us to locate energy sources as a priority in any place where we travelled.
7. Were there legislation, hierarchal organisational structures, or complex decision-making procedures that may have hindered your response to the disaster?	The strategic organisation of the intervention were governed by the INSARAG regulations. This international regulation currently allows teams that have accepted it to work under the same umbrella. The organisations have been certified and committed to compliance it. This certification is renewed every 4 years, and its regulations and procedures are constantly evolving.
8. In terms of pre-disaster preparedness for the event you have described, did you cooperate with volunteers, other organisations, professionals, NGOs, or individuals from the wider community? If so,	Our team cooperated with civil and governmental organisations in the country itself, and in other countries that sent emergency aid: - ISAR (Iceland) - BFAST (Belgium) - Civil Defence (Dominican Republic) - Civil Guard (Spain) - National Police (Spain) - Basque Autonomous Police (Spain) - Military Emergency Unit (Spain)

could you please briefly elaborate and list these?	
9. Were there any major lessons learned by your organisation in how you responded to the disaster: **a) in order to improve its and/or the community's resilience?** **b) in relation to the SAR proposed technologies and/or Use Cases?** **Did your organisation change or adapt to address challenges over the years, and if so, how?**	a) The need to provide training and help in the management of information to the society of the affected country. b. Unification of communications and autonomous, reliable and efficient energy sources. Our organisation acquired new solar portable power. We have acquired more efficient and portable equipment in order to minimise space and transport weight. We have also evolved in the systems for locating and managing the positioning of the equipment, to work off-line.

Case study: Search for a person lost in the mountain	
Questions	**Answers**
1. Can you briefly describe a specific disaster event and your organisation's role in it? What other organisations and professionals did you cooperate with in this response?	**Case description** August, 2019 The search for lost or missing persons in the natural environment is one of the most common search actions for rescue teams. It is also the rescue operation in which the greatest number of search engines and technological resources are used. K9 teams, together with drones and search teams on foot or motorised, are the first resources used. ESDP The ESDP assisted in this rescue by using search dogs with two objectives: 1. to rule out the presence of the victim in the assigned search areas 2. Locate the missing person if they are in one of these areas. The ESDP collaborated in this rescue with: • Firefighters of Madrid • Guardia Civil • Police • Civil Protection • Private volunteers • Other NGO

	
2. If the case study / disaster is documented, please provide a relevant reference/link.	https://www.elmundo.es/deportes/mas-deporte/2019/09/03/5d6d8df2fdddff08158b466e.html http://www.telemadrid.es/programas/telenoticias-1/busqueda-Blanca-despliegue-Comunidad-Madrid-2-2155004494--20190902025040.html
3. What were the major challenges and advantages of working with other SAR organisations and professionals during the response phase of this specific disaster?	**Challenges** The biggest challenges for this type of operation are usually: 1. The coordination of many people in a very large area 2. The effective communication of searchers, when many are inexperienced volunteers not integrated into organisations. 3. The lack of precision in the reporting of search activities, due to the lack of compatible technological resources. **Advantage** The possibility of having many people who can carry out searches in large areas, and having different organisations that provide different and complementary technologies and useful resources.
4. What are the major challenges and advantages of working with volunteers during the response phase of this specific disaster?	**Challenges** The coordination and channelling of information are the main challenges. **Advantage** Local volunteer teams usually know the terrain very well. They provides us valuable information about the environment and the terrain. They can help with information that does not appear on the maps. Searches for lost or missing persons can take several days, and volunteers can provide people for several search rounds.
5. Have there been mistakes made during the response phase of the above disaster	The errors commented on were those of communication, and inefficient management of resources, as areas were repeatedly searched due to imprecise reporting of the areas already searched.

event, either by your organisation or in cooperation with others? How can this be avoided in the future?	
6. During your response to the disaster, did you experience unfulfilled needs in terms of technological resources, technical skills, logistics, communication, or reporting either as an organisation or in cooperation with other organisations? Could you please briefly elaborate on the most prominent?	It would have been very useful to have software capable of making track data from different apps and systems compatible with the volunteers' GPS. It would have facilitated the coordination and review of the areas searched by each tracking team. It would also have been desirable to have drones with more flight range, and with more thermal imaging penetration capability. Also the possibility of performing atomic flights in areas of difficult access (e.g. canyon bottoms). It would also have been desirable to have drones with more flight range, and with more thermal imaging penetration capability. Also the possibility of performing atomic flights in areas of difficult access (e.g. canyon bottoms), and the possibility of using artificial intelligence to identify a person's body or personal objects with a previous description.
7. Were there legislation, hierarchal organisational structures, or complex decision-making procedures that may have hindered your response to the disaster?	Currently the response systems for the search of lost or missing persons are based on emergency protocols developed in the Autonomous Communities. These protocols are effective, but sometimes slow. http://www.interior.gob.es/documents/10180/11389243/Informe+Personas+Desaparecidas+2020.pdf/19fca169-a401-432e-928c-a88d23708d04
8. In terms of pre-disaster preparedness for the event you have described, did you cooperate with volunteers, other organisations, professionals, NGOs, or individuals from the wider community? If so, could you please briefly elaborate and list these?	Our team cooperated with civil and governmental organisations: • Firefighters of Madrid Community • Guardia Civil • Police • Civil Protection • Private volunteers • Other NGO
9. Were there any major lessons learned by your organisation in how you responded to the disaster: **a) in order to improve its and/or the community's resilience?** **b) in relation to the SAR proposed technologies and/or Use Cases?**	a) Unification of communications. Unification of location and data management programmes to make the application of procedures and the organisation of search teams more effective. b) Our organisation has improved the mapping and equipment location system, buying new location equipment for rescue dogs and dog guides, and using open map databases.

Did your organisation change or adapt to address challenges over the years, and if so, how?	

Case study: EU-Modex Lisbon 2019	
Questions	**Answers**
1. Can you briefly describe a specific disaster event and your organisation's role in it? What other organisations and professionals did you cooperate with in this response?	**Case description** The EU exercise in the framework of the EU Civil Protection Mechanism major disaster response coordination exercises was held in Lisbon from 4 to 7 November 2019. The overall **objective** of the **European** Civil Protection Modules **Exercises** (**EU Modex**) is to test and train modules and **EU** Civil Protection experts made available by Participating States, in order to prepare them for international operations in the framework of the **European** Civil Protection Mechanism.
2. If the case study / disaster is documented, please provide a relevant reference/link.	https://www.eu-modex.eu/Red/ https://www.securitecivile.be/en/content/european-civil-protection-modules-exercises#:~:text=through%20this%20framework.-,EU%20Modex,the%20European%20Civil%20Protection%20Mechanism
3. What were the major challenges and advantages of working with other SAR organisations and professionals during the response phase of this specific disaster?	**Challenges** The biggest challenges for this type of exercises are usually: • Coordination of teams of different nationalities to improve the European Mechanism's response to disasters • Recognise shortcomings in working procedures and seek effective solutions • To test new technologies in scenarios close to real situations **Advantage** • The possibility of improving response mechanisms • Exchange information between professionals and volunteers working within the same framework • Compare different technologies and techniques that can provide different solutions to common problems
4. What are the major challenges and advantages of working with volunteers during the response phase of this specific disaster?	**Challenges** Level the capacity and the effectiveness of the response of the volunteer and professional teams to better serve the community.

	Advantage Level the capacity and the effectiveness of the response of the volunteer and professional teams to better serve the community.
5. Have there been mistakes made during the response phase of the above disaster event, either by your organisation or in cooperation with others? How can this be avoided in the future?	1. To think that voluntary emergency teams are not capable of responding at the level of professional teams. 2. Ability to maintain good communication with the control centre and other work teams. 3. Lack of technological means to assist in the safety of dogs during search operations
6. During your response to the disaster, did you experience unfulfilled needs in terms of technological resources, technical skills, logistics, communication, or reporting either as an organisation or in cooperation with other organisations? Could you please briefly elaborate on the most prominent?	Lack of technological means to assist in the safety of dogs during search operations: • Inability to detect risks in confined spaces • Inability to reliably locate the dog during work • Inability to know the route of the dog during the search of the structures, to know where it has searched and where it has not.
7. Were there legislation, hierarchal organisational structures, or complex decision-making procedures that may have hindered your response to the disaster?	It's not the case.
8. In terms of pre-disaster preparedness for the event you have described, did you cooperate with volunteers, other organisations, professionals, NGOs, or individuals from the wider community? If so, could you please briefly elaborate and list these?	Teams from all over Europe, both volunteers and professionals, collaborate in this type of exercise. On this occasion we work in collaboration with: • Greece Firefighters • Finland Firefighters • THW Germany • ISAR UK • DSU Romania
9. Were there any major lessons learned by your	a) Need for common and reliable communication systems b) Need for effective means of location for team coordination c) Improvement of portable risk detection systems

organisation in how you responded to the disaster: **a) in order to improve its and/or the community's resilience?** **b) in relation to the SAR proposed technologies and/or Use Cases?** **Did your organisation change or adapt to address challenges over the years, and if so, how?**	

HRT Hellenic Rescue Team

Case study collection template	
Questions	**Answers**
1. Can you briefly describe a specific disaster event and your organisation's role in it? What other organisations and professionals did you cooperate with in this response?	Mountain rescue mission in mount Olympus. A mountaineer was trapped with nowhere to go for 3 days, with very bad weather conditions. We supported the special branch of the Fire Department.
2. If the case study / disaster is documented, please provide a relevant reference/link.	https://www.cnn.gr/ellada/story/89719/exantlimenos-o-roymanos-oreivatis-fotografies-apo-tin-epixeirisi-diasosis-ston-olympo
3. What were the major challenges and advantages of working with other SAR organisations and professionals during the response phase of this specific disaster?	Coordination and time management.
4. What are the major challenges and advantages of working with volunteers during the response phase of this specific disaster?	Challenges: Level of competence, procedures, coordination, number of volunteers Advantages: More people with skills to address the event Allocation of work to more people Easier allocation of areas
5. Have there been mistakes made during the response phase of the above disaster event, either by your organisation or in cooperation with	It was not the case.

others? How can this be avoided in the future?	
6. During your response to the disaster, did you experience unfulfilled needs in terms of technological resources, technical skills, logistics, communication, or reporting either as an organisation or in cooperation with other organisations? Could you please briefly elaborate on the most prominent?	Not knowing the weather conditions in the area. Despite the fact that it was summer, the weather conditions were very bad in the area with extremely strong winds, storms and hail. We also lost the ability to communicate with the person trapped because his phone had not battery left. Creating conditions to communicate quicker and locating the exact position of the trapped person faster
7. Were there legislation, hierarchal organisational structures, or complex decision-making procedures that may have hindered your response to the disaster?	The fire department, as a government authority, was managing the event. We supported decision-making and all procedures whenever necessary.
8. In terms of pre-disaster preparedness for the event you have described, did you cooperate with volunteers, other organisations, professionals, NGOs, or individuals from the wider community? If so, could you please briefly elaborate and list these?	No. HRT were the volunteers in working with the fire department
9. Were there any major lessons learned by your organisation in how you responded to the disaster: **a) in order to improve its and/or the community's resilience?** **b) in relation to the SAR proposed technologies and/or Use Cases?** **Did your organisation change or adapt to address challenges over the years, and if so, how?**	a) We tried to communicate the importance of safety gear and radio equipment when climbing b) SAR equipment might be in a position to increase the efficiency and speed of operations. We always try to take the experience gained from every mission that we take place in order to develop further our operational capability

PROECO

Case study collection template 1 - The explosion in Mihăilești -PROECO	
Questions	**Answers**
1. Can you briefly describe a specific disaster event and your organisation's role in it? What other organisations and professionals did you cooperate with in this response?	1. On May 24, 2004, at 6:53 in Mihăilești commune, Buzău county, on DN2 (segment of the European road E85), 32 kilometres south of Buzău, an explosion occurred due to the accident of a truck transporting 20 tons of ammonium nitrate. 2. A future member of PROECO - a cluster founded in 2016 - participated as a volunteer, being in the area as a tourist. In this response were involved: - the local police; - the crew of military firefighters of the County Inspectorate for Emergency Situations; - local volunteers from Mihăilești commune; - national mass-media.
2. If the case study / disaster is documented, please provide a relevant reference/link.	https://www.google.ro/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwiOoJ2FitfrAhVrAxAIHTIuDjMQFjAAegQIAxAB&url=https%3A%2F%2Fen.wikipedia.org%2Fwiki%2FMih%25C4%2583ile%25C8%2599ti_explosion&usg=AOvVaw1_Ov3yh2Rh90gAmj-BFiDs
3. What were the major challenges and advantages of working with other SAR organisations and professionals during the response phase of this specific disaster?	1. The major challenges were: - the short reaction time available; - coordinating the distribution of tasks taking into account the differences in equipment and training of the participants in the intervention; 2. The advantages of collaboration did not have time to manifest because, between the moment of the fire and the moment of the explosion, about 45 minutes, the intervention forces only had time to enter the intervention device.
4. What are the major challenges and advantages of working with volunteers during the response phase of this specific disaster?	1. Due to the short reaction time available, the volunteers arrived in several stages, their organisation making the intervention practically inefficient.
5. Have there been mistakes made during the response phase of the above disaster event, either by your organisation or in cooperation with others? How can this be avoided in the future?	1. The mistakes made during the response phase of the above disaster event were: - the local police officer did not have a minimum training on the rules of conduct in emergency situations and did not take any measures to evacuate the area from persons other than those necessary for the intervention; - local volunteers, due to the very early morning hours and the lack of the 112 alarm system, arrived very late at the scene of the incident; - the military firefighters, who complied with the intervention procedure, did not have a device for detecting dangerous chemicals to warn them of

	the time left until the ammonium nitrate explosion temperature reached. 2. These mistakes have already been corrected, as follows: - the introduction of hours of practical training in emergency situations for police officers; - equipping the intervention teams of military firefighters with chemical detection equipment at European level; - equipping volunteers with telephones with the emergency number 112 and "RO-Alert" installed.
6. During your response to the disaster, did you experience unfulfilled needs in terms of technological resources, technical skills, logistics, communication, or reporting either as an organisation or in cooperation with other organisations? Could you please briefly elaborate on the most prominent?	At the level of volunteers, the shortcomings were: - lack of personal protective equipment; - lack of chemical detection equipment; lack of a communications system. - lack of specific training of volunteers in case of chemical accidents with dangerous chemicals (until the date of the accident the training was done exclusively to limit the destructive effects of disasters).
7. Were there legislation, hierarchal organisational structures, or complex decision-making procedures that may have hindered your response to the disaster?	The shortcomings were not of a legislative, hierarchal organisational structures or complex decision - making nature. At the level of volunteers and the police, the shortcomings were due to lack of training specific to the type of disaster described above and the lack of means of transmission and chemical detection. At the level of volunteer firefighters, the chemical detection technique appropriate to the typology of the disaster produced was missing.
8. In terms of pre-disaster preparedness for the event you have described, did you cooperate with volunteers, other organisations, professionals, NGOs, or individuals from the wider community? If so, could you please briefly elaborate and list these?	Analysing the characteristics of this disaster, PROECO members, as trainers, have been involved in the last 3 years in preparing the local police for emergencies.
9. Were there any major lessons learned by your organisation in how you responded to the disaster: **a) in order to improve its and/or the community's resilience?** **b) in relation to the SAR proposed technologies and/or Use Cases?**	1. The major lessons are: a) the need to participate, as trainers, in the training of young people in emergency situations; b) the need to participate in European profile projects in order to be up to date with technological developments in the analysed field and to exchange experience with partners from other EU countries. 2. PROECO has adapted and changed according to the specific evolution of emergencies.

Did your organisation change or adapt to address challenges over the years, and if so, how?	The technical-material basis was diversified, especially regarding the chemical, biological and nuclear intervention technique. Similarly, members with an area of expertise covering most S&R-specific missions were co-opted into PROECO.

Case study collection template 2 - railway accident with dangerous toxic substances - PROECO	
Questions	**Answers**
1. Can you briefly describe a specific disaster event and your organisation's role in it? What other organisations and professionals did you cooperate with in this response?	1. On 15.08.2004, at 04.45, the Vrancea County Civil Protection Inspectorate was informed by the service officer of the I.P.J. Vrancea, that in the Gugeşti station there was a railway accident as a result of which a train broke in two, and 3 diesel tank wagons overturned and caught fire. At 07.30 the fire was located by the fire brigades from Focşani, Râmnicu Sărat and the volunteer civil fire brigades from Gugeşti and Coteşti communes. A number of 6 firefighters were injured in the accident. They were completely or partially destroyed 6 tank wagons, about 500 m.l. c.f., 2 track changers, 500 m.l. 27 KW power line, 3 support pillars; 2.Two future PROECO members participated as volunteers, being by chance in the area. In this response were involved: - local police and gendarmes; - the crew of military firefighters of the County Inspectorate for Emergency Situations; - the local firefighters volunteers from Gugești and Cotești communes; - national mass-media; - specialised railway formations.
2. If the case study / disaster is documented, please provide a relevant reference/link.	https://www.google.ro/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwjE08D3i9frAhVowIsKHchJB5MQFjAAegQIBBAB&url=https%3A%2F%2Fwww.hotnews.ro%2Fstiri-arhiva-1260449-tren-plin-benzina-motorina-explodat-gugesti.htm&usg=AOvVaw1qinUIHBksmOolGcY0L9Zm
3. What were the major challenges and advantages of working with other SAR organisations and professionals during the response phase of this specific disaster?	1. The major challenges were: - the short reaction time available; - coordinating the distribution of tasks taking into account the differences in equipment and training of the participants in the intervention. 2.The advantages of collaboration were: - prior to the incident, exercises were conducted that simulated such a disaster with all actors involved;

	- professional and volunteer teams were equipped according to the type of disaster and prepared to deal with such a scenario; - the local administration - the mayor is the head of civil protection - has allocated financial resources for the endowment of voluntary fire brigades and has taken care of their training.
4. What are the major challenges and advantages of working with volunteers during the response phase of this specific disaster?	1. The major challenges are: - ensuring compliance by volunteers with the tasks of the Intervention Plan previously developed in order to limit such railway incidents with dangerous toxic substances; - ensuring flexibility in the execution of the intervention plan in accordance with the changes in the evolution of the operational situation in this particular case. 2. The major advantages are: - the multitude of tasks performed by volunteers (such as: extinguishing the fire, evacuating the population within a radius of 1km around the station, providing logistical services for military and volunteer firefighters); - positive motivation of volunteers, as residents of the affected community, to restore the functioning of an infrastructure that ensures its well-being.
5. Have there been mistakes made during the response phase of the above disaster event, either by your organisation or in cooperation with others? How can this be avoided in the future?	There were no major errors in the execution of the intervention. The only problem was the 100% isolation of the intervention area by the police and gendarmerie. However, cases of non-compliance were isolated, quickly identified and remedied.
6. During your response to the disaster, did you experience unfulfilled needs in terms of technological resources, technical skills, logistics, communication, or reporting either as an organisation or in cooperation with other organisations? Could you please briefly elaborate on the most prominent?	Due to the specificity of the intervention, there were no needs that were not met. In addition to the volunteer firefighters, trained and equipped according to the type of accident, the other volunteers helped to evacuate the population from the area, including the logistical provision of the intervention, having real means to carry it out.
7. Were there legislation, hierarchal organisational structures, or complex decision-making procedures that may have hindered your response to the disaster?	The legislation, hierarchal organisational structures and complex decision-making procedures corresponded to the operational needs that arose in the evolution of the disaster. There were no items to hinder our response to the disaster.

8. In terms of pre-disaster preparedness for the event you have described, did you cooperate with volunteers, other organisations, professionals, NGOs, or individuals from the wider community? If so, could you please briefly elaborate and list these?	Collaboration with volunteers, other organisations, professionals or individuals from the wider community, it was good. In this situation, the community from Gugești showed that it has a good resilience, its activities being restored to normal within 2 days from the disaster.
9. Were there any major lessons learned by your organisation in how you responded to the disaster: **a) in order to improve its and/or the community's resilience?** **b) in relation to the SAR proposed technologies and/or Use Cases?** **Did your organisation change or adapt to address challenges over the years, and if so, how?**	1. The major lessons are: a. the need to participate, as trainers, in increasing the level of training of the volunteer services in emergency situations; b) continued participation in European profile projects in order to be up to date with technological developments in the analysed field and to exchange experience with partners from other EU countries. 2. PROECO has continued to adapt and changed according to the specific evolution of emergencies. The completion of the technical-material base continued, especially regarding the chemical, biological and nuclear intervention technique. Similarly, members with an area of expertise covering most S&R-specific missions were co-opted into PROECO.

Case study collection template 3 - disco fire - PROECO	
Questions	**Answers**
1. Can you briefly describe a specific disaster event and your organisation's role in it? What other organisations and professionals did you cooperate with in this response?	1. The fire in the Colectiv club took place on the night of Friday, October 30, 2015, inside a club located in Bucharest in a former hall of the Pionierul factory. The fire broke out during a free Goodbye to Gravity concert, [7] with the release of a new album called "Mantras of War". The fire was caused by fireworks used during the concert, fireworks that led to the ignition of the polyurethane sponge (slightly flammable) used for soundproofing on a pillar of the building. The flames spread very quickly throughout the club causing injuries - in some cases causing death, by burning, suffocation, carbon monoxide poisoning and other gases, to a significant number of concert participants. Professional intervention crews acted with 75 ISU Bucharest-Ilfov trucks, of which 2 mobile hospitals, 57 SMURD trucks and ambulances, 11 water and foam crews, 3 release crews, 3 crews for transporting multiple victims, 2 crews with escalators, to which were added Police and Gendarmerie cars that ensured the smoothing of traffic for ambulances. A total of 97 people died, 183 injured people were identified, of which 135 were hospitalised.

	2. Two future PROECO members participated as volunteers, being by chance in the area. In this response were involved: - local police and gendarmes; - the crew of military firefighters of the County Inspectorate for Emergency Situations; - SMURD medical emergency service; - Ambulance medical emergency service; - Private medical emergency service; - national mass-media.
2. If the case study / disaster is documented, please provide a relevant reference/link.	https://www.google.ro/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwjw5pydjdfrAhVlwosKHXwYDnkQFjAAegQIARAB&url=https%3A%2F%2Fro.wikipedia.org%2Fwiki%2FIncendiul_din_clubul_Colectiv&usg=AOvVaw1UmBNTAS31bkoDfGhxzAqp
3. What were the major challenges and advantages of working with other SAR organisations and professionals during the response phase of this specific disaster?	1. The major challenges were: - the main priority given to medical triage and the provision of emergency medical care on the spot, stabilisation of victims and emergency transport to hospital; - the very short reaction time available; - coordinating the distribution of tasks taking into account the differences in equipment and training of the participants in the intervention, in closed and small spaces. 2. The advantages of collaboration were: - providing logistical support for professional intervention teams.
4. What are the major challenges and advantages of working with volunteers during the response phase of this specific disaster?	1. The major challenges were: - the voluntary services for emergency situations in Bucharest, due to the short time of manifestation of the disaster, did not have time to intervene. 2.The major advantages were: - occasional volunteers acted at the scene of the fire, many of them without specialised training in S&R. As a result, their help was limited to helping the emergency media services in evacuating the affected people and decongesting the space around the club to allow access to professional training.
5. Have there been mistakes made during the response phase of the above disaster event, either by your organisation or in cooperation with others? How can this be avoided in the future?	Given the specific nature of the disaster, PROECO volunteers did not exceed the skills acquired during the training program. They participated in setting up medical triage points and transporting victims to these points.
6. During your response to the disaster, did you experience unfulfilled needs in terms of technological resources, technical skills, logistics,	In such an incident, unique in the annals of emergency management, it was not found unfulfilled needs in terms of technological resources, technical skills, logistics, communication, or reporting either as an organisation or in cooperation with other organisations. As the time between the first phone call to 112 and the arrival of the first professional teams was only 10 minutes

communication, or reporting either as an organisation or in cooperation with other organisations? Could you please briefly elaborate on the most prominent?	and the duration of the intervention lasted about 30 minutes, the capacity of the intervention, from the perspective of time, voluntary services for emergencies was exceeded, the actions of volunteers being only individual level. This type of disaster has revealed to us the limits of using volunteers in a unique situation.
7. Were there legislation, hierarchal organisational structures, or complex decision-making procedures that may have hindered your response to the disaster?	The legislation, hierarchal organisational structures and complex decision-making procedures corresponded to the operational needs that arose in the evolution of the disaster. There were no items to hinder our response to the disaster. It should be mentioned that the problems were of an administrative nature - the club did not have an operating approval from the military firefighters - and organisationally - the lack of means to fight the fire in the club.
8. In terms of pre-disaster preparedness for the event you have described, did you cooperate with volunteers, other organisations, professionals, NGOs, or individuals from the wider community? If so, could you please briefly elaborate and list these?	In the scenarios based on which intervention exercises are performed, there was no one to simulate the conditions of the incident. This was a shortcoming in the preparation of the intervention forces, regardless of their affiliation.
9. Were there any major lessons learned by your organisation in how you responded to the disaster: **a) in order to improve its and/or the community's resilience?** **b) in relation to the SAR proposed technologies and/or Use Cases?** **Did your organisation change or adapt to address challenges over the years, and if so, how?**	1.The major lessons are: a) understanding the limits of use of volunteers, regardless of their form of organisation. The need to participate, as trainers, in increasing the level of training of the volunteer services in emergency situations; b) continued participation in European profile projects in order to be up to date with technological developments in the analysed field and to exchange experience with partners from other EU countries and in the case of a unique typology of disasters. 2.PROECO has continued to adapt and changed according to the specific evolution of emergencies. The completion of the technical-material base continued, especially regarding the chemical, biological and nuclear intervention technique. Similarly, members with an area of expertise covering most S&R-specific missions were co-opted into PROECO.

Case study collection template 4 - Heavy rainfall in Brașov county -PROECO	
Questions	**Answers**

1. Can you briefly describe a specific disaster event and your organisation's role in it? What other organisations and professionals did you cooperate with in this response?	1. In period 24 - 25.02.2016, massive rain floods took place in the county of Brașov. As a result of the heavy rainfall, a number of 74 properties were affected, 133 yards were flooded, two other localities were left without electricity, 132 people were rescued and 148 people were evacuated. 2. The participation was provided by 2 member of PROECO, as a volunteer, located in the area. In this response were involved: - the local and the traffic police; - the crew of military firefighters of the County Inspectorate for Emergency Situations; - volunteer fire brigades from the communities of Brașov, Săcele, Tărlungeni and Apața; - volunteer teams of local emergency committees from Săcele, Tărlungeni and Apața; - SMURD emergency medical service; - private emergency medical service; - national mass-media.
2. If the case study / disaster is documented, please provide a relevant reference/link.	view-source:http://www.isujbv.ro/comunicate-de-presa-si-buletine-informative/ Website of the Inspectorate for Emergency Situations Braşov - newsletter "floods produced in Braşov municipality and other locations of the county 02.2016".
3. What were the major challenges and advantages of working with other SAR organisations and professionals during the response phase of this specific disaster?	1. The major challenges were: - the short reaction time available; - coordinating the distribution of tasks taking into account the differences in equipment and training of the participants in the intervention; - relocation of evacuees and provision of survival resources; - damage to local infrastructure elements. 2.The advantages of the collaboration were: - all participating forces simulated such a situation through a field exercise a year earlier; - the endowment of the volunteer teams corresponded to the specifics of the disaster; - the information transmission system, including that of the 112 emergency call service, coped with the amount of information transmitted.
4. What are the major challenges and advantages of working with volunteers during the response phase of this specific disaster?	1. The major challenges of working with volunteers during the response phase of this specific disaster were: - avoiding the agglomeration of resources to the needs of an specific affected area; - finding detours to damaged road infrastructure areas; - using the same radio frequency for all forces involved. 2. The major advantages of working with volunteers during the response phase of this specific disaster were: - the volunteers, as members of the same communities, were able to quickly transmit a correct assessment of the effects of the disaster and the needs for intervention;

	- volunteer teams arrived, in most cases, first on the spot, helping to optimise the distribution of professional forces; - the volunteer teams made optimal use of local resources.
5. Have there been mistakes made during the response phase of the above disaster event, either by your organisation or in cooperation with others? How can this be avoided in the future?	1. The mistakes made during the response phase of the above disaster event were: - the voluntary teams of the localised communities had only a completed staff of about 70%; - there was no redistribution of intervention forces that completed the intervention to help other intervention forces still in the works. 2. These mistakes have already been corrected, as follows: - Brașov County Committee for Emergency Situations analysed the situation and took measures to improve existing emergency procedures; - the Local Risk Analysis and Coverage Plans have been adapted to the new operational requirements.
6. During your response to the disaster, did you experience unfulfilled needs in terms of technological resources, technical skills, logistics, communication, or reporting either as an organisation or in cooperation with other organisations? Could you please briefly elaborate on the most prominent?	As volunteers, we did not have unmet needs during the intervention.
7. Were there legislation, hierarchal organisational structures, or complex decision-making procedures that may have hindered your response to the disaster?	The shortcomings were not of a legislative, hierarchal organisational structures or complex decision - making nature that may have hindered your response to the disaster.
8. In terms of pre-disaster preparedness for the event you have described, did you cooperate with volunteers, other organisations, professionals, NGOs, or individuals from the wider community? If so, could you please briefly elaborate and list these?	Following this incident, PROECO members, as trainers, became involved in the operational preparation for volunteer fire brigades.

9. Were there any major lessons learned by your organisation in how you responded to the disaster: **a) in order to improve its and/or the community's resilience?** **b) in relation to the SAR proposed technologies and/or Use Cases?** **Did your organisation change or adapt to address challenges over the years, and if so, how?**	1. The major lessons are: a) the need to participate, as trainers, in the training of young people in emergency situations; b) continued participation in European profile projects in order to be up to date with technological developments in the analysed field and to exchange experience with partners from other EU countries. 2. PROECO has adapted and changed according to the specific evolution of emergencies. Similarly, members with an area of expertise covering most S&R-specific missions were co-opted into PROECO.

Case study collection template 5 - Uncontrolled burning of dry vegetation -PROECO	
Questions	**Answers**
1. Can you briefly describe a specific disaster event and your organisation's role in it? What other organisations and professionals did you cooperate with in this response?	1. Between 01.03.-10.03.2019, on areas of over 20 hectares around the assembled communities of Sibiu County, a number of 25 dry vegetation fires broke out, a substantial increase compared to the same period of 2018, when they were registered. just over 10 fires of dry vegetation. The fires were due to the scorching heat and the human action of burning plant debris, garbage, waste and other combustible materials, without obtaining a fire permit and without taking measures to prevent the spread of fire in the vicinity. A substantial increase compared to the same period of 2018, when there were just over 10 fires of dry vegetation. No casualties were reported, but minor damage was reported. 2. The participation was provided by 1 member of PROECO, as a volunteer, located in the area. In this response were involved: - members of the voluntary emergency service in the affected communities. - the local police; - the crew of military firefighters of the County Inspectorate for Emergency Situations; - employees of the Forest District; - national mass-media.
2. If the case study / disaster is documented, please provide a relevant reference/link.	http://www.isusibiu.ro/comunicate_de_presa/doc/2019/Buletin%20Info%20nr%206%20Ardere%20Veg%20Uscata%2015%2003%202019.pdf
3. What were the major challenges and advantages of working with other SAR organisations and professionals during the response phase of this specific disaster?	1. The major challenges were: - difficult access of personnel and intervention techniques in the affected mountain areas; - coordinating the distribution of tasks taking into account the differences in equipment and training of the participants in the intervention;

	2. The advantages of collaboration were: - the volunteers being from the affected communities, they helped to find solutions for accessing the affected area and using existing local resources; - organizing volunteers in work shifts to ensure the continuity of the fight against fires.
4. What are the major challenges and advantages of working with volunteers during the response phase of this specific disaster?	1. The major challenges of working with volunteers during the response phase of this specific disaster were: - avoiding the agglomeration of resources to the needs of an specific affected area; - finding detours to damaged road infrastructure areas; - knowledge by volunteers of the topography of areas affected by fires . 2. The major advantages of working with volunteers during the response phase of this specific disaster were: - the volunteers, as members of the same communities, were able to quickly transmit a correct assessment of the effects of the disaster and the needs for intervention; - volunteer teams arrived, in most cases, first on the spot, helping to optimise the distribution of professional forces; - the volunteer teams made optimal use of local resources.
5. Have there been mistakes made during the response phase of the above disaster event, either by your organisation or in cooperation with others? How can this be avoided in the future?	No mistakes were made **during the response phase of the above disaster event, either by your organisation or in cooperation with others**
6. During your response to the disaster, did you experience unfulfilled needs in terms of technological resources, technical skills, logistics, communication, or reporting either as an organisation or in cooperation with other organisations? Could you please briefly elaborate on the most prominent?	At the level of volunteers, the shortcomings were lack of sufficient means of communication for the specific information needs of this type of disaster.
7. Were there legislation, hierarchal organisational structures, or complex decision-making procedures that may have hindered your response to the disaster?	There were no shortcomings regarding legislation, hierarchal organisational structures, or complex decision-making procedures that may have hindered your response to the disaster.

8. In terms of pre-disaster preparedness for the event you have described, did you cooperate with volunteers, other organisations, professionals, NGOs, or individuals from the wider community? If so, could you please briefly elaborate and list these?	Following this incident, PROECO members, as trainers, became involved in the operational preparation for volunteers.
9. Were there any major lessons learned by your organisation in how you responded to the disaster: **a) in order to improve its and/or the community's resilience?** **b) in relation to the SAR proposed technologies and/or Use Cases?** **Did your organisation change or adapt to address challenges over the years, and if so, how?**	1. The major lessons are: a) Issuance of a work permit with fire by the mayor, by the head of the voluntary service for emergencies in each community; b) Conduct regular patrols of volunteers from mountain communities to identify people who do not comply with relevant legislation and potential outbreaks. 2. PROECO has adapted and changed according to the specific evolution of emergencies. Specialists in combating this type of disaster were co-opted into PROECO.

PUI

Case study collection template	
Questions	**Answers**
1. Can you briefly describe a specific disaster event and your organisation's role in it? What other organisations and professionals did you cooperate with in this response?	We have deployed an INSARAG classified rescue team to help the victims of the explosion of the ammonium nitrate depot in the port of Beirut. Thus, we collaborated with other international rescue teams for the USAR part and the operations management part (Turkey, the Netherlands, etc.), the Beirut firefighters and the local authorities (Mayor of Beirut, Governor), as well as the Lebanese army and the police.
2. If the case study / disaster is documented, please provide a relevant reference/link.	https://wetransfer.com/downloads/9a74b32214e1607743f465ed066494d120201008173354/ac69b6b1b760f56cf1d4786bda1c367a20201008173412/e953dd

3. What were the major challenges and advantages of working with other SAR organisations and professionals during the response phase of this specific disaster?	It was difficult to implement the operational protocol of INSARAG because the authorities have the authorisation of the installation of RDC (Reception Departure Centre) and the function of the UCC (USAR coordination Cell) was limited; the Beirut firefighters were deeply involved in the rescue operations because of the fact that ten firefighters were died in the explosion and thus the collaboration with them was excellent, so it was possible to have logistical means to move but also to install both our BoO (Base Of Operation) and Command Post. The work with the other rescue teams (Turkey and the Netherlands ..) was very positive as we were able to provide the teams some dogs in the area where the Turkish team was responsible. The advantage of the INSARAG network is that all classified teams have the same protocols and collaborate easily; however, communication between rescue teams by radio, for example, is difficult because we do not have the same communication tools: Only the satellite phone or emails can be used between Command Posts.
4. What are the major challenges and advantages of working with volunteers during the response phase of this specific disaster?	We did not work with volunteers in Beyrouth; However, the advantage of collaborating with them is that the volunteers have a very good knowledge of the areas, local population and they have in general local contacts which can facilitate the logistical support and the safety of the rescue teams; The elected, for example, appreciate that volunteers work with the teams to improve efficiency; the challenge is to supervise these volunteers who are often motivated without having the technical knowledge of emergency services, not even the appropriate equipment and often need professional supervision to act with safety.
5. Have there been mistakes made during the response phase of the above disaster event, either by your organisation or in cooperation with others? How can this be avoided in the future?	There is a confusion about our mission in Beirut firefighters and not a mistake; we didn't explain enough to the Beirut firefighters that we were there to help them and give priority to the firefighter victims of the explosion. They thought that we were not going to work with them so that we were there for them as colleagues to help them save their staff.
6. During your response to the disaster, did you experience unfulfilled needs in terms of technological resources, technical skills, logistics, communication, or reporting either as an organisation or in cooperation with other organisations? Could you	It was not possible to make video streaming with the drone and retransmit the images live because the telephone network and internet were destroyed; we had to copy the drone's video recordings in a USB key and put them to USAR coordination cell in charge of coordinating the emergency services; the mapping format used was not the same for all command structures: we were therefore in contact with the creators of the ICMS (INSARAG Coordination Management System) used by INSARAG in order to ask them of the type of mapping

please briefly elaborate on the most prominent?	format we should use. The very high outside temperature made it difficult to use the thermal camera because the temperature amplitudes were low and thus the contrasts were also very limited. Radio communication between teams was impossible because we could not use the same frequencies;
7. Were there legislation, hierarchal organisational structures, or complex decision-making procedures that may have hindered your response to the disaster?	Lebanon is a complicated country. The local political tensions along with the presence of the army made it difficult to work. When the mayor and the governor took the responsibility into their hands, the coordination was better and facilitated the work afterwards; in addition, the COVID context made the deployment complicated with the obligation to perform 3 COVID PCR tests and follow a strict protocol. The army did not allow the installation of a full DRC or CCU, which made the coordination of the aid very difficult.
8. In terms of pre-disaster preparedness for the event you have described, did you cooperate with volunteers, other organisations, professionals, NGOs, or individuals from the wider community? If so, could you please briefly elaborate and list these?	Although the local firefighters were trained in firefighting, they did not expect such an explosion. The economic crisis affecting Lebanon has caused a lack of materials and training among firefighters. To my knowledge, the population was not prepared and thus they did not have the proper instructions to follow in the case of a technological or chemical accident.
9. Were there any major lessons learned by your organisation in how you responded to the disaster: **a) in order to improve its and/or the community's resilience?** **b) in relation to the SAR proposed technologies and/or Use Cases?** **Did your organisation change or adapt to address challenges over the years, and if so, how?**	a/ The training of populations, first responders and volunteers in this type of accident is necessary: they must receive the instructions to follow in the case of explosion or industrial accident, in particular the populations located near the industrial areas or near the port; instructions must be drawn up and given to each family concerned. The local emergency services must benefit both from the training and the IT tools allowing them to consult files on chemical risks and mobile tools. b/ a video streaming device is necessary for the diffusion of images from the drone live to the command post; it is therefore necessary to have a powerful mobile Wi-Fi router system; the thermal cameras of the drones must function correctly when the outside temperature is very high; a cartographic base must be compatible with several formats. The radio communication is impossible without the same frequencies: A special frequency have to be taken into consideration, a channel reserved for the exchanges between teams, for example in order to inform the teams for a potential danger.

SUMMA

Case study collection template 1 - EXPLOSION IN RECYCLING WASTE FACTORY IN MADRID	
Questions	**Answers**
1. Can you briefly describe a specific disaster event and your organisation's role in it? What other organisations and professionals did you cooperate with in this response?	11.45 am on 4 May 2017. Explosion in recycling waste factory in Arganda del Rey (20 km from Madrid). SUMMA112 has a Mobile Advanced Life Support Unit in that municipality that acted as first responder along with firemen. While they were carrying out the triage work outside the hot zone there is a second explosion where firemen are affected, and the expansive wave reaches slightly the sanitary resource (mobile advance life support of SUMMA112) 2. The organisations involved were: -Local Politics -Civil Guard -Firefighters -SUMMA112: vehicle of the head of the guard, medical helicopter, 6 mobile UVIs, disaster vehicle, 5 basic life supports (conventional ambulances) Civil protection: 2 basic life supports (conventional ambulances).
2. If the case study / disaster is documented, please provide a relevant reference/link.	https://www.elconfidencial.com/espana/madrid/2017-05-04/explosiones-fabrica-disolventes-arganda-madrid_1377225/
3. What were the major challenges and advantages of working with other SAR organisations and professionals during the response phase of this specific disaster?	1. The main challenges were: - the coordination of the distribution of tasks considering the differences in equipment and training of the participants in the intervention. -The second explosion forced new decisions on the perimeter and distribution of resources, as well as a new triage. The emotional burden of knowing that a partner has been a victim in the incident 2-The advantages of the collaboration were the high number of resources that facilitated the rapid evacuation of the seriously ill and other victims
4. What are the major challenges and advantages of working with	1. The advantage of the volunteers (civil protection) is that they facilitate the triage by taking care of the greens (when triage is carried out) and reassessing them in

volunteers during the response phase of this specific disaster?	addition to carrying out evacuation work, also with minor illnesses, on the evacuation wheel. 2-The greatest difficulties are found in their welfare actions since they do not have the individual protection equipment that other organisations such as Summa, firefighters ...
5. Have there been mistakes made during the response phase of the above disaster event, either by your organisation or in cooperation with others? How can this be avoided in the future?	1-Despite the fact that the perimeter of the hot zone was very wide, the second explosion affected professionals who were outside it. If it could have been foreseen with technology (drones with chemical sensors...) the security perimeter would have been extended. 2-In the evacuation, the person in charge of the list where the patient is registered to which hospital he goes and in which resource not only write down the card number but IF HE IS AWARE also fills in his name and surname for a better follow-up in the hospital
6. During your response to the disaster, did you experience unfulfilled needs in terms of technological resources, technical skills, logistics, communication, or reporting either as an organisation or in cooperation with other organisations? Could you please briefly elaborate on the most prominent?	-The technological resources discussed in the previous point were missed. It is important to have sensors that access and inform us of the risks of new explosions and their scope. -Otherwise, the work was good. Communications were good. When the professionals were affected by the second explosion, they communicated with the coordinating centre through tetra, which was very useful. - Coordination with other organisations was good. It would be good to have a meeting with the heads of each organisation to discuss improvements in coordination
7. Were there legislation, hierarchal organisational structures, or complex decision-making procedures that may have hindered your response to the disaster?	The shortcomings were not of a legislative nature, nor were there any complex organisational or decision-making structures. At the level of volunteers and the police, the deficiencies were due to the lack of specific training for the type of disaster described above and the lack of means of transmission and chemical detection. At the level of firefighters, there was a lack of chemical detection techniques appropriate to the type of disaster produced or a more accessible and rapid type of detector.

8. In terms of pre-disaster preparedness for the event you have described, did you cooperate with volunteers, other organisations, professionals, NGOs, or individuals from the wider community? If so, could you please briefly elaborate and list these?	We have previously worked with the following organisations carrying out manoeuvres and training: -Firefighters -Police -Civil protection and volunteers
9. Were there any major lessons learned by your organisation in how you responded to the disaster: **a) in order to improve its and/or the community's resilience?** **b) in relation to the SAR proposed technologies and/or Use Cases?** **Did your organisation change or adapt to address challenges over the years, and if so, how?**	1. The major lessons are: - The need to introduce technological means, sensors... that give us a clear vision of the magnitude and danger of the disaster to prevent second explosions that could affect the first responders The need for more training between different organisations to make communications more fluid. - The need for meetings between the heads of each organisation to give feedback on the interaction between them and propose improvements. 2- SUMMA112 participates in various European projects on disasters and catastrophes in order to keep up to date with technological, training and organisational resources for intervention in a disaster.

Case study collection template 2- PEPPER GAS POISONING	
Questions	**Answers**
1. Can you briefly describe a specific disaster event and your organisation's role in it? What other organisations and professionals did you cooperate with in this response?	it was pepper gas poisoning. 12 people were poisoned in a lunchtime by inhaling an irritant gas at a Social Security office in Madrid's Carabanchel district. The community emergency telephone 112 received a call at 12.36 hours warning that people in the Carabanchel area of an office were beginning to feel a scratchy throat, crying and itching. Two Summa Units and the Municipality Fire Brigade arrived at the place and cleared the building.

	The Emergency Medical Service of Madrid SUMMA112 is part of the Emergency Coordination Centre 112, common to the whole community of Madrid, The coordinating doctor, responsible for receiving the initial help call at the Centre, assigned two specific two advanced life support units of SUMMA 112 from that area, the doctors, nurses and emergency technicians with electro medicine, capnography and pulse oximetry confirmed the state of the victims.
2. If the case study / disaster is documented, please provide a relevant reference/link.	http://www.telemadrid.es/noticias/madrid/Doce-intoxicados-inhalar-irritante-Carabanchel-0-1920108013--20170711052619.html
3. What were the major challenges and advantages of working with other SAR organisations and professionals during the response phase of this specific disaster?	The challenges were to achieve adequate communication and synchronisation between the health team and the fire brigade so that the action would be as safe and rapid as possible, ruling out risks in the joint action of assistance to the victims
4. What are the major challenges and advantages of working with volunteers during the response phase of this specific disaster?	In the Community of Madrid, during the initial emergency action, except for disasters of major cause that exceed the usual emergency assets (which are many, given the population of the city of Madrid), Madrid has two professional emergency health services, usually active with doctors, nurses and technicians in both institutions, so disasters are the situations when there is more interaction with volunteer staff, it would always be convenient to have more training to improve joint action and efficient and decisive communication in these situations.
5. Have there been mistakes made during the response phase of the above disaster event, either by your organisation or in cooperation with others? How can this be avoided in the future?	The mass victim procedure was not applied. This can be avoided in the future By carrying out more training so that this type of procedure can be activated from the very beginning
6. During your response to the disaster, did you experience unfulfilled needs in terms of technological resources, technical skills, logistics, communication, or reporting either as an organisation	The report that was produced describes problems in acting on the procedure, but there is no subsequent debriefing and no cause and effect relationship as to why the multi-victim procedure was not activated. The triage cards for the multiple victim incident were not used, nor was the identification of the victims to be sent to the

or in cooperation with other organisations? Could you please briefly elaborate on the most prominent?	health care team coordinating the incident, so the filiation/identification of the victims was not notified to the coordinating centre and head of duty in time.
7. Were there legislation, hierarchical organisational structures, or complex decision-making procedures that may have hindered your response to the disaster?	Yes, the procedure for discerning the cause of poisoning (possible pepper gas) delaying contact between health personnel and victims until the safety perimeter is confirmed.
8. In terms of pre-disaster preparedness for the event you have described, did you cooperate with volunteers, other organisations, professionals, NGOs, or individuals from the wider community? If so, could you please briefly elaborate and list these?	There was no pre-disaster preparation, it was a densely populated area, and there was little prospect of such an incident
9. Were there any major lessons learned by your organisation in how you responded to the disaster: **a) in order to improve its and/or the community's resilience?** **b) in relation to the SAR proposed technologies and/or Use Cases?** **Did your organisation change or adapt to address challenges over the years, and if so, how?**	Multiple-victim incident practices are conducted annually, so this procedure is practiced usually. Training is also given on the agile use of triage cards during this type of incident, and the collection of data and filiation, in the chaos that is possible, as well as the maintenance of the data on the triage card, with the same purpose. The use of sensors by the health care team furthermore the fire brigade would also be of interest, in order to reduce the time required for action.

Case study collection template 3- SMOKE, BLEACH AND AMMONIA POISONING	
1. Can you briefly describe a specific disaster event and your organisation's role in it? What other organisations and professionals did you cooperate with in this response?	15 December 2019. Fire in a house in the outskirts of Madrid that finally affects 4 blocks of houses. There is also ammonia and bleach poisoning. There are 13 light and 4 moderate victims. The SUMMA112 is in charge of activating and coordinating the multiple victim incident. It works together with:

	-Firefighters -Local and national police -Civil protection (volunteers)
2. If the case study / disaster is documented, please provide a relevant reference/link.	http://www.madrid.org/112/index.php/actualidad/noticias-de-emergencias-blog/363-incendiocoslada
3. What were the major challenges and advantages of working with other SAR organisations and professionals during the response phase of this specific disaster?	The main challenge was communication between the different organisations, unifying for all the organisations the use of personal protective equipment and the risk forecast to perimeter the safe area (there was an intense smell of ammonia and the type of substances involved could not be quantified due to lack of technical means).
4. What are the major challenges and advantages of working with volunteers during the response phase of this specific disaster?	-Disadvantages: Inadequate knowledge and training of volunteers in multi-victim incident protocols. Lack of availability of appropriate EPIs - Advantages: Great help in triage to take care of minor patients (green) and evacuation of patients
5. Have there been mistakes made during the response phase of the above disaster event, either by your organisation or in cooperation with others? How can this be avoided in the future?	The errors to be mentioned were: - It was not possible to make a forecast of chemical or biological watering because there was no access to the house, although there was a strong smell of ammonia. - One of the resources did not use the right mask (it used an FFP2 instead of FFP3) due to the lack of knowledge of the chemical risk. - The safety distance was not marked. - The "multiple victim incident" protocol is not activated until the SUMMA112 chief of guard arrives at the incident. Communication with the coordinating centre was complicated in order to activate it earlier.
6. During your response to the disaster, did you experience unfulfilled needs in terms of technological resources,	Technological devices with sensors that could have estimated the chemical risk substances involved in the incident would have been needed.

technical skills, logistics, communication, or reporting either as an organisation or in cooperation with other organisations? Could you please briefly elaborate on the most prominent?	After the incident there was a debriefing of all summa 112 resources involved in the incident that was very instructive. Debriefing should be done between the different organisations that participated in the incident
7. Were there legislation, hierarchal organisational structures, or complex decision-making procedures that may have hindered your response to the disaster?	The shortcomings were not of a legislative nature, nor were there any complex organisational or decision-making structures. At the level of volunteers and the police, the deficiencies were due to the lack of specific training for the type of disaster and the lack of means of transmission and chemical detection. At the level of firefighters, there was a lack of chemical detection techniques appropriate to the type of disaster produced or a more accessible and rapid type of detector.
8. In terms of pre-disaster preparedness for the event you have described, did you cooperate with volunteers, other organisations, professionals, NGOs, or individuals from the wider community? If so, could you please briefly elaborate and list these?	We have previously worked with the following organisations carrying out manoeuvres and training: -Firefighters -Police -Civil protection and volunteers. -Emergency Military Unit (UME).
9. Were there any major lessons learned by your organisation in how you responded to the disaster: **a) in order to improve its and/or the community's resilience?** **b) in relation to the SAR proposed technologies and/or Use Cases?** **Did your organisation change or adapt to address challenges over the years, and if so, how?**	The conclusions reached after this incident were: -Communications between the various organisations involved must be improved. - There is a need for new technologies that can access the area of the incident to make the risk of the incident more accurate (and safe). - If there are doubts about the type of chemical/biological risk always use the highest level of personal protective equipment. - It is important to train and provide adequate material to volunteers (civil protection). -AFTER the incident, it is very important to carry out debriefings between the organisations involved and

	between the different organisations (fire brigade, health service, police, volunteers, etc.) - The SUMMA112 Chiefs of Duty make reports of the multiple victim incidents in which they intervene with input on potential failures and proposals for improvements.

Case study collection template 4 - Toluene (glue vapour) poisoning in a building in Madrid	
1. Can you briefly describe a specific disaster event and your organisation's role in it? What other organisations and professionals did you cooperate with in this response?	17/07/2020, Intoxication of 5 people by toluene. Workers were renovating a house and the glue fumes they used caused the poisoning. He participated in the intervention: -SUMMA112 -Police -Firefighters -Civil protection
2. If the case study / disaster is documented, please provide a relevant reference/link.	https://www.lavanguardia.com/local/madrid/20200717/482343677952/heridos-graves-dos-trabajadores-intoxicados-en-un-sotano-por-los-vapores-de-un-pegamento.html
3. What were the major challenges and advantages of working with other SAR organisations and professionals during the response phase of this specific disaster?	The main challenge was communication between the different organisations, unifying for all the organisations the use of personal protective equipment and the risk forecast to perimeter the safe area (there was an intense smell of ammonia and the type of substances involved could not be quantified due to lack of technical means).
4. What are the major challenges and advantages of working with volunteers during the response phase of this specific disaster?	Although in the Community of Madrid there is a protocol unified by the PLATERCAM law, the lack of training for volunteers makes it difficult to intervene.
5. Have there been mistakes made during the response phase of the above disaster event, either by your organisation or in cooperation	Use of appropriate personal protective equipment by all participants

with others? How can this be avoided in the future?	
6. During your response to the disaster, did you experience unfulfilled needs in terms of technological resources, technical skills, logistics, communication, or reporting either as an organisation or in cooperation with other organisations? Could you please briefly elaborate on the most prominent?	In this incident firemen had good access, although having technology that can enter the hot spot without a rescuer entering is very important
7. Were there legislation, hierarchal organisational structures, or complex decision-making procedures that may have hindered your response to the disaster?	The shortcomings were not of a legislative nature, nor were there complex organisational or decision-making structures. At the level of volunteers and police, the shortcomings were due to the lack of specific training for the type of incident.
8. In terms of pre-disaster preparedness for the event you have described, did you cooperate with volunteers, other organisations, professionals, NGOs, or individuals from the wider community? If so, could you please briefly elaborate and list these?	We have previously worked with the following organisations carrying out manoeuvres and training: -Firefighters -Police -Civil protection and volunteers
9. Were there any major lessons learned by your organisation in how you responded to the disaster: **a) in order to improve its and/or the community's resilience?** **b) in relation to the SAR proposed technologies and/or Use Cases?**	The conclusions that emerged from this incident: - Need for technologies that access the hot zone before the first responders. - Proper use of personal protective equipment (when in doubt always use the highest level) - To know the way of work/technologies that are carried out in other countries through the European projects

Did your organisation change or adapt to address challenges over the years, and if so, how?	

Case study collection template 5- Chlorine Leakage	
1. Can you briefly describe a specific disaster event and your organisation's role in it? What other organisations and professionals did you cooperate with in this response? 	The event, according to information from the Emergency Service 112 of the Community of Madrid, originated when sodium hypochlorite and hydrochloric acid were mixed, forming a mixture of 50 litres of volume with this solution, which caused a chlorine leak, in a gaseous state (cloud), within the installations of a private swimming pool, in the municipality of Mostoles on 11 July 2017. The emergency services received a warning at 5.23 PM and SUMMA 112 teams went to the scene, together with the local police of Mostoles, the Fire Department of the Community of Madrid and the Fire Department of the Town Hall of Mostoles, who collaborated in the removal of the chlorine can, the origin of the accident. SUMMA forms part of the Integrated Emergency System 112 of the Community of Madrid, is responsible for emergency healthcare in the Community of Madrid and provides these services through the coordinating healthcare personnel, who work online within the Emergency Coordination Centre of the Community of Madrid 112. SUMMA also includes the primary care emergency services, which are coordinated by the SUMMA112 emergency health care system, and more than 30 advanced life support systems, between air and land. In this case, following the call from the pool alert, the call was answered in the Coordination Centre, first by an announcer, and then by a SUMMA Medical Coordinator in the same regulatory centre. The doctor, after assessing the situation, designated the necessary resources to cover the incident. In this incident, two SUMMA Rapid Intervention Vehicles were activated with two doctors, two nurses and two technicians, all from SUMMA, four basic life support Units and the SUMMA chief on duty.

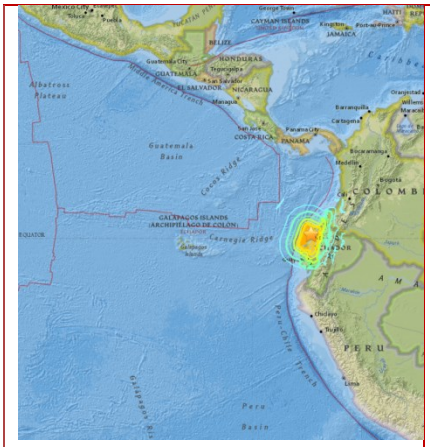
	The initial alert concluded with coordination with the hospitals *(useful centres) to which the patients were transferred, and which were coordinated by SUMMA112 Nurse Regulators. Due to this toxic cloud, 17 people were affected, 10 of whom were transferred to various hospitals - all of them with minor injuries - while the rest were treated in a field hospital on the street, as confirmed by the SUMMA chief of duty. Most of the injured were of a mild nature, with symptoms of respiratory failure and irritation. The SUMMA112 also activated its special disaster vehicle, with which it formed a campaign hospital. This hospital took in the injured until they were transferred to different hospitals. Two men of 39 and 49 years old and a child of 8 were transferred to the Hospital Rey Juan Carlos in Mostoles. Two women of 41 and 35 years old and a girl of 6 were evacuated to Fuenlabrada; another woman of 48 years old and a boy of 15 months old to the University Hospital of Móstoles, and a boy of 10 years old and a girl of the same age to the Hospital of Alcorcón.
2. If the case study / disaster is documented, please provide a relevant reference/link.	http://www.actualidad21.net/intoxicadas-17-personas-entre-ellas-varios-menores-tras-un-escape-de-cloro-en-una-piscina-de-mostoles/ https://youtu.be/L5dlmQRZ_pM, https://youtu.be/9GEvWtMY0y4 http://www.telemadrid.es/noticias/madrid/escape-cloro-intoxicados-piscina-Mostoles-0-1920108021--20170711074234.html https://youtu.be/lHFH99Io3LU
3. What were the major challenges and advantages of working with other SAR organisations and professionals during the response phase of this specific disaster?	In this case, as a toxic cloud was produced, it was the firemen, who having CBRN personal protective equipment, with isolation from the airway, entered the toxic epicentre, where the dilution that was causing the toxic cloud was and contained the expansion of the cloud, delimiting the liquid in a container suitable for this dilution. The firemen team measured the concentration of the gas, and the ph. of the resulting mixture. Later, they diluted the content of the drum in the pool, where they started the treatment plant and gradually controlled the ph.

	This material and these actions were necessary to solve the technical part of the problem that caused the incident. The SUMMA112 personnel took care of the health care of the victims, of setting up the campaign hospital, and coordinated and realised the evacuation of those affected to a useful centre. The challenge was to communicate with the fire team while they were wearing the CBRN equipment, as it makes communication difficult, and organise so many victims with a pragmatic logistic
4. What are the major challenges and advantages of working with volunteers during the response phase of this specific disaster?	In this case, the emergency personnel who responded to this incident were professional teams, so there were no volunteers.
5. Have there been mistakes made during the response phase of the above disaster event, either by your organisation or in cooperation with others? How can this be avoided in the future?	There was a delay by SUMMA112 in activating the Multiple Victim Incident procedure. Normally, the electronic medical record is used to record the attendance of the patients attended by SUMMA112, but in Multiple Victim Incidents where it is necessary to act quickly and to triage patients with a different order of action than usual, plastic-coated paper triage cards are used, which allow for agility in registration and physical organisation when there is a large group of patients to be attended. In this case, the use of triage cards is not activated from the beginning.
6. During your response to the disaster, did you experience unfulfilled needs in terms of technological resources, technical skills, logistics, communication, or reporting either as an organisation or in cooperation with other organisations? Could you please briefly elaborate on the most prominent?	Yes, in relation to technological resources, it would have been desirable that SUMMA personnel could also have had the specific sensors for this type of situation, as well as the triage sheets being available via telematics. Likewise, CBRN suits are very useful for their purpose, which is to protect professionals, but they are not focused on facilitating communications. There would also have been more complete learning from the event when sharing reports from all professionals, both firefighters and police and health personnel, in order to draw lessons learnt.
7. Were there legislation, hierarchal organisational structures, or complex decision-making procedures that may have hindered your response to the disaster?	More than complex procedures, what happens in this type of situation is that the tetra radio system used for communications, because it is safer, implies as well a traditional reception and sending of oral messages between professionals, while requiring another extra time to write down what has been communicated orally with all

<table>
<tr><td></td><td>the details that have been notified by spoken message, and confirmation that the sender and receiver data correspond to previous in the different communications, related to the state of the situation, seriousness and measures to be taken with the patients, and finally confirmation of the sending of patients to the different hospitals useful for the patients.</td></tr>
<tr><td>8. In terms of pre-disaster preparedness for the event you have described, did you cooperate with volunteers, other organisations, professionals, NGOs, or individuals from the wider community? If so, could you please briefly elaborate and list these?</td><td>Regarding the previous preparation for this event, it would be desirable that we could carry out simulations of CBRN incidents, in order to speed up the joint action of all stakeholders. The performance of SUMMA has improved, from years ago, because specific training for this type of incident has been carried out with the Military Emergency Unit, but it would be desirable to carry out more joint simulations with all those who are involved at any given time due to their proximity, that is, it would be interesting to carry out joint simulations with the police and the fire brigade, who are usually the ones we work with most frequently in these incidents in the Community of Madrid, including the Military Emergency Unit, also when the disasters exceed the resources available to us in the Autonomous Community, according to the PLATERCAM law.</td></tr>
<tr><td>9. Were there any major lessons learned by your organisation in how you responded to the disaster:
a) in order to improve its and/or the community's resilience?
b) in relation to the SAR proposed technologies and/or Use Cases?
Did your organisation change or adapt to address challenges over the years, and if so, how?</td><td>Three degrees or levels of activation of the resources are defined to face mass casualty assistance.
In the attached table, an estimate of the initial resources required based on the number of victims is made, although it will be the Head of physicians on call who activates more or less resources based on the evaluation at the scene of the incident.
<table><tr><th>LEVEL</th><th>TOTAL ESTIMATED VICTIMS</th><th>ALS VICTIMS</th><th>INITIAL RESPONSE</th></tr><tr><td>0</td><td>10</td><td>2-3</td><td>1 ALS (UVI, VIR O MH) + 2 BLS + VEC</td></tr><tr><td>1</td><td>10-100</td><td>15%</td><td>2 ALS + 4 BLS + VEC + MIR</td></tr><tr><td>2</td><td>100-500</td><td>15%</td><td>4 ALS + 8 BLS + VEC + MIR</td></tr><tr><td>3</td><td>>500</td><td>15%</td><td>6 SVA + 12 BLS + MIR</td></tr></table>
In case of more than one focus, or CBRN risk, the initial level will be established as a level two.</td></tr>
</table>

	• ALS: Advanced Life Support (Air or Ground Ambulance) • UVI: with physician, emergency nurses and two emergency technicians. • VIR: with physician, emergency nurses and one emergency technician. • MH: Medical Helicopter: 1- SUMMA 01: with emergency physician, emergency nurses and emergency technicians. 2- SUMMA 02: with emergency physician, emergency nurses and two emergency technicians. • BLS: Basic Life Support, with two emergency technicians. • VEC: Special Disaster Vehicle, with two emergency technicians. • MIR: Rapid Intervention Module, with two emergency technicians, with special training such as aquatic rescue and CBRN risk. • Special ALS: special vehicle for biological risk formed by the biological risk group: emergency physician, emergency nurse and emergency technicians and coordinator. All with specific training in special situation there can be up to three ALS, basics and other collective ambulances. Nowadays there a special vehicle only specific for communications in catastrophes or mass victims' incidents, to solve the difficulties of transmission of date and messages in adverse circumstances for usual units

Case study collection template 6- EARTHQUAKE IN ECUADOR	
1. Can you briefly describe a specific disaster event and your organisation's role in it? What other organisations and professionals did you cooperate with in this response?	An earthquake of magnitude 7.8 occurred on Saturday 16 April at 6.58 pm with an epicentre in Pedernales, Manabí province, in the northwest of Ecuador. In view of the magnitude of the catastrophe, international assistance was requested and the two Spanish Urban Search and Rescue Teams ERICAM and UME, accredited by INSARAG were activated, on behalf the OSOOC: Virtual On-Site Operations Coordination Centre https://vosocc.unocha.org/ Both groups have the necessary qualification and validation of INSARAG and the UN to intervene in major international catastrophes. Both teams are medium size because of the logistic capacity, work capacity and self-sufficiency in energy, food and water,



Regardless of their size , all of them must have at least one doctor and one nurse although their operation increases as the group becomes more numerous, with the group also having emergency technicians.

GOALS

USAR groups are responsible for the search and rescue of possible survivors buried in the rubble of an urban catastrophe. It also deals with their sanitary treatment. They also offer help to the population and perform reconnaissance and shoring of buildings damaged by seismic movement or other disaster.

All groups are made up of rescue personnel – firefighters, telecommunications specialist, logistics expert and health personnel. The material that is to be taken to the mission is:.

MATERIAL

For logistics' sake a list of all the material is kept, with its specific location in each transport container, and with marking and weight control of each one. It also has to be assessed that being a medium equipment to use, water and food to supply each team for 7 days must be carried.

Regarding communications, the necessary material to set up a coordination centre was included in case there was none before, at the time of arrival at the disaster zone. There are also radio systems in case the usual communications remain inoperative after the catastrophe, in addition to autonomous electricity systems and satellite communication. To be able to locate people trapped in a collapsed structure, geophones must be taken. They are seismic sensors that detect the presence of victims and precisely locate their location under the ruins. Telescopic poles with a search camera must be also included to allow communication with the injured through the rubble.

Together with the group there are two canine guides with dogs trained to search for both living and deceased victims.

For the extrication of patients: There is a complete range of material that includes radial and holes for drilling walls and debris, for cutting, shoring, and lifting loads in case of complex rescue situations.

Taking into account that there is the possibility of encountering polytraumatised patients, we have complete immobilisation material: collars, limb splints, spinal board and a Kendrick device. As transport material canvases and stretchers are included.

The material for height rescue, such as harness kits, pulleys, sealers, winches, tripods, rappel belts are brought.

The sanitary personnel must cart the following material:

- Electro medicine equipment: defibrillator monitor, pulse oximeter-capnography and portable volumetric respirator next to an oxygen bullet.
- Medication case with serum therapy, material for minor surgery and emergency assistance in incidents of multiple victims.

Apart from two sanitary containers, for an advanced medical post, each member must carry catastrophe intervention backpacks that contain the sanitary products and material for initial triage and respiratory and intravenous emergency treatment.

Finally, the equipment comprises treatment for patients with possible crushing syndromes, compartment syndrome and possible amputations (guidelines of the WHO Guidelines for these cases).

On 18 April the groups USAR ERICAM and UME were activated. We were given two hours to be on our way to the meeting point of the operation, and soon after that we were moving the material to the truck to take it to the military airport of Torrejón de Ardoz.

The departure to Ecuador lasted until April 29th, we went together with UME, with whom we were working as a team.

We carried out several search operations in the towns of Canoa and Manta. It had been more than four days since the earthquake, although there were still aftershocks.

	
2. If the case study / disaster is documented, please provide a relevant reference/link.	https://www.worldvision.org/disaster-relief-news-stories/2016-ecuador-earthquake-facts https://www.comunidad.madrid/notas-prensa/2016/04/20/ericam-ya-trabaja-manta-canoa-oeste-ecuador
3. What were the major challenges and advantages of working with other SAR organisations and professionals during the response phase of this specific disaster?	ERICAM and UME had never worked together on an international assignment before, so it was enriching to work together. We had to wait one day at the airport in Ecuador until we could start our work, several days had already passed since the earthquake, the difficulty of communication meant that we had to move both teams to different cities without being able to do useful work initially and in turn gradually reduced the chances of finding people alive behind the rubble. There were moments of difficulty, we found ourselves against improvised barricades by the citizens to get water and food. ERICAM benefited from going with the UME because they carried defence weapons. It was a challenge to coordinate to make synergy. On the fifth day we rescued medical and electro medical equipment from the Chone General Hospital. The workers of the hospital were on the street, they had hardly been able to extract electromedicine material to be able to attend the patients, so we helped their autonomy, within a situation of great lack of economic resources for them (the value of the rescued material exceeded one million dollars) There was hardly any possibility of rescuing people from the rubble, but we helped the citizens in this other way
4. What are the major challenges and advantages of working with volunteers during the response phase of this specific disaster?	The main challenges are to build a excellent organisation in terms of both tasks and data provided by all the teams to achieve effective and efficiency-based operations.

	It was an advantage that there were many teams wanting to help, it needs very good organisation to make everyone operational
5. Have there been mistakes made during the response phase of the above disaster event, either by your organisation or in cooperation with others? How can this be avoided in the future?	If our organisation was delayed because of the difficulty of obtaining permission to work in a foreign country with coordination issues after suffering an earthquake, preparing procedures to be able to work in the future by means of simulations as real as possible, will allow us to resolve the difficulties that arise when the catastrophe actually occurs
6. During your response to the disaster, did you experience unfulfilled needs in terms of technological resources, technical skills, logistics, communication, or reporting either as an organisation or in cooperation with other organisations? Could you please briefly elaborate on the most prominent?	Yes, it would have been convenient to have more technological resources to help coordination and communication with the rest of the organisations that attended the catastrophe
7. Were there legislation, hierarchal organisational structures, or complex decision-making procedures that may have hindered your response to the disaster?	Yes, there was a lot of bureaucracy that delayed our action for many hours, making it difficult for us to operate in the field
8. In terms of pre-disaster preparedness for the event you have described, did you cooperate with volunteers, other organisations, professionals, NGOs, or individuals from the wider community? If so, could you please briefly elaborate and list these?	ERICAM, like the other USAR groups, requires specific periodic training and passing an exam with INSARAG to continue to be accredited as an International Urban Rescue Group. This test is held every five years, and ERICAM was last examined in May 2016. It had to undergo a review of its facilities by external European auditors (INSARAG base is in Geneva) and also had to pass activation and action in the face of a supposed hurricane in Germany. In addition to the initial action as an urban rescue team; when the first ones arrived at the disaster area, the ERICAM group organised the coordination centre (OSOCC) and the reception and departure centre for USAR teams (DRC). Furthermore, ERICAM as an INSARAG certified USAR team has completed the UN BSITF (Basic Security In the Field) Course for all our personnel, and a specific course for UNDAC for the heads of the team.

	https://www.unocha.org/our-work/coordination/un-disaster-assessment-and-coordination-undac/undac-methodology-and-training#:~:text=UNDAC%20training%20consists%20of%20the,that%20they%20sign%20the%20contract.
9. Were there any major lessons learned by your organisation in how you responded to the disaster: a) in order to improve its and/or the community's resilience? b) in relation to the SAR proposed technologies and/or Use Cases? Did your organisation change or adapt to address challenges over the years, and if so, how?	a)Yes, autonomy is required on the internet lines when there is a possibility of it, because otherwise, communication is very difficult, both between expatriate organisations and with the institution itself in the country of origin. b) Sensors would be useful for the security of the team, and communication tools would be very useful as well for getting advanced information, in terms of the hazards and other relevant information. Training and communication tools are also very important to get synergy and efficiency between all stakeholders of a catastrophe.

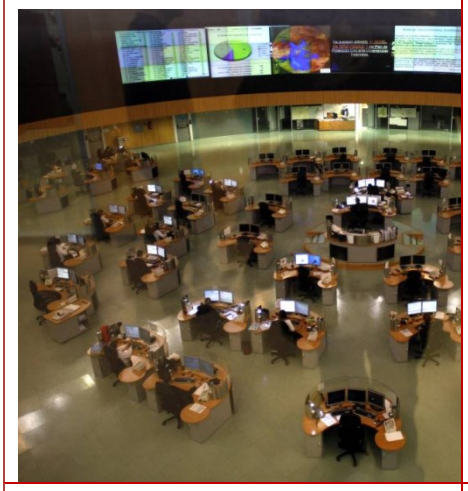
Case study collection template 7- `Unforeseen preventive coverage´	
1. Can you briefly describe a specific disaster event and your organisation's role in it? What other organisations and professionals did you cooperate with in this response?	In SUMMA 112, there has been described to types of coverage that our organisation offers depending if it is an anticipated or an unforeseen coverage. The difference is that in the first one SUMMA 112 has the knowledge of a risk event that may cause sanitary demand and in the second one it is not predicted. Depending on the type of coverage evaluated, SUMMA 112 usually activates a basic life support or an advanced life support. It was the 22nd of December 2019. In this case it was an unforeseen preventive coverage due to an explosion in a pharmaceutical industry (Química Sintética S.A) near the town Alcalá de Henares, Madrid. The initial alert is at 6:14h. SUMMA 112 guard chief (which concerns a doctor) activates the critical care mobile unit in Alcalá de Henares (advanced life support), 1 basic life support unit, the logistic vehicle and the watch supervisor (which concerns a nurse), the firemen, local and national police and Spanish red cross with another basic life support. At 6:20h multiple victims procedure is activated by the guard chief, when she gets the information of an explosion taken place in a chemical industry nearby the population.
2. If the case study / disaster is documented, please provide a relevant reference/link.	http://www.telemadrid.es/programas/buenos-dias-madrid/Vecinos-Alcala-empresa-accidente-Tarragona-2-2197900200--20200123091214.html
3. What were the major challenges and advantages of working with other SAR organisations and professionals during the response phase of this specific disaster?	In this case the explosion did not reached finally the population, so there were only 2 victims who needed medical assistance, but fortunately they were discharged were the incident took place. The communications between firemen, local and national police were successful, and the procedure was followed correctly.

4. What are the major challenges and advantages of working with volunteers during the response phase of this specific disaster?	In this case, as there were no victims, volunteers stayed listening until instructions were transmitted for them. No patients needed to be transported to hospitals. The major challenge was to wear portable or wearable sensors to detect as soon as possible what type of chemical substance had been released.
5. Have there been mistakes made during the response phase of the above disaster event, either by your organisation or in cooperation with others? How can this be avoided in the future?	What supposes more challenge in our organisation while working with other SAR groups is: --Communications, as we don't use the same technological devices. -- During the approach phase, get the information as much as coordinated as possible so that SUMMA 112 resources take into account the wind, the toxic cloud and the point where the intervention group (firemen usually) established the secure zone. This can be avoided if the call centre sends this type of information, which contains CBRN contents, to all the resources activated to the incident. As an example: "all the units activated to Alcala explosion, you can approach the incident from the north of it, passing through the ¨stadium' and stopping 1km far where you don't smell anything and the intervention group has fixed the secure zone".....
6. During your response to the disaster, did you experience unfulfilled needs in terms of technological resources, technical skills, logistics, communication, or reporting either as an organisation or in cooperation with other organisations? Could you please briefly elaborate on the most prominent?	In this case the procedures, the communications and the personal protective equipment were correctly used.
7. Were there legislation, hierarchal organisational structures, or complex decision-making procedures that may have hindered your response to the disaster?	In this case, the burden of the work fell on firefighters, and there was not much duty in the collaboration organisations.
8. In terms of pre-disaster preparedness for the event you have described, did you cooperate with volunteers, other organisations, professionals, NGOs, or individuals from the wider community? If so, could you please briefly elaborate and list these?	_Civil Protection (some of them volunteers and other professionals). -Spanish Red Cross. -Firefighters- -Local and national Police -Civil Guard. - Military Emergency Unit (UME)

	- Teams of psychologists.
9. Were there any major lessons learned by your organisation in how you responded to the disaster: a) in order to improve its and/or the community's resilience? b) in relation to the SAR proposed technologies and/or Use Cases? Did your organisation change or adapt to address challenges over the years, and if so, how?	-De-briefings should be applied systematically. This is the way to be aware of the aspects that have been applied correctly and the things that should be corrected and learnt for future events. -It is important to take seriously all the proposals based on learnt lessons, so that they translate into new recommendations, news procedures, resources, in order to front facing future events with these lessons learnt from the past. Very often, the organisations take a lot of time to change or adapt to address challenges.

Case study collection template 8- Seseña´s Tire Fire	
1. Can you briefly describe a specific disaster event and your organisation's role in it? What other organisations and professionals did you cooperate with in this response?	A suspected intended tire fire in one of the biggest illegal graveyard of wheels in Europa (over 5 million wheels, more than 90.000 tons), took place in Seseña, border community between Madrid and Toledo. The fire forced the evacuation a population of 6,000 people in El Quiñon, due to the toxic cloud. The Community of Madrid activated level I PLATERCAM, meanwhile Castilla La Mancha, activated their correspondent level 2 in order to get the help of the Military Emergency Unit and the hydroplanes of the Ministry of Culture. The principal elements from the bury of wheels were natural rubber, synthetic rubber and carbon black but its combustion can generate toxic gases, such as hydrogen sulphide. The burning of polymers that are part of rubber, such as styrene, butadiene, polybutadiene or synthetic polyisoprenes, in addition to the presence of retardants, such as organosulfur compounds or benzothiazole can cause a problem by generating toxic and irritable gases. SUMMA 112 activated: -- 1 Basic life support. -- 1 Advanced Life Support. -- ! Rapid Intervention vehicle (functions as an advanced life support). -- Special vehicle of Catastrophes and the MIR (truck with 16 medical care posts, in addition to two critical care posts.

	  -- The guard chief. We collaborated with: 1.- Firefighters from Madrid Community and from Castilla la Mancha. 2.- President of Madrid Community and her counterpart in Castilla La Mancha. 3.- Presidential advisor, environmental advisor, responsible for civil protection, responsible for civil guard. 4.- Manager of SUMMA 112 who appeared every day at the fire to check the progress. 5.-Responsible of our Catastrophes Department in SUMMA 112. 6.- Hospitals nearby the incident and those we consider useful according to the expected injuries of the victims (may not be transported to the nearest hospital but the useful one, like the trauma centre for example). 7.- Public Health Authorities. 8.- Responsibilities for environmental measurements.
2. If the case study / disaster is documented, please provide a relevant reference/link.	--https://www.rtve.es/noticias/20160513/incendio-cementerio-neumaticos-sesena-obliga-activar-nivel-1-alerta-nube-humo/1350343.shtml -- https://www.youtube.com/watch?v=zJCbp6NQwcg#action=share -- https://www.youtube.com/watch?v=OKVmuoKiQnw&feature=youtu.be&ac
3. What were the major challenges and advantages of working with other SAR organisations and	The major challenge when working with other SAR organisations is to be able to work as a unified team, following the same objectives and working as one. With the

professionals during the response phase of this specific disaster? 	creation of advanced joint teams, as ERICAM, which is formed with specific health care workers form SUMMA 112 and specific firemen from Community of Madrid, you make sure of joint trainings, knowledge, you know each other and you get familiar with both procedures, from SUMMA 112 and from Firefighters, as well as, elaborate new joint procedures. Nevertheless it´s advantages are the improvement of every organisation knowledge, the motivation and best practices to work in a safe way. Within this level of PLATERCAM activation, a crisis cabinet is constituted. Our chief of catastrophes department of SUMMA 112 in the meeting where the Director Plan and the chiefs of the groups put in common all the information gathered.
4. What are the major challenges and advantages of working with volunteers during the response phase of this specific disaster?	In this incident there were no volunteers.
5. Have there been mistakes made during the response phase of the above disaster event, either by your organisation or in cooperation with others? How can this be avoided in the future? 	Not in this case, but very often there is a lack of communication between different levels inside an organisation, and between different organisations. Sometimes firefighters receive the information before sanitary services like SUMMA 112, and this leads to a delay in activation of the EMS. Although in Madrid we share one common workplace called 112 where firefighters, civil guard, SUMMA 112 and SAMUR-PC (from local sanitary emergency response), we don't share same informatic tools, so, unfortunately, being physically so near, does not necessary improves performance. This could be avoided if when mass casualties take place that involve many different stakeholders, these different organisations could share the same informatics programs and technologies and could see the same income screen at their desks.
6. During your response to the disaster, did you experience unfulfilled needs in terms of technological resources, technical skills, logistics, communication, or reporting either as an organisation or in cooperation with other organisations? Could you please briefly elaborate on the most prominent?	In the crisis cabinet, it is desirable to treat practical aspects that can make safer the assistance for the first responders. In this case, aspects such as how to prevent the inhalation of the gases coming from the toxic cloud, which kind of face masks should use health care workers that were activated as a preventive coverage. Give them information coming from the environmental measures about the composition of the toxic cloud.
7. Were there legislation, hierarchal organisational structures, or complex decision-making	In this case, as the PLATERCAM was activated, the Director Plan is the one who decides the overall management of the ongoing incident. As there were no victims, for the SUMMA 112 turned to be less complicated. I wonder how this could

procedures that may have hindered your response to the disaster?	have developed if there had been mass victims taking account there were two Communities affected (Madrid and Castilla La Mancha).
8. In terms of pre-disaster preparedness for the event you have described, did you cooperate with volunteers, other organisations, professionals, NGOs, or individuals from the wider community? If so, could you please briefly elaborate and list these? 	1- Firefighters. 2- Civil guard. 3- Civil Protection. 4- Local and national Police. 5- Military Emergency Unit (UME). 6- Spanish Red Cross. 7- Public health Authorities. 8- Occupational risk Prevention Service.
9. Were there any major lessons learned by your organisation in how you responded to the disaster: a) in order to improve its and/or the community's resilience? b) in relation to the SAR proposed technologies and/or Use Cases? Did your organisation change or adapt to address challenges over the years, and if so, how?	a) Improve the information and communication with the population. b) Improve personal protective equipment for chemical substances and its compatibility with the other components of the suit (we have a chemical face mask but it is not compatible with the waterproof glasses). c) Wearable/portable sensors. It is desirable to wear radiological meters too. In the hospital, professionals from the Radiology service wear these radiological meters.

UGL

Case study collection – Ais Gill Train accident – UK (1995)	
Questions	**Answers**
1. Can you briefly describe a specific disaster event and your organisation's role in it? What other organisations and professionals did you cooperate with in this response?	The 1995 Ais Gill rail accident occurred near Aisgill, Cumbria, UK, at about 18:55 on 31 January 1995. A class 156 Super-Sprinter was derailed by a landslide on the Settle-Carlisle Railway line and was subsequently run into by a similar train travelling in the opposite direction. The Conductor of 156 Super- Sprinter was fatally injured in the collision and 7 passengers including the train driver were seriously injured. The case study investigated a multi-agency response to this accident. The Ais Gill incident was chosen because it was a small-scale disaster for which an account could be constructed

	with an acceptable level of validation. Interviews were conducted in cooperation with organisations that participated in CONCORDE project. Individuals who played a key managerial role in the incident were interviewed and various documents were examined In this response several teams were involved: - Cumbria Police - Railtrack DCC at York - Carlisle Communications Centre - Volunteer Mountain Rescu
2. If the case study / disaster is documented, please provide a relevant reference/link.	- Ais Gill Train accident UK 1995 – Wikipedia - Railways Archive, HSE_AisGill1995 - Concorde Project (Development of Coordination Mechanisms During Different Kinds of Emergencies)
3. What were the major challenges and advantages of working with other SAR organisations and professionals during the response phase of this specific disaster?	Major challenges working with other SAR organisations and professionals during the response phase: 1. Solid documentation was not available to us in order to analyse the causes of the incident in the best possible way and to deeply know what happened 2. Lack of evacuation plan till last minute 3. Lack of coordination and communication 4. Significant period of time elapsed (about 1hr) since the location of the train crash was not clear
4. What are the major challenges and advantages of working with volunteers during the response phase of this specific disaster?	Major challenges working with volunteers during the response phase: 1. Personality conflicts between the volunteers Major advantages: 1. Community volunteers brought local knowledge and contacts unavailable to people from outside a community 2. Volunteers brought a wide range of professional skills with them from their other roles in life 3. Volunteers provided a first response at community level that often cannot be provided by government or external agencies 4. Local volunteer involvement promoted local ownership and accountability of operations
5. Have there been mistakes made during the response phase of the above disaster event, either by your organisation or in cooperation with others? How can this be avoided in the future?	Major issues faced during the response phase: 1. Field staff did not know the evacuation plan until last minute. 2. Commanders did not inform passengers 3. Misunderstandings between commanders and the rest of the crew 4. Responsibilities transferred to inexperienced people Proposals to avoid the above issues in the future: 1. Train employees regarding the rules and operational plans and encourage them to make suggestions for improvements

	2. Educate new employees about the safety programme and requirements of the job 3. Keep updated records of relevant training and safety meetings 4. Interview employees after each injury to determine not only the facts, but if the injury could have been avoided
6. During your response to the disaster, did you experience unfulfilled needs in terms of technological resources, technical skills, logistics, communication, or reporting either as an organisation or in cooperation with other organisations? Could you please briefly elaborate on the most prominent?	This is not applicable to our company, because our role was to only conduct interviews after the incident
7. Were there legislation, hierarchal organisational structures, or complex decision-making procedures that may have hindered your response to the disaster?	This is not applicable to our company, because our role was to only conduct interviews after the incident
8. In terms of pre-disaster preparedness for the event you have described, did you cooperate with volunteers, other organisations, professionals, NGOs, or individuals from the wider community? If so, could you please briefly elaborate and list these?	This is not applicable to our company, because our role was to only conduct interviews after the incident
9. Were there any major lessons learned by your organisation in how you responded to the disaster: **a) in order to improve its and/or the community's resilience?** **b) in relation to the SAR proposed technologies and/or Use Cases?** **Did your organisation change or adapt to address challenges over the years, and if so, how?**	Major lessons are: a) The concept of self resilience. During disasters and mass casualty incidents, ordinary citizens prove to be capable of a range of activities to support emergency services. This could be defined as 'citizen response', which would play an important role to this specific event. Also, it is vital to facilitate (as government) an internet application for victims and relatives for self-registration and connection; we found that civilians during disasters are aware and responsible and were able to register themselves and inform their relatives. Disasters are rare; therefore, it is not justifiable to train first responders in specific skills during a crisis or the use of specific crisis tasks or

	procedures. The role or function of digital citizen response in the preparatory phase of disaster management is crucial. Incentives to encourage citizens using the disaster management app or the decision support system to have further training to increase her position in the system is necessary to be given. Neglecting this role, results in ineffective misuse of social media during the acute phase of a disaster or mass casualty incident b) Many processes in complex environments, such as an emergency medical response, are dynamic and typically involve considerable human interaction resulting in high degree of variability of scenario outcome. There are many decision makers, decision points and kinds of decisions, events and number of reactive workflows that address the occurrence of specific events. Most of the activities in each process must be performed by people and cannot be automated or even partially delegated to automated means

Case study collection – Kings Cross Bombings London (2005)	
Questions	**Answers**
1. Can you briefly describe a specific disaster event and your organisation's role in it? What other organisations and professionals did you cooperate with in this response?	The 7 July 2005 London bombings, were a series of coordinated Islamic terrorist suicide attacks in London, England, that targeted commuters travelling on the city's public transport system during the morning rush hour. Four terrorists separately detonated three homemade bombs in quick succession aboard London Underground trains across the city and, later, a fourth on a double-decker bus in Tavistock Square. The train bombings occurred on the Circle line near Aldgate and at Edgware Road, and on the Piccadilly line near Russell Square.
2. If the case study / disaster is documented, please provide a relevant reference/link.	- 7 July 2005 London bombings – Wikipedia - Concorde Project (Development of Coordination Mechanisms During Different Kinds of Emergencies)
3. What were the major challenges and advantages of working with other SAR organisations and professionals during the response phase of this specific disaster?	Major challenges working with other SAR organisations and professionals during the response phase: 1. Field staff had no objective proof for the correctness of their actions, only delivered evidence 2. Amend guideline to document location in writing 3. Nobody had the time to spend even more time to describe a patients locations in writing, when there were 50 other injured patients Major advantages:

	1. Prior experience in terrorist attacks
4. What are the major challenges and advantages of working with volunteers during the response phase of this specific disaster?	N/A
5. Have there been mistakes made during the response phase of the above disaster event, either by your organisation or in cooperation with others? How can this be avoided in the future?	There is always room for improvement and correcting actions that haven't followed properly all procedures, such as: 1. Field staff had no objective proof for the correctness of their actions, only delivered evidence, they were vulnerable to blame 2. Policy makers were not aware about that 3. Technology implementation decision process not in the hands of users 4. No monitoring and actual proof of condition of some patients before death and time of death Proposals to avoid the above issues in the future: 1. Results of monitoring and communicating with users has to be accessible to field staff in charge 2. Better use of existing and future SAR technology
6. During your response to the disaster, did you experience unfulfilled needs in terms of technological resources, technical skills, logistics, communication, or reporting either as an organisation or in cooperation with other organisations? Could you please briefly elaborate on the most prominent?	This is not applicable to our company, because our role was to only conduct interviews after the incident
7. Were there legislation, hierarchal organisational structures, or complex decision-making procedures that may have hindered your response to the disaster?	This is not applicable to our company, because our role was to only conduct interviews after the incident
8. In terms of pre-disaster preparedness for the event you have described, did you cooperate with volunteers, other	This is not applicable to our company, because our role was to only conduct interviews after the incident

organisations, professionals, NGOs, or individuals from the wider community? If so, could you please briefly elaborate and list these?	
9. Were there any major lessons learned by your organisation in how you responded to the disaster: **a) in order to improve its and/or the community's resilience?** **b) in relation to the SAR proposed technologies and/or Use Cases?** **Did your organisation change or adapt to address challenges over the years, and if so, how?**	Major lessons are: a)1.In there kind of situations, the community has to be well informed in order to help and support the state organisations. b)1.In relation to the SAR proposed technologies, there is a need for communication under difficult circumstances, like a terrorist attack, were there was such a huge telecoms disruption. Vodafone reported that its mobile telephone network reached capacity at about 10 am on the day of the bombings, and it was forced to initiate emergency procedures to prioritise emergency calls (ACCOLC, the 'access overload control').

Case study collection – Collapse of Factory Building – Bangladesh (2013)	
Questions	**Answers**
1. Can you briefly describe a specific disaster event and your organisation's role in it? What other organisations and professionals did you cooperate with in this response?	The building, Rana Plaza, housed a number of separate garment factories employing around 5,000 people, several shops, and a bank. On 23 April 2013 (one day before the collapse), a TV channel recorded footage that showed cracks in the Rana Plaza building. Immediately afterward, the building was evacuated, and the shops and the bank on the lower floors were closed. Later in the day, the owner of the building, said to the media that the building was safe and workers should return tomorrow. On the morning of 24 April, there was a power outage, and diesel generators on the top floor were started. Only moments after that, the building collapsed, leaving only the ground floor intact. Organisations involved in this response: - Local rescue emergency services
2. If the case study / disaster is documented, please provide a relevant reference/link.	- Dhaka garment factory collapse (2013) – Wikipedia - Concorde Project (Development of Coordination Mechanisms During Different Kinds of Emergencies)
3. What were the major challenges and advantages of working with other SAR organisations and professionals during the response phase of this specific disaster?	Major challenges working with other SAR organisations and professionals during the response phase: 1. Uncoordinated SAR organisations were bumping onto each other, wasting crucial time

	2. Health system was slow at its response in such a crisis
4. What are the major challenges and advantages of working with volunteers during the response phase of this specific disaster?	Major challenges working with volunteers during the response phase: 1. No central guidelines were in place, so a non-coordinated and unorganised crowd of volunteers was trying to help. Major advantages: 1. Some of those volunteers knew more about the building, compared to the emergency rescue teams
5. Have there been mistakes made during the response phase of the above disaster event, either by your organisation or in cooperation with others? How can this be avoided in the future?	Several omissions have occurred, such as: 1. No documentation of pre-hospital rescue and emergency management was present 2. People – Medics and public focus on rescue, but overlook the proper coordination 3. The state had no training on how to organise and handle mass emergencies 4. There was no emergency management process 5. Insufficient information on medical condition and priorities In order to avoid and be prepared in the future: 1. Operational plans must be in place, where procedures on how to act in different types of emergencies are described in detail 2. Proper training of professionals has to take place
6. During your response to the disaster, did you experience unfulfilled needs in terms of technological resources, technical skills, logistics, communication, or reporting either as an organisation or in cooperation with other organisations? Could you please briefly elaborate on the most prominent?	Bangladeshi officials refused to accept the assistance offered to them by the UN. A large portion of the rescue operation consisted of inadequately equipped volunteers, many of whom had no protective clothing and wore sandals. Some buried workers drank their urine to survive the high temperatures, waiting to be saved.
7. Were there legislation, hierarchal organisational structures, or complex decision-making procedures that may have hindered your response to the disaster?	This is not applicable to our company, because our role was to only conduct interviews after the incident

8. In terms of pre-disaster preparedness for the event you have described, did you cooperate with volunteers, other organisations, professionals, NGOs, or individuals from the wider community? If so, could you please briefly elaborate and list these?	This is not applicable to our company, because our role was to only conduct interviews after the incident
9. Were there any major lessons learned by your organisation in how you responded to the disaster: **a) in order to improve its and/or the community's resilience?** **b) in relation to the SAR proposed technologies and/or Use Cases?** **Did your organisation change or adapt to address challenges over the years, and if so, how?**	Major lessons learned in how to respond to disasters are: a)1. More training is required, mostly by professionals and state forces a)2. Communicating the need of volunteers and creating awareness regarding Health and Safety, which will reduce the risk of an incident, but if and when that occurs, communities will respond in an organised manner and appropriately b)1. More knowledge and communication of what types of SAR technologies exist is needed b)2. More professionals can help in the training of volunteers on those technologies

Case study collection – Christchurch earthquake (2011)	
Questions	**Answers**
1. Can you briefly describe a specific disaster event and your organisation's role in it? What other organisations and professionals did you cooperate with in this response?	A Mw6.2 (ML6.3) earthquake occurred in Christchurch on Tuesday 22 February 2011. The earthquake caused widespread damage across Christchurch, killing 185 people.
2. If the case study / disaster is documented, please provide a relevant reference/link.	- 2011 Christchurch earthquake – Wikipedia - http://www.thelancet.com/pdfs/journals/lancet/PIIS0140-6736(12)60313-4.pdf - Concorde Project (Development of Coordination Mechanisms During Different Kinds of Emergencies)
3. What were the major challenges and advantages of working with other SAR organisations and professionals during the response phase of this specific disaster?	Major challenges working with other SAR organisations and professionals during the response phase: 1. Robust emergency plans where in place. Major advantages: 1. The robust emergency plans, unfortunately, didn't anticipate the need to receive, triage, and manage so many undifferentiated injured patients.

4. What are the major challenges and advantages of working with volunteers during the response phase of this specific disaster?	Major challenges working with volunteers during the response phase: 1. There was a large number of health professionals attending the Christchurch hospital emergency department, and that raised the need for a formalised plan for their reception and accommodation. 2. Similar problems associated with too many doctors or too few doctors available to help, have been reported after other earthquakes. Major advantages: 1. Health professionals have a really strong community and sense of respect for human life, and are always willing to help in emergency situations. 2. Health professionals with different expertise, if guided accordingly, can make a huge difference saving human lives.
5. Have there been mistakes made during the response phase of the above disaster event, either by your organisation or in cooperation with others? How can this be avoided in the future?	Issues have been faced during the response phase, and those as recorded, are: 1. Health professionals went to the place they thought they would be needed most. There was no information for then where they were needed. 2. There was also, no communication link with off duty doctors, and no plan in place. 3. There was also no guideline, which mainly burdens the local community. 4. Regarding the patient management, a mismatch between numbers of available doctors and need occurred. Patients where clustered in hospitals requiring help, where there were not enough doctors. Possible solutions for the above could be: 1. Revise plan and actions to call off duty stuff. 2. Structure an operational plan in case of an emergency, with clear guidelines for doctors and volunteers.
6. During your response to the disaster, did you experience unfulfilled needs in terms of technological resources, technical skills, logistics, communication, or reporting either as an organisation or in cooperation with other organisations? Could you please briefly elaborate on the most prominent?	This is not applicable to our company, because our role was to only conduct interviews after the incident

7. Were there legislation, hierarchal organisational structures, or complex decision-making procedures that may have hindered your response to the disaster?	This is not applicable to our company, because our role was to only conduct interviews after the incident
8. In terms of pre-disaster preparedness for the event you have described, did you cooperate with volunteers, other organisations, professionals, NGOs, or individuals from the wider community? If so, could you please briefly elaborate and list these?	This is not applicable to our company, because our role was to only conduct interviews after the incident
9. Were there any major lessons learned by your organisation in how you responded to the disaster: **a) in order to improve its and/or the community's resilience?** **b) in relation to the SAR proposed technologies and/or Use Cases?** **Did your organisation change or adapt to address challenges over the years, and if so, how?**	Major lessons learned in how to respond to disasters are: a) More training and drills with different and complicated scenarios are required, in order to make aware the professionals and volunteers how they will have to react in such an occasion, who they will take orders from, and with whom they have to communicate so that they offer their help that is so needed. a) Communicating the results of those drills, and collaborating with other state forces, will improve community's resilience.

Case study collection – Evangelos Florakis Naval Base explosion – Cyprus (2011)	
Questions	**Answers**
1. Can you briefly describe a specific disaster event and your organisation's role in it? What other organisations and professionals did you cooperate with in this response?	On July 11, 2011 at 5:50 a.m. at Evangelos Florakis Naval Base, situated at Mari, Larnaca in Cyprus, a large amount of ammunition and military explosives self-detonated, killing 13 people and injuring 62 more. More specifically, the first ambulance arrived at the scene of the explosion at 6:10 a.m., 15 minutes after receiving the message. The Crisis Management and Coordination Centre, at 6:30 a.m. assessed the incident to be dealt with as a large-scale disaster-crisis. From 6:45 a.m. Specialised Officers of the Ministry of Health arrived at the scene and took over the management of the scene and the coordination with the other services (Police, Fire Brigade, National Guard). A total of 3 doctors, 27 Nurses, 17 ambulance drivers with 15 ambulances of the Ministry of Health were mobilised and a total of 63 injured people were transported to the various Hospitals. The explosion was the worst peacetime military accident ever recorded in Cyprus, with a yield of approximately 481 tons TNT Equivalent. It was

	the largest artificial non-nuclear explosion of the 21st century until the 2020 Beirut explosions. Organisations and professionals involved in this response: - Cyprus Government - Ministry of Health - Healthcare professionals - National Guard of Cyprus - Cyprus Police - Local rescue emergency services
2. If the case study / disaster is documented, please provide a relevant reference/link.	- Evangelos Florakis Naval Base explosion – Cyprus (2011) - Wikipedia
3. What were the major challenges and advantages of working with other SAR organisations and professionals during the response phase of this specific disaster?	Major challenges of working with other SAR organisations and professionals during the response phase: - Some disagreements and arguments regarding crucial decisions - Lack of collaboration and coordination resulting in a loss of crucial time. Specifically, when ambulances and hundreds of other people entered the scene, unfortunately there were no measurements for the existence of radioactivity. The lack of coordination from the state services could have incalculable consequences for the health of all those who entered the scene on the day of the explosion. The way to immediately detect radioactive leakage should be one of the first priorities in the event of a power outage - Reliance upon others to complete a task - Lack of trust between organisations Major advantages of working with other SAR organisations and professionals during the response phase: - Both individual and team knowledge fostered - Analyzing various situations, seen by different perspectives - Maximised involvement and continuous learning
4. What are the major challenges and advantages of working with volunteers during the response phase of this specific disaster?	This is not applicable for this situation, since it was a naval military base explosion and permission was given only to authorised personnel
5. Have there been mistakes made during the response phase of the above disaster event, either by your organisation or in cooperation with others? How can this be avoided in the future?	There is always room for improvement and correcting actions that haven't followed properly all procedures, such as: - Authorities skipped crucial tests on the stability of the building structure - Checking the equipment on regular intervals - Maintaining stable temperature, throughout the year, in every building where flammable equipment is stored - Trained personnel with expertise regarding flammable liquids or objects Future measures that could play a key role in the avoidance of accidents or incidents:

	- Prevent or minimise the use of flammable substances - Introduction of technical processes that do not need highly flammable substances - Safe storage of hazardous substances - Extraction and ventilation systems - Use of tools and machines that do not produce sparks - Safety data sheets available clearly indicated - In-depth instruction and training
6. During your response to the disaster, did you experience unfulfilled needs in terms of technological resources, technical skills, logistics, communication, or reporting either as an organisation or in cooperation with other organisations? Could you please briefly elaborate on the most prominent?	This is not applicable to our company, since we only conducted interviews with the authorities after the accident
7. Were there legislation, hierarchal organisational structures, or complex decision-making procedures that may have hindered your response to the disaster?	This is not applicable to our company, since we only conducted interviews with the authorities after the accident
8. In terms of pre-disaster preparedness for the event you have described, did you cooperate with volunteers, other organisations, professionals, NGOs, or individuals from the wider community? If so, could you please briefly elaborate and list these?	This is not applicable to our company, since we only conducted interviews with the authorities after the accident
9. Were there any major lessons learned by your organisation in how you responded to the disaster: **a) in order to improve its and/or the community's resilience?**	Major lessons learned in how to respond to disasters are: A crucial action was decided by the Ministry of Health at 9:30 a.m. which emphasised in the full mobilisation of the officers of the Department of Mental Health Services to provide psychological support to both the relatives of the victims and the people who were in the area during and immediately after the explosion (sailors, firefighters).

b) in relation to the SAR proposed technologies and/or Use Cases? **Did your organisation change or adapt to address challenges over the years, and if so, how?**	To learn from accidents like this one, some factors are important. These aspects are related to the structure or to safety management, such as accidents registrations and action plans. An important aspect of learning from accidents is that the processes can be thought to address different 'levels' of learning. - In order to be able to assess the risk to Public Health of both those present at the explosion at the NVEF and the residents of the area, it was necessary to know the materials to which the locals may have been exposed. It is noted in this case that if a Coordinating Body had been set up to deal with the crisis, according to the Decision of the Council of Ministers, the Minister of Health and the Minister of Defence would have been in direct communication and consultation from the outset facilitating the exchange of such information - Being able to reproduce certain knowledge - Being able to apply the knowledge in a similar setting as it was first offered - Being able to apply the knowledge adequately in other (new) settings - Continuous and yearly training is required, in order to keep the awareness as high as possible in case an emergency occurs

Case study collection – Evacuation of a Municipality of Athens summer camp – GR – field exercise (2010)	
Questions	**Answers**
1. Can you briefly describe a specific disaster event and your organisation's role in it? What other organisations and professionals did you cooperate with in this response?	The municipality of Athens, had conducted operational plan for civil protection in urban cities and environments. Among those, there is an evacuation plan of a summer camp in case of fire. There was a field drill conducted in order to stress test the response of the parties involved, following the guidelines of the operational plan. The professionals involved were: - Local police department - Firefighters - Utility companies - Emotional support services - Critical suppliers
2. If the case study / disaster is documented,	Operational Plan "Themistoklis", Municipality of Athens, Greece

please provide a relevant reference/link.	
3. What were the major challenges and advantages of working with other SAR organisations and professionals during the response phase of this specific disaster?	Major challenges working with other SAR organisations and professionals during the response phase: - Communication and smooth collaboration between the SAR organisations Major advantages: - Trained personnel and aware of the procedures that had to be followed
4. What are the major challenges and advantages of working with volunteers during the response phase of this specific disaster?	Major challenges of working with volunteers during the response phase: - Personality conflicts between the volunteers Major advantages of working with volunteers during the response phase: - Volunteers provided a first response at community level that often cannot be provided by government or external agencies - Community volunteers brought local knowledge and contacts unavailable to people from outside a community - Volunteers brought a wide range of professional skills with them from their other roles in life
5. Have there been mistakes made during the response phase of the above disaster event, either by your organisation or in cooperation with others? How can this be avoided in the future?	Major issues faced during the response phase: - Staff did not know the evacuation plan in depth, resulting in confusion - Staff did not inform immediately the groups of people that had to evacuate the camp Proposals to avoid the above issues in the future: - Identify camp hazards and conduct risk assessment - Form an emergency planning and response team - Update the risk assessment and the emergency response plan in regular intervals - Train Camp staff on first aid, CPR, emergency kits and supplies - Orient the Camp staff on the new plan - In depth talk and demonstration of different evacuation scenarios - Highlight locations of key utility shut-off valves and switches - Diagrams and maps of the camp grounds and each building
6. During your response to the disaster, did you experience unfulfilled needs in terms of technological resources, technical skills, logistics, communication, or reporting either as an	During our involvement we faced the following challenge: - The communication and the reporting on the appropriate authorities were frequently lost via cell phones and the planning of the evacuation was behind schedule

organisation or in cooperation with other organisations? Could you please briefly elaborate on the most prominent?	
7. Were there legislation, hierarchal organisational structures, or complex decision-making procedures that may have hindered your response to the disaster?	This is not applicable to this situation
8. In terms of pre-disaster preparedness for the event you have described, did you cooperate with volunteers, other organisations, professionals, NGOs, or individuals from the wider community? If so, could you please briefly elaborate and list these?	Our company elaborated with volunteers, other organisations, professionals and individuals from the wider community: - Chief and assistant chief of local firefighters department - Chief and assistant chief of local police department - Local doctors and nurses - Local Volunteer Mountain Rescue
9. Were there any major lessons learned by your organisation in how you responded to the disaster: **a) in order to improve its and/or the community's resilience?** **b) in relation to the SAR proposed technologies and/or Use Cases?** **Did your organisation change or adapt to address challenges over the years, and if so, how?**	Major lessons learned in how to respond to possible disasters are: - Continuous and yearly training is required, mainly by repeating the drills in order to keep the awareness as high as possible in case the emergency occurs - Analyse the incident. Gathering as many facts about the incident or accident should be the top priority - Communicate efficiently - Evaluate the process

Annex IV: Literature review collection template

Any bibliographical reference should be documented with the following template.

LITERATURE REVIEW TEMPLATE & GUIDANCE	
SOURCE (CITATION) INFORMATION	
Publication title:	
Year/Month of publication:	**Publishing organisation / authors:**
Reference citation: please use the Vancouver citation style and make sure to also include: editor, pages.	**Relevant link:**
Type of publication: (please specify, i.e. scientific journal, report, project, website – if EU project also provide: name of project, contract number, deliverable number)	**Level of source:** ☐International ☐European ☐Multinational ☐National ☐Other (please specify **& include relevant country/ies.** if available)
STUDY BRIEF OVERVIEW	
Objective/Focus of Study: (please describe very briefly; 2-3 lines). Also include: a) **Focus:** either on specific assets (e.g. infrastructure, financial systems) or on the whole community and its attributes. b) **Spatial coverage:** (e.g. from individual communities to nations). c) **Domain:** either the **characteristics/attributes**[1] of the systems or community, or the **capacities**[2] within them.	
Methodology used: e.g. theoretical, field study, questionnaires, interviews, top-down, bottom up, qualitative, quantitative, other (specify)	**Type of disaster environment/applicability:** indicate whether the study is of general applicability or specific to a particular disaster and/or phase of crisis management; if so, also state the disaster and/or phase of crisis management it applies to.
Study limitations: (please briefly state any limitations – e.g. sample size , of local/specific environment – the study may exhibit)	
STUDY/REPORT SPECIFIC INFORMATION	
1. Type/definition of involved community: ☐ Community of practice and interest ☐ Interaction-based community ☐ Place-based community ☐ Other (please specify)	**Briefly describe the "community" and list the "community" actors:** (e.g. first responders, volunteer groups, social groups see preliminary classification in Section 1.1.1 but feel free to modify/indicate if different)

2. Is there a specific definition for "Community Resilience" in disasters? (If so, please report it)	**3. Is the "Community resilience" definition suitable for the scope of works of S&R?** (if not, briefly please explain why)
4. What are the major factors in terms of attributes/capacities[2] that contribute in building "Community Resilience"? (please describe in terms of the fundamental set of resources, i.e. human/behavioural, technological, organisational as defined below **at least for the Response Phase** in case a distinction is possible; you may propose/provide supplementary classification in case it would better categorise the identified attribute/capacity). **In parenthesis please indicate to which event management cycle(s) of resilience functions the attribute / capacity is <u>most</u> applicable (you may indicate multiple phases, if applicable)**. Indices: A = Anticipate/Plan-prepare: address the "potential" – lay the foundation to keep services available and assets functioning during a disruptive event. M = Monitor/Absorb: address the "critical" – maintain most critical asset functions and service availability while repelling or isolating the disruption. R = Respond/Recover: address the "actual" and respond to regular or irregular disruptions by adjusting functioning to existing conditions; restore all asset functions and service availability to their pre-event functionality. L = Learn/Adapt: address the "factual" by learning from experiences of both successes and failures; using knowledge from the event, alter protocol, configuration of the system, personnel training or other aspects to become more resilient. **Set of resources**	
Human/Behavioural (e.g. technical skills, expertise and competencies, as well as cognitive resources, particularly those relating to decision-making processes)	
Attributes / Capacities:	
Technological: (e.g. infrastructure-related, UAV/robot/vehicle-related, infrastructure/traffic control, software, hardware)	
Attributes / Capacities:	
Organisational: (hierarchical structures, formal procedures, logistics, information use and reporting, communication)	
Attributes / Capacities:	
Others? (not covered by a single category; proposal for different categorisation)	
5. Which of the above attributes / capacities are most relevant to the Use Cases KPIs, proposed technologies and objectives of S&R? (please select and indicate accordingly: VR = very relevant; MR = most relevant; please briefly describe the selected attribute/capacity in case its term is not self-explanatory or requires additional insight)	
6. How can professional-volunteer interaction/collaboration best contribute in building "Community resilience", in particular in the Response Phase? (please answer by considering	

the Human/Technological/Organisational set of resources and indicate relevant success factors/key areas/practice/tool, if possible/available and/ or major difficulties)
7. Legal/regulatory/ISO standardisation issues (**if, applicable; mainly for VUB**): Indicate legislative/regulatory/standardisation issues (e.g. limitations; legal/standardisation incentives) that are likely to influence the "community resilience" in terms of: • Solution implementation and deployment • Professional-volunteer coordination and collaboration
8. Major conclusions in relation to the S&R objectives, proposed technologies, UCs and/or professional-volunteer interactions: (please describe very briefly)
NOTES/DEFINITIONS: [1] **Characteristic/attribute:** quantities of some attribute or the simple presence or absence of things without any evaluation of quality [2] **Capacity:** evaluations of performance or quality

Annex V: Literature review summary template

A short overview of the literature review performed summarizing common findings or distinct differences from a comparative analysis of the reviewed sources should be provided by using the template provided below.

LITERATURE REVIEW SUMMARY EMPLATE
1. Overview / definitions • **"Community"** → Identify the different definitions of "Community", obtain insight into how these may affect "resilience" and select the definition most relevant to S&R scope of works and objectives. List of relevant actors. • **"Community Resilience"** → How is it defined? In your opinion what is the definition most relevant to S&R scope of works and objectives and how to achieve "Community Resilience"?
2. Major factors (attribute/capacities) that shape "Community Resilience"
Human/Behavioural:
Technological:
Organisational:
Most relevant to S&R Use Cases KPIs, proposed technologies and objectives:
3. Legislative /regulatory /standardisation issues: → [Mainly VUB]: Indicate issues (e.g. limitations; legal/standardisation incentives) that are likely to influence the "Community resilience"?
4. Role/contribution of professional-volunteer interactions in building community resilience → please answer by considering the Human/Technological/Organisational set of resources and indicate relevant success factors/key areas/practice/tool, if possible/available and/ or major difficulties
5. Major conclusions in relation to the S&R objectives, proposed technologies, UCs and/or professional-volunteer interactions: (please describe very briefly)