740575	FIRE-IN	D1.4. Report on current and future common capability challenges (CCCs and FCCCs) #3

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D1.4. Report on current and future common capability challenges (CCCs and FCCCs) #3

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Abstract:

FIRE-IN has identified Future and Common Capability Challenge through a network of diverse experts. These experts connect knowledge, experience, best practices, lessons learned and their expert in different thematic (urban fire, search and rescue and medical emergencies, NRBQe, natural disasters, landscape fires), different organizations (F&R services, emergency managers, risk managers, NGO, and others), and roles (from operational to tactical or strategical decision making, from local to international ones). Using World-Café Workshops and Webinars, they were asked to identify the main capability gaps and challenges in front of 20 scenarios (from a dirty bomb to a rescue on a cave, or from prevention on fire in a large commercial building, to landscape fire risk management). Future and Common Capability Challenges focused on 6 Capabilities (Incident Command, Knowledge Cycle, Community Involvement, Decision-making cycle, Risk Reduction and Preparedness). And 4 Challenges (High Flow of Resources in a Hostile environment – HF, Hight Impact Low Frequency – HILOF, Multileadership/Multiagency - ML, Uncertainty- UN). The increasing complexity of challenges are key to focus efforts efficiently, in a concept parallel to warfare generations and fire generations. To diagnose the types of challenges in any scenario, a set of indicators helps in focusing efforts on key capability gaps.

F&R experts insisted on preventing and preparing for large emergencies with high impact in the society and that can cause collapse, in the safety for responders, in decision-making, in resources... Acquiring expertise in these kinds of emergencies is a must, and those F&R experts and organization who have it, should consciously act as hubs of innovation to improve preparedness, involving communities, stakeholders, first-responders, policymakers....

A cultural change is needed in European societies, building risk awareness, understanding their active role in large emergencies, and building resiliency. Risk is managed by a lot of conflicting policies, from environmental to urbanistic, from economic to industrial... Risk governance should be based on traceability.

Properly understanding and differentiating challenges is key to focus European and national policies, boosting bottom-up harmonization policies, a top-down command framework (ICS type). But it´s not enough with placing interoperable modules within a shared framework. Knowledge and decision-making are key aspects for an effective operational, tactical and strategical management.

Keywords:

Capability gaps; expertise; challenges; incident command; multi-leadership; large emergencies; uncertainty; expertise; collapse; knowledge; incident command; preparedness; risk management

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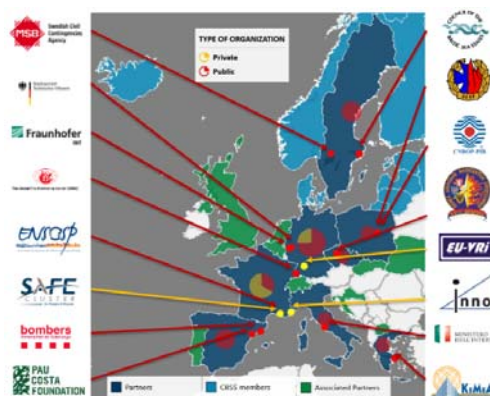
Executive Summary

The FIRE-IN project is an initiative funded by the European Commission and initiated on the 1st of May 2017. FIRE-IN has been designed to raise the security level of EU citizens by improving the national and European Fire & Rescue (F&R) capability development process. FIRE-IN addresses the concern that capability-driven research and innovation in this area needs much stronger guidance from practitioners and better exploitation of the technology potentially available for the discipline.

The purpose of this report is to compile the work done in FIRE-IN up to this third cycle, to show the results obtained in the third cycle of workshops, to determine future challenges and to address some recommendations.

Table 1. FIRE-IN partners

Participant No.	Participant organisation name	Part. short name	Country
1	Pôle de compétitivité SAFE CLUSTER (ex Pôle Pégase)	SAFE	France
2	Ecole Nationale Supérieure des Officiers de Sapeurs-Pompiers – French National Fire Fighter Officers Academy	ENSOSP	France
3	Italian Ministry of Interior	CNVVF	Italy
4	Bundesanstalt Technisches Hilfswerk	THW	Germany
5	Global Fire Monitoring Center	GFMC	Germany
6	INERIS Développement	INEDEV	France
7	Fraunhofer INT	FhG-INT	Germany
8	Fire Ecology and Management Foundation Pau Costa Alcubierre	PCF	Spain
9	Catalonia Fire Service Rescue Agency	CFS	Spain
10	Scientific and Research Centre for Fire Protection	CNBOP	Poland
11	The Main School of Fire Services	SGSP	Poland
12	Council of Baltic Sea States	CBSS	Sweden
13	Swedish Civil Contingencies Agency	MSB	Sweden
14	KEMEA	KEMEA	Greece
15	Czech Association of Fire Officers	CAFO	Czech Republic
16	inno TSD	inno	France

Geographical Distribution of the FIRE-IN Partners and AE in Europe:

1. Introduction

FIRE-IN has been designed to raise the security level of EU citizens by **improving the national and European Fire & Rescue (F&R) capability development process**. The project addresses the concern that capability-driven research and innovation in this area need much stronger guidance from practitioners.

FIRE-IN fostered the process of innovation in this domain, by promoting cutting edge solutions to recognised operational needs. This was expected to significantly reduce residual risks and raise the security level of EU citizens. This is addressed in four main lines of activity:

(i)   the identification and harmonisation of **operational capability gaps** based on the contribution provided by a significant and heterogeneous network of practitioners,
(ii) the scouting of promising solutions and the constant interaction of practitioners with research and industry representatives to address the aforementioned gaps,
(iii) the definition of a F&R Strategic Research and Standardisation Agenda (SRSA) as well as
(iv) the development of a concept for more efficient use of test & demonstration and training facilities to support innovation and joint skill development.

FIRE-IN has set up and tested a step-based approach aiming to deliver well-conceived capability-driven research. These steps have been jointly developed and applied by FIRE-IN partners and their practitioner, research, and industry networks. They have been tested and refined during three iterative implementation cycles executed along the project's lifetime.

2. Objectives

The overarching outcome of the project will be a proven process for supporting capability-driven research in F&R topics, which will be advocated by an extended network of stakeholders from all EU Member States (MS). The network will be linked at cross-domain and cross-border level and will report harmonised operational requirements into national and EU programmes for capability development that may refer to R&D.

2.1.   Specific objectives of the project FIRE-IN

The main FIRE-IN objective outlined above was formulated in relation to specific needs of F&R capability development:

1. Firstly, European civil protection including F&R practitioners and related services needs the development of technologies, procedures, organisational concepts (from now on referred to in sum as "solutions") that meet relevant operational needs. To this end, FIRE-IN was required to adopt a **practitioner-driven approach to come up with recommendations on research and innovation (R&I)** that are based on two important conditions:

   a. a shared understanding of the innovation potential of novel solutions coming out of R&I activities,

   b. a widely accepted understanding of innovation and standardisation needs, across subdomains and scenarios, across profiles and backgrounds.

   These conditions have to be ensured among F&R practitioners (from the same and across disciplines) **working together in facing emergencies and major crisis situation**s. The latter requires not only an analytical approach to capability development, but also **a network-of-networks based cooperation and interaction strategy: that is, exploiting the knowledge of existing regional, national, and sub-national networks of operational actors and practitioners and widely disseminating findings regarding innovation**. Following this approach, current and future Common Capability Challenges (CCCs) can be defined across F&R sub-domains and civil protection areas while promising solutions resulting from research activities can be made accessible to the entire F&R community.

2. Secondly, by **focusing research and development into the most common, pressing capability gap**s, and also to select promising solutions over less suitable ones. The aim is to **avoid spending budget on research that would not deliver added operational values**.

3. Thirdly, since FIRE-IN can only be a starting point for a **better structured capability development process,** with the interaction between responders, researchers and market actors.

2.2.   Objectives of this report

This **D1.4. Report on current and future common capability challenges (CCCs and FCCCs) #3** aims to deliver Common and Future Capability Challenges (CCCs, FCCCs) based on the identification and harmonisations of operational capability challenges on different thematics (search and rescue, structure fires, landscape fires, natural disasters, CBRNe), focusing on different current and future issues. As a difference to D1.2 and D1.3, this deliverable includes the workshops on future scenarios, developed during the last cycle, aiming at uncertain, emerging threats. As what we seek in this deliverable is to focus innovation policies, it is important that the approach is multi-emergency, seeking common patterns.

3. Methodology

FIRE-IN set up and tested a step-based approach aimed at repeatedly <u>gather knowledge, wisdom and expertise</u> <u>from practitioners on capability gaps</u> challenging a wide range of scenarios in the emergency arena, in order to look for common patterns delivering key common capability gaps. It is a process of repeatedly synthetize lessons learned from expertise (both individual experts from a lifetime of practice, and groups of experts discussing in front of a whiteboard), and repeatedly <u>harmonize redundant information on capability gaps</u> developed independently (both on individual scenarios synthetising capability gaps from different whiteboards, and on the cross-domain Capability Challenge matrix identifying commonalities and making sense of patterns from the different scenarios).

Clear steps for establishing scenarios, experts and discussions, are key to be able to have enough repetitions to identify patterns. 3 cycles, 5 thematics, 16 workshops, 21 scenarios, and 12 to 16 experts provided us a wide range of information. So, for every cycle, main steps were:
- At the beginning of each cycle,
  - o Guidelines to choose scenarios were set, aiming at selecting challenging scenarios on different thematics, allowing a general view on key Capabilities and Challenges that needs efforts and innovation. After last cycle <u>21 scenarios</u> had been set.
- At the centre of each cycle,
  - o For each scenario, the involvement of <u>12-16 experts approx.</u> in each scenario with a wide range of perspectives, to capture knowledge from different networks, expertises and arenas.
  - o The organisation of 16 structured workshops, with a set of steps, roles, templates and repetitions. <u>10 workshops were face-to-face</u>, discussing 15 scenarios, and <u>6 were online</u>.
  - o For every one of the scenarios (21 in total), the synthesis of the discussion on capability gaps, discussed in different steps and sub-groups.
- At the end of each cycle,
  - o The identification of patterns of Capabilities and Challenges repeatedly discussed, framing a tentative Future and Common Capabilities Matrix.
  - o The specific capability gaps discussed in every scenario were classified into each Capability Challenge of the tentative matrix, and if needed the F/CCC matrix was reformulated, and capability gaps were rearranged.
  - o <u>Three versions of the F/CCC matrix</u> were produced, ranging from 35 to 20 F/CCCs, from the first to the last cycle. Each one of this F/CCCs was explained by different specific capability gaps.

Thematics

To carry out all this work, 5 Thematic Working Groups (TWGs) were established, focusing on 5 very challenging thematics in the emergency arena:

- **TWG A, Search and Rescue (SAR) and Emergency Medical Response (EMR)**. Managed by CFS, with ENSOSP, CNVVF, Pole SAFE and CAFO.

- **TWG B, Structure fires crisis mitigation, prevention, and protection**. Managed by CNVVF, with ENSOSP, CAFO, SGSP, MSB.

- **TWG C, Landscape fires crisis mitigation**. Managed by GFMC, with CFS, PCF, MSB and KEMEA.

- **TWG D, Natural Disasters crisis mitigation**. Managed by THW, with MSB, CNVVF, CFS and KEMEA.

- **TWG E, CBRNE crisis mitigation**. Managed by CAFO, with ENSOSP, SGSP, KEMEA, CNVVF.

In the 3rd Cycle of workshops, TWG A focused on **Innovation** with a general perspective rather than only in Search and Rescue (SAR) and Emergency Medical Response (EMR), due to the needs required for approaching FCC.

<u>Scenarios</u>

1st Cycle Workshops:

1. An air crash with multiple victims in a remote location near the border of two countries (TWGA)
2. A whole season of search and rescue operations, with two major operations: Search and Rescue in a cave and lost people in a mountainous area (TWGA)
3. A high-rise building fire (TWGB)
4. A tunnel fire (TWGB)
5. A complex and aggressive wildfire in a peri-urban area (TWGC)
6. Landscape vulnerability mitigation (policy, prevention and preparedness) (TWGC)
7. Floods (TWGD)
8. Flash floods (TWGD)
9. Accident of CBRNE substances during their transport (TWGE)
10. Use of CBRNE substances in a terrorist attack (TWGE)

2nd Cycle Workshops:

11. Multiple structural collapses in buildings due to an earthquake (TWGA)
12. Prevention in Large shopping mall area fires (TWGB)
13. Landscape fires (TWGC)
14. A winter storm (TWGD)
15. A pandemic disease threats Europe (TWGE)

3rd Cycle Workshops:

16. Improving innovation circuits around practitioners, facing the next 10 years of increasingly complex emergencies management in the area of information and uncertainty (TWGA) (See Appendix 3)
17. Decrease on the population while it is expected an increase in the number of elderly and overweight people, which will impact on the evacuation procedures and tools to be employed in case of fire to ensure the safety of vulnerable (e.g., completely or partially impaired people). In addition, new energy, communication and construction technologies will bring new materials into the buildings with possible new risks in the event of a fire (TWGB) (Appendix 3)
18. Tsunami in the Mediterranean (TWGD) (Appendix 3)
19. Emergencies with a combination of specific risks with a global impact. In the case of CBRNE, these may be pandemics, contamination by radioactive or chemical substances in several countries or continents. Under the conditions of these threats, other incidents will take place, both of a natural and manmade: events associated with the release of hazardous substances, floods, earthquakes with the need to move a large number of people in the area affected by the pandemic (TWG E) (Appendix 3)

3rd Cycle final workshops

20. Scenario like the actual context with a gradual change towards a worsening service (See appendix 4)
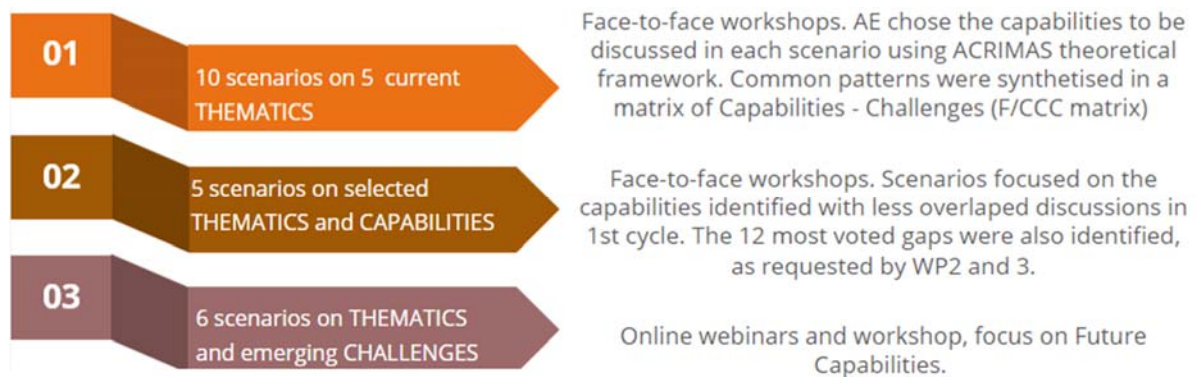21. Collapse due to major emergencies [See appendix 4]

Cycles

During the 3 cycles, adjustments on the criteria to select scenarios were done, in order to:

- 1st cycle: Challenging scenarios in the F&R arena, two for each thematic, aiming at stablishing the first draft of the F/CCC matrix. Scenarios were described using ACRIMAS methodology. In this first cycle, AE could vote between 13 tasks, selecting the 3 with more gaps they wanted to discuss. AE voted repeatedly on tasks related to organization management, community involvement and knowledge cycle.
- 2nd cycle. Challenging scenarios, focusing on those capabilities identified as important in the first cycle, but with less overlapped discussion, such as information management, pre-planning, human factors, technology... Even with this effort on actively choosing capabilities less discussed, some of the same discussions from first cycle appeared again. During this cycle, we identified the most repeated capability gaps discussed.
- 3rd cycle. Challenging scenarios, focusing on emerging challenges, in front of an unknown, unpredictable future.

01 10 scenarios on 5 current THEMATICS — Face-to-face workshops. AE chose the capabilities to be discussed in each scenario using ACRIMAS theoretical framework. Common patterns were synthetised in a matrix of Capabilities - Challenges (F/CCC matrix)

02 5 scenarios on selected THEMATICS and CAPABILITIES — Face-to-face workshops. Scenarios focused on the capabilities identified with less overlaped discussions in 1st cycle. The 12 most voted gaps were also identified, as requested by WP2 and 3.

03 6 scenarios on THEMATICS and emerging CHALLENGES — Online webinars and workshop, focus on Future Capabilities.

This process of repeatedly open to gather knowledge, and synthetise it while harmonising repeated information has been surprising, fascinating, and at the same time difficult to capture. Many things were unexpected. The first was the comfort of the groups of experts with the methodology used in face-to-face workshops, repeatedly discussed in the conclusions. They related this to the fast bridges of trust build between experts that recognized each other's expertise, and the World Café methodology that allowed/forced interaction between them in small groups, talking about their expertise.

It was also unexpected the common voting and repeatedly discussion on the same topics, scenario after scenario. Even in the first cycle in the one of the workshop's second scenario, the experts themselves recognized that they were choosing new topics to discuss just to avoid discussing 'about the same topics over and over, and getting bored' surrounded by what they recognize were other people with good expertise. Sometimes experts from different thematics approach the same gap using different terminology and different approach, but behind these different approaches it was easy to distinguish the same key gaps time after time. That drove us to adjust the methodology in the second cycle, and fix two of the three capabilities to discuss among the ones less chosen in the first cycle. We prioritise gathering a wide range of capability gaps and challenges over having few gaps but with much more repeated discussion.

When we explored in the first cycle the repeated discussions on the same topics, we explored not only the repeated approaches, but also the ones that seemed a bit different. Then we could see the driving force of the key challenges (from the usual FLOW of resources and information in a hostile area, to HIGH impact LOW frequency, to MULTILEADERSHIP to UNCERTAINTY as explaining part of these

differences). This framework of challenges, already known in the military arena as War Generations or in the Forest Fires as Fire Generations, was surprisingly useful during the second cycle to help clarify discussions on gaps during workshops.

Also unexpected was how easily operative experts translated capability gaps to capabilities were trying to develop, and to their own efforts and best practices. We felt proud to meet so many experts for whom the 'capability gaps' they were worried about was the driving force to innovations in their area of expertise, from tools, to processes, from using something in a new context to creating a brand-new process or tool. Capability gaps for first-responders are a driving force for innovation.

The last unexpected outcome from this methodology was how many of the challenging scenarios we chose happened in the next years, and how key the Common Capability Challenges made sense in the context of this new crises. Concepts that where difficult to explain in 2019 after the second cycle, such as the problem of strategic ownership or the need to strategically prioritize avoiding the collapse of emergency and key systems or the problem of uncertainty as a key Challenge in the matrix, etc suddenly made sense for everybody after COVID.

The matrix

The experts focused on a common set of tasks within the 10 scenarios (1st Cycle of WS) analysis. Although the World-Café methodology suggested 13 different supporting and preparatory tasks to investigate [Linde-Fresh et al.; 'FIRE-IN D1.1 FIRE-IN Framework'], throughout the 10 scenarios in the 5 workshops (WS), the experts focused on a common set of these **tasks**:
1. Coordination command & control
2. Situation assessment
3. Training & exercises
4. Doctrine, procedures development
5. Community awareness raising
6. Supply of basic services to enable crisis management
7. Policy making
8. Information management & distribution
9. Logistics

Integrating the full results of the 10 scenarios (1st Cycle of WS) it appeared that the common points could be organized in **four generic challenges and seven main capabilities**. The capabilities were:
1. Incident Command Organization
2. Pre-planning
3. Guidance instruments
4. Knowledge cycle in the fire service
5. Information management
6. Community involvement
7. Technology

A paradigm shift is needed to give value to qualitative information.

Qualitative information in methodologies such as those applied in FIREIN comes from expert opinions and is of great value. Responders do not make decisions on the basis of totally objective elements, but on the basis of an internal abstraction built on their experiences accumulated throughout their lives. The interaction between the different experts built a subjective reality that is certain which can be transformed into hypotheses that can then be quantitatively objectified.

In the World Café methodology there is the role of 'note-taker' and 'facilitator'. Both roles are of great importance because they must be experts capable of abstracting the gaps in the discussions, exposing them clearly and transforming the information into value. It is important that the people who perform this role are chosen appropriately because their subjectivity is of interest as it comes from their expertise. Therefore, it is interesting that they have an intentionality coming from their expertise. It is equally important to choose the person or team that distils the information from the discussions and transforms it into deliverables, for the same reasons explained for the 'note-taker' and 'facilitator'. In summary, they should be experts who understand the topic under discussion, understand the language, the concepts (not just the words) and can detect patterns and interrelationships. Their intentionality and subjectivity are an added value.

In order to choose the people who can develop these roles, it can be interesting to choose the 'nodes' from expert networks (formal and informal) who became focal points. (See section 5.6. Networks remain independent of formal processes from D1.4).

1st Cycle methodology:

In the first cycle of the project, the associated experts of each thematic working group, i.e. "search & rescue & emergency medical response", "structural fires", "landscape fires", "natural disasters" and "CBRNE", identified the main challenges currently associated to their field of crisis response. D1.2 document presented the common challenges.

The framework used the World Café Method1 and the ACRIMAS project terminology, to describe scenarios, capabilities, etc.[2].

TWG partners chose and described the 10 scenarios to be discussed, and during the workshop, experts choose the capabilities they felt more important to discuss.

Next step was to identify the most common capabilities and challenges the experts chose to discuss, looking for patterns between the 10 scenarios. A new matrix of capabilities and challenges was identified. Capability gaps were arranged in capabilities related to four main common challenges: High flow of effort in hostile environment (HF), Low frequency, high impact events (HILOF), Multi-agency/multi-leadership environment (MA-ML), High level of uncertainty (UN). The Common Capability Challenges (CCC).

See deliverable **D 1.2. Report on current and future common capability challenges (CCCs and FCCCs) #1** for further explanations [link: http://demo.fire-in.eu/wp-content/uploads/2020/03/D1.2-Report-on-Common-Capability-Challenges1.pdf].

It is important to note that during the first cycle, the ***World Café Method*** was very useful to rapidly build trust among experts, to focus on those gaps and capabilities emergency responders wanted to focus on, and to collect the experiences of different experts coming from different fields. The methodology became useful bot to build confidence quickly and to talk about applied topics.

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[1] Linde-Fresh et al., 'Fire-In D1.1 FIRE-IN Framework'.
[2] Dirk Stolk et al., 'ACRIMAS D5.1 Approaches and Solutions' (TNO, 23 April 2012), https://www.acrimas.eu/attachments/article/5/D5-1_ACRIMAS_report_Approaches_Solutions.pdf.

The topics that experts choose to discuss were also repeated for the different scenarios (topics related to incident command, to knowledge, and procedures, and to community involvement were the most repeated. But also, many gaps were repeated once and again by different types of experts in front of different scenarios. For this reason, the same methodology was used in the second cycle of workshops.

2nd Cycle methodology:

In the second cycle of the project, the thematic working group, i.e., "search & rescue & emergency Medical response", "structural fires", "landscape fires", "natural hazards" and "CBRNE" and specially the solution providers (WP2 and WP3), revisited the matrix of Common Capability Challenges (CCCs) built after the first cycle of work. They discussed the subjects that they found the most challenging, specifically the wide arrange of gaps discussed. Their feedback was presented in D1.3. A cross analysis of the ten workshops (1st and 2nd cycle) results gave rise not only into expanding the capabilities discussed, but also an inclusive list of top gaps for the responders, the ones more discussed. The D1.3 list clarified the matrix of CCCs initially presented in the project. Therefore, D1.3 presented the **cross-analysis process** performed by the experts in different fields of fire and rescue in Europe during the second cycle of the project. As a result of this process of cross analysis of the gaps raised by the practitioners during the ten workshops of the two first cycles of the project, the top gaps for the fire and rescue community in Europe were identified:

- Adapt the legal framework and requirements on prevention and self-protection of infrastructures and activities to first responders' needs, lessons learned from past events... Plan the implementation of laws and plans. Adapt the regulations to emergency situations.

- Establish standards of roles, capabilities, competencies and processes for a multi-agency framework and the mechanisms to certify them. Nowadays under similar names, there are different capabilities, competencies, and processes.

- Increase the awareness of society, of the risk, of the expectations from responders, and of their potential roles in it.

The framework used the **World Café Method**[3] and the matrix of Capabilities and Challenges. To avoid repeating the same results as in the previous cycle, the work in this cycle was focused on specific capabilities, avoiding the focus on the most repeated ones in the first cycle, where information was completed, and focusing on the next ones.

See deliverable **D 1.3. Report on current and future common capability challenges (CCCs and FCCCs) #2** for further explanations [link: http://demo.fire-in.eu/wp-content/uploads/2020/09/D1.3_Report-on-Common-Capability-Challenges2.pdf].

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[3] Linde-Fresh et al., 'Fire-In D1.1 FIRE-IN Framework'.

3rd cycle methodology:

For the third cycle, the goals and objectives were *to advice EU and policymakers, to focus innovation efforts to fit, not only the main gaps and challenges discussed in the first two cycles, but also those derived by uncertain, potential, emerging threats and hazards*. Thus, providing the EU and policy makers a framework to develop innovations that fit challenges and solutions.

To accomplish **objective 1**, the following steps were considered:

a. **Set the emerging scenarios**. TWG leaders were asked about what emerging threats and capability challenges were worth it to focus on during the workshops. Scientist and experts should be involved in the process of identifying those emerging threats. It was pointed out that emerging threats may be linked to new technologies, climate change, increasing complexity and interconnections of risks, societal changes, risk management systems, etc. The Challenges to focus on were planned to be specially those derived from uncertainty and multileadership

b. **Characterise Capability Challenges in terms of innovation efforts needed**. This step was planned to be carried out through (a) describing challenges and capability gaps and characterizing them in terms of innovation efforts needed, and (b) identifying the most critical improvement needs and capability gaps where innovation efforts are needed to face the selected emerging scenarios and challenges.

To accomplish **objective 2**, it was planned to work on (a) analysing the fit between challenges and innovative applied innovations, and (b) defining solutions in terms of how the progress to solve Future Common Challenges (FCC) and Common Capability Challenges (CCC) can be tested. This work is on WP3.

So, in the third cycle of the project, the associated experts of each task working group, i.e. "search & rescue & emergency Medical response", "structural fires", "landscape fires", "natural hazards" and "CBRNE", were asked to address **Future Common Capability Challenges**.

Through different webinar, surveys and 1 workshop, experts and scientist were exposed to define scenarios and discuss about them. These events (webinars and workshop) were initially planned to be face-to-face and using an adaptation of the **NATO FATE-Method - Futures Assessed alongside socio-Technical Evolutions** which allows to envision different future based on certain described scenarios.

Due to the emergence of the COVID19 pandemic, the face-to-face workshops had to be replaced by online webinars, and face-to-face two-days FATE based workshop was substituted by 4 hours-5 online webinars, surveys and one final workshop. It is worth noting that the **online webinars and workshops have not been as successful as the previous face-to-face ones** of 1st and 2nd Cycle. The online framework makes difficult fluid dialogue, parallel conversations, non-verbal communication, and other aspects that make them very different from face-to-face events and the application of methodologies as the World Café. This methodology was demonstrated to be successful during the 1st and 2nd Cycle but was difficult to apply on-line. On the other hand, the return for the participants (networking, possibility of parallel conversations, etc.) is much lower. Most experts had a super exposition to online meetings and were very sceptic to accept new virtual meetings. Convincing experts with a scientific background was much easier than responders' experts, that participating in any more online workshops was worth their time. In some cases, even after having confirmed attendance, many experts did not attend to the event.

There were **5 webinars** on-line and were planned with two aims on mind:

1. The selection of experts and scientist for the webinars should focus on those involved in the characterisation of the emerging threats scenarios and challenges.

2. Webinars should focus on **emerging threats,** and on **improving innovation capabilities** around F&R thematises**,** facing the next 10 years of increasingly complex emergencies management

This focus was approached because, on the one hand, it was one of the aims of the Call that FIRE-IN project win. The call highlighted that practitioner's do not focus on monitoring innovation and research that could be useful to them. So, it was necessary to give them opportunities to get together and express common requirements. On the other hand, FIRE-IN proposal was that practitioners will come up with recommendations on research and innovation, and research and industry will provide existing and innovation; aiming at focusing innovation to avoid spending budget on research that would not deliver added operational values; and aiming at fostering operationally qualified research capability developments in civil protections and Fire and Rescue Services.

The webinars allowed to gather Capability Gaps, and looking for common points between them, especially those that were not repeated in the previous two cycles (See APPENDIX 1 for the webinar Results).

There were **4 surveys** circulated after the webinars. These surveys were focused on the capability gaps, with its constraints and opportunities, as a continuation of the workshop. It was a way to focus on concrete challenges, and not to wander among the many existing ones, avoiding confusion and not focusing on results. (See the different surveys in APPENDIX 2).

Researchers and experts were involved to define the different scenarios, so they play a major role in the final results obtained. Some of the scenarios approached during the webinars were highly specifics (e.g. smart buildings or a tsunami in the Mediterranean) while others were more general (innovation in the F&R circuits). But all of them where about facing future, emerging threats

Therefore, the last **workshop** on-line was focussed on two different scenarios: a scenario like the actual context with a **gradual** change towards a worsening service, with all types of emergencies in it, and a scenario of **sudden** collapse due to major emergencies (without specifying what large emergency brought the system to collapse) (See detailed description of the scenarios and the workshop methodology in APPENDIX 3 & 4).

The **focus was on large scenarios rather than small ones** as the result of concerns that have been detected among the responders. Small scenarios can be complicated but often responders have a clear idea of how to solve them and it may be that what they lack is specific knowledge, a tool, a process, a resource. On the other hand, in scenarios of greater magnitude, the concern is greater as it can lead to collapse and uncertainty, progressively or abruptly. These types of scenarios involving many factors, actors, elements, etc. are the ones that have been identified as generating the greatest concern and have therefore been prioritised for analysis.

The results of challenges and capacities obtained in previous cycles have also been used in this third cycle and confronted with these future scenarios. The tables in section 'Common & Future Capability Challenges' include all the results obtained throughout the three cycles reflected in previous deliverables, processed, and merged to obtain the conclusions of this report.

Along this process, some of the points found in deliverable 1.3 for HF, FILOF, ML and UN; have been carried over from one to the other general challenge, following the idea of the **existence of an increase in complexity** described below but without dispensing with them.

This is not to say that some of the results obtained could not be in more than one general challenge, but priority has been given to placing them where they are most representative and, as mentioned above, following a line of increasing complexity as explained next.

The challenges described in the deliverable (HF, HILOS, ML, UN) respond to an **increase in the level of complexity**. This increase is in many cases gradual, and some actions are blurred from one to the other, so there is a certain gradation. This means that we can for e.g. have the objective of increasing credibility and trust in uncertain scenarios but we can start working on it in HF scenarios even if it is with a different approach. Therefore, change is not always abrupt, and overlaps may be encountered among them.

The 5 webinars:

The 3rd Cycle of the project included 5 webinars. From the 9th to 13th of November of 2020, different webinars gathered experts from different fields to analyse the future from different perspectives. This was the first part of the 3rd Cycle and was aimed to identify and discuss about different elements for these future scenarios. After the webinars, different on-line surveys were distributed to continue working and collecting conclusions for the workshop event in 2021. This section describes the results of the webinars.

Table 1. Topics and participants to the webinars.

TWG	Title of the webinar	Speaker	Date
	Title of the presentations		
TWG-A	Improving innovation circuits around practitioners, facing the next 10 years of increasingly complex emergencies management in the era of information and uncertainty		09/11/2020
	Innovation in disaster risk reduction and resilience.	Stefano Grimaz	
	Global wildfire events: Complex Challenging system. New capabilities for a new culture	Marc Castellnou	
TWG-B	Create resilient communities capable of dealing with the fires of structures that will characterize cities in the decade 2030-2040.		10/11/2020
	Fire safety and sustainability in the built enviroment.	Margaret McNamee	
	Building renovation and fire safety: perspective from construction product manufactures.	Quentin de Hults	
	A.I. and new technologies supporting Fire Safety	Ruggiero Lovreglio	
TWG-C	What disaster fires tell us about global change and future landscape fire challenges.		14/12/2020
	Addressing future response challenges of civil protection in Europe: Toward harmonizing command systems?	Jean-Paul Monet, SDIS Bouches-du-Rhône	
	Community awareness and self-protection – lessons learned, present efforts and future challenges for citizens and responders	David Caballero, PCF	
	Fire-use for preventative land and fuel management and response	Marc Castellnou, CFS	

TWG	Title of the webinar	Speaker	Date
	Title of the presentations		
TWG-D	Tsunami in the Mediterranean Sean. Cascading events.		
	Tsunami in the Mediterranean Sea	Georgios Sakkas	
	Preparedness and Response phases: tsunami risk, warning system and potential challenges for first responders due to a tsunami in Greece	Gerassimos Papadopoulos	
	Earthquakes and cascading phenomena	Vicki Kouskouna	
TWG-E	Emergencies with a combination of specific risks with a global impact. Multi-risk CBRNE scenarios.		13/11/2020
	Emerging threat: CBRNE global disaster	Petr Oslejsek	

See the full results and discussion of the Webinars in APPENDIX 1.

4. Common and Future Capability Challenges

4.1. Six main capabilities

The challenges identified in 1st and 2nd cycle refer to one (or several) of the seven capabilities of column 1 (**Table 2**), but in the 3rd cycle they have been renamed and rearranged to fit the different results that have been collected (column 2, **Table 2**):

Table 2. Capabilities considered in the 1st, 2nd and 3rd Cycle of Workshops.

Column 1 (1st and 2nd Cycle)	Column 2 (3rd Cycle)
• Pre-planning • Guidance instruments • Incident Command Organization • Knowledge cycle in the fire service • Information management • Community involvement • Technology	• Incident Command Organization • Preparedness • Risk reduction • Knowledge Cycle (*) • Community involvement • Decision making cycle (*)

The aim is to have less capabilities with few information or too much of it, simplifying and focusing the Capability Challenges onto what the experts actually talked about with more nuances.

Some definitions to clarify the emergency knowledge cycle and decision-making cycle concepts.

EMERGENCY KNOWLEDGE CYCLE CONCEPT

Emergency Knowledge Cycle: After an incident there is a small window of opportunity to compile experiences, information and decisions taken, but it is difficult to analyse all these elements and transforming it directly into knowledge due to the pace of events. Those who experience the emergency acquire knowledge but the transfer to collective knowledge. Briefings, daily shift changes and post-incident analysis are the first step to spread expertise and knowledge. More paused reflection can lead to lessons learned. These lessons learned can be included in operational guides and are one of the pillars of doctrine jointly to best practices and science. This doctrine is implemented in trainings and later practiced and implemented through exercises and drills that can lead to new lessons learned or continue through the cycle.

DECISION-MAKING CYCLE
The decision-making cycle is the management of information that becomes knowledge and facilitates decision-making.

Information alone does not help decision-making, even if there is a lot of it. On the contrary, a great amount of information can lead to inaction or decision-lag. In order to make a decision, information must go through a cycle. This cycle starts with the processing of information. Once the information has been processed it has to be interpreted by experts in this sort of information management. These experts transform the information into knowledge. This theoretical knowledge has to be checked against experience in real situations on the ground by experts on-field. Once the theoretical knowledge has been considered from this perspective, it becomes applicable knowledge. This knowledge, in the hands of actors capable of assess possible opportunities and constraints, can lead to decision-making.

4.2. Four main Challenges on Emergencies

Challenges emergency services confront reorders the operational and organizational concepts that are more successful to confront them. When the emergency becomes more complex, successful strategies, command and control standards, relationships with communities and stakeholders, and the focus on the investment in knowledge and preparedness, change.

Increasing complexity in challenges in managing emergencies, forces different types of solutions. The same way that this happens in the challenges in Warfare, organized in Generations of Warfare, when evolving technologies pose new challenges, result in different doctrine, operational, organizational, and cultures of war; and challenges in Forest Fires, organized in generations, result in different prevention, decision-making, operational, organizational and cultures, to solve each one of the challenges.

This concept of increasing complexity organizing the types of solutions is particularly useful when trying to focus on the Capability Challenges related to framing an uncertain future.

4.2.1. Indicators

Trying to boost all Capability Challenges in all Thematic is impossible, and just generates infotoxicity. In order to detect which is the scenario that an organization/thematic is facing, a set of indicators where identified. These indicators aim to characterize the type and degree of challenge of any given scenario. That provides focus on the specific challenges that will need to be approached. Indicators do not work by thematic, but transversally

Each challenge has a set of indicators, that allow us to rank the challenges in any given scenario. In brief, indicators are selected to be used as a tool for organizations and facilitate them that they can situate themselves and decide which Capability Challenges they should focus.

4.2.2. High Flow of resources in a hostile environment (HF) scenario

✓ A fast arrival, fast deployment and the capacity of sustaining efforts in time is key.
✓ There is a need to work inside a hostile environment positioning crews in time and place to deploy tactics, and to organize efforts from outside.
✓ A bottleneck is to maintain operative effort in time and space.
✓ With similar challenges than the second generations of warfare and the second generation of forest fires.

Identified indicators are:

▪ **Window of opportunity timeframe:** Period during which critical operations can be taken that will make the most significant difference in the output of the emergency. Depending on the emergency and the type of impact considered, can be measured in minutes, hours, days or weeks. For example, in Flash Floods experts talked roughly about the golden hour, and in earthquakes about the golden day to make the biggest difference in number of victims. Rescue operations after this time can still be made successfully but the rate of success decreases

▪ **Window of opportunity spaceframe:** Scale of space in which critical operations can be taken that will make the most significant difference in the output of the emergency. Depending on the emergency and the type of impact considered, can be measured in meters to kilometres or squared meters to squared kilometres. For example, in a high-rise building experts talked about the distance between the fire and the working plant, or in Floods about the area affected directly and indirectly affected by floods

▪ **Accessibility to the hostile environment:** Difficulty of access to the hot zone, incorporating the size of the access door and the hostility of the environment, and safety for responders in this hostile environment. Depending on the emergency and the type of hostility considered, it can be measured by the number of some types of operational resources that can be performing necessary actions in a time frame, in a safe way. For example, in tunnels, experts talked about the time different breathing apparatus provide of safe work of one firefighter inside a tunnel in minutes, meanwhile in the plane crash in an inaccessible area they talked about the number of rescue and organizational resources that can be mobilized in the first hours to make a difference into saving people. The door of entrance to the emergency is a bottleneck, and the hostility of the scenario reduces the velocity of solving the threat.

▪ **Capacity of solving the threat/hazard:** Capacity to eliminate, reduce, separate, etc the threat/hazard with a tool or technique.

4.2.3. High Impact Low Frequency (HILOF) scenarios

✓ These events are emergencies that exceed firefighters' capacities and have a high impact on the society.
✓ As there aren´t enough resources, the ones in place should focus on critical points and key missions. Avoiding the collapse of the emergency system and maintaining the initiative over the emergency is key.
✓ Low Frequency means very few opportunities to acquire and maintain the needed expertise. Fragmentation of fire services reduces expertise.
✓ A bottleneck is to develop capabilities in fire services and in the society.

Identified indicators are:

- **Emergencies exceeding responders' capacitie**s. Emergencies are evolving consistently faster than the capacity of managing them by the responders. Priorities are needed, and the cost of opportunity of what is done is what is not done, and vice versa. Depending on the situation it can be measured by the speed of evolution of the emergency versus speed of resolution of this emergency. For example, in forest fire, experts talked about speed of the fire versus speed of the lines, and on flash floods on the speed at which new emergencies are piled versus the resources pre-positioned in the right place to solve them.

- **Collapse of response system**. When the response system is unable to respond to new alerts in a normal way. Simultaneity of small and large events with multiple operational periods depletes the resources, or produces failures in logistics, communication, organizative.... In scenarios that may lead to collapse, it is not possible to have eyes, resources and means in all areas as these often quickly overcome the capacity to respond. Therefore, the way to deal with these situations is to try to run the emergency towards a known situation where action can be taken and be successful, assuming that there may be some loss along the way (e.g., X ha of burnt forest). These possible losses must be agreed upon prior to the emergency, since it will not be possible to achieve everything, and a choice will have to be made between various options based on the values that have been agreed in advance as a society. Depending on the situation it can be measured by at what scale and for how long the normal response is not available. In earthquakes, experts talked about large scale mobilization and camps of responders at different scales (from local to international) to normalize response, and in biological risk they talked also about avoiding the potential collapse of logistician, basic service providers...

- **Accumulated experience on decisors.** Responders learn and get skills on what actions and decisions may work better in different scenario are by responders by accumulated experience and routines. When a type of capability challenge is infrequent, this important baggage is not available. Depending on the situation, this can be measured by the exposure of any decision maker to similar situations. This experience is required when a new capability challenge occurs, that can happen at a strategical, tactical or operational level, in planning, coordination or intervention.

4.2.4.   Multiagency/Multileadership (MA/ML) scenarios

- ✓ There are often multiple decision-makers (=leaderships) at different levels and from various agencies, with overlapped competences. Sometimes there are also unknown and unclear stakeholders.
- ✓ There is complex integration of interests, decision-making levels, communication system, cultures, languages...
- ✓ A bottleneck is to integrate the decision-making in short time at different scales and levels focusing on strategic objectives

Identified indicators are:

- **Multiagency in the hot zone.** Each organization have their own mandates, cultures, procedures, protocols, languages, communication system and networks, decision-making levels... The more organizations are involved in the hot zone, the more complex objectives can be achieved, but also more and more energy must be spent in building interoperability. Depending on the emergency, it can be measured by the number of organizations actively involved in the response phase of the emergency, specially inside the hot zone. From a rescue in a cave, where only rescuers and

medical personnel and cave specialist may be inside the hot zone, to an earthquake, where not only the usual first responders are in the hot zone, but also many stakeholders, as critical infrastructure managers, community stakeholders, NGOs, logisticians, building collapse mitigation, military, responders from other regions or countries or continents, etc.

- **Multi-scale response coordination.** There are often multiple decision-makers (=leaderships) at different levels and from various agencies, with overlapped competences, mandates, self-interests using the opportunity in their own organization interest. Sometimes there are also unknown and unclear stakeholders. A bottleneck is to integrate the decision-making in short time at different scales and levels focusing on strategic objective. The shear complexity of the higher-level coordination organigram gives a good idea of conflicting political and social interests confluencing in the management of the emergency.

  Depending on the emergency, it can be measured by the number of political scales and mandates involved in the high level of coordination of the emergency. From a tunnel, where maybe two neighbouring response organizations within a country are involved dealing with a tunnel in fire, to a multi-country flood, where different levels of coordination within each country (local, regional, country, European, international...), with different mandates, from dealing with health, NBRQ chain events, rescue, water management, meteorology predictions, displacement of large number of people, etc.

- **Asymmetry between risk decision and consequences:** Risk is managed by an ecosystem of actors at different scales, with different responsibilities, knowledge, and impacts. Some of these actors owe controls of risk, that is to say, they can take actions to change the severity, likelihood, exposure or vulnerability of such risk. Other receive its impacts. This gap, between those who owe controls of risk and those who receive its impact, and those with knowledge on it, is known as moral hazard. An example is when a stakeholder who has a control on a risk has an incentive to increase its exposure to this risk because it does not bear the full costs of that risk. The lack of traceability between the controls of risk and the impacts is a key factor in the lack of integral risk management. It generates a lack 'strategic ownership', as describe by pandemic experts.

  A measure of this kind of challenge may be the number of stakeholders with significant controls on risk but without a mandate or key interest in reducing it. For example, in forest fires, where land use planners promoted urbanizing forest areas or conservationist promoted unmanaged forest without receiving in any way the consequences in large wildland urban interphase fire. For example, at the beginning of COVID19 pandemics, masks, latex gloves, etc. were over demand and those who controlled the production or distribution had some sort of power. These stakeholders can inhibit or facilitate actions during emergencies so is important to know about them and work with them in advance, previously to the emergency. For example, researchers can produce models, or standards.

- **Infotoxicity.** There is a high flow of new information, new alerts and messages coming from different sources. A lot of it is noise. And the more we try to gather information, the more decisions are delayed and managed thorough a long chain of command, the more they are made with expired information, and the more decision-lag is built. Nowadays, we do not have a way to measure infotoxicity but we know some of the elements that lead to it. An individual has a limited capacity to remember, process and use certain amount of information. A group of people working together could increase this amount, but the more complex the structure of an organization is (ex. number of people with capacity to decide), the more time is needed to make decisions.

So, there is a balance between amount of information to be processed and transformed into something feasible for decision-making, the amount of people involved in decision making, and the time required for tacking the decision (decision-lag). It can be measured as a network by the flow of reports, orders, messages, meetings, databases, etc per time.

4.2.5. High Level of Uncertainty (UN) scenarios

- ✓ Dynamic, unexpected risks and opportunities are emerging at a high pace due to complex, unpredictable interactions.
- ✓ High flow of new unpredicted risks that overcome the available resources; changes in situations exceed the communication capacity.

Identified indicators are:

- **Complex unpredictable emergency:** The event shows characteristics of complex systems, there is high degree of uncertainty, there is not a lineal link between cause and effect. There is a difference between **complex and complicated**. Complicated means to have a high level of difficulty. These situations may be hard to solve but you can face them with knowledge, procedures, rules, and resources. Instead, complex situations involve unpredictability, at least to a certain degree, and imply that there is not a lineal link between cause and effect. When making decisions it is important not to confuse a complicated situation with a complex situation, as in the former you must focus on how to solve the situation, while in the latter either you disrupt known sources of uncertainty from the early stages, focusing on how collapse is fabricated, either you build resiliency and robustness to survive and tolerate uncertainty. We can be prepared for future scenarios with designed measures (resolutive or palliative), but the complexity factor implies that there will be situations not unpredictable.

- **Highly-paced, dynamic evolution of the emergency.** The emergency changes at a high pace due to a dynamic evolving risk with highly complex interactions, unexpected consequences and opportunities. The more we focus on known certain risk in the near futures, the more we lose track of unexpected sources of uncertainty that can cause collapse in the medium and long-term. This complex dynamic overcomes the information channels and decision- making capacity. It is difficult to recognise the sources of uncertainty that lead to collapse and incorporate those components that are successful. This requires a wide and transversal vision with high sensibility to challenges and opportunities in real emergencies. Each high impact uncertain emergency is infrequent for individual FRS but have a higher occurrence per decade at a European scale.

  The large legal, political, and social impacts at this scale, judging the result of complex interactions and incomplete in information after the fact, translates into guilt inhibiting learning. Understanding the phenomena needs a change of scale. Examples go from a forest fire with a sudden change towards extreme behaviour due to complex interactions between atmospheric phenomena and the outputs of the fire (temperature, humidity, smoke, particles...), to flash floods, where the timing when the flood is certain enough to act on it is too short to respond, and the number of false alarms at a larger timeframe is too big. With climate change the frequency of these types of events are increasing.

- **Reactive, defensive response of society and responders.** The focus of response organizations is those risks that are certain, known and predictable, for which they are liable. There is an overreliance on technological models and past local events. Experts said these problems must be faced with capacity to improvise, flexibility, creativity, building alliances with communities and stakeholders.

4.2.6.   Example of indicators use in scenarios

The 'indicators' included help in focusing efforts on key capability gaps because they can contribute to facilitate the diagnose of the types of challenges in any scenario and to also help to identify in which scenario we are (HF, HILOF, ML, UN).

The purpose of *Section 4.1.6. Example of indicators use in scenarios* is not to carry out a detailed analysis of the indicators collected here. It simply aims at showing a possible way of analyzing the indicators in case this point is further developed in the future to be able to prioritize.

Table 3. Challenges (CH) and indicators for three of the scenarios played. A rescue in a cave, a fire in a tunnel connecting two countries and an earthquake affecting some villages and partially on some city.

Ch.	Indicators	Cave rescue	Tunnel connecting two countries fire	Earthquake
HF	Window of opportunity timeframe	orange	orange	red
	Window of opportunity spaceframe	green	green	red
	Accessibility to the hostile environment	red	red	orange
HILOF	Emergencies exceeding responders' capacities	green	yellow	red
	Risk of collapse of response system	green	green	red
	Accumulated experience on decisors	red	yellow	orange
ML	Multiagency in the hot zone	yellow	orange	red
	Multi-scale response coordination	green	orange	red
	Asymmetry between risk decision and consequences	green	yellow	red
	Infotoxicity	green	green	red
UN	Complex unpredictable emergencies:	green	green	yellow
	Highly paced, dynamic evolution of the emergency.	green	yellow	yellow
	Reactive, defensive response of society and responders	green	green	yellow

As a rescue in a cave cannot be solved without specialists, internal or external to the fire and rescue agency, to be able for enough rescuers to access safely the cave in the limited timeframe to save the victim; knowledge of the cave and experience and equipment of rescuers is key. The safe flow of specialized resources who are prepared is the priority. We are in the High Flow of Resource territory with a touch of HILOF.

A tunnel fire cannot be solved without managing the coordination between two countries, and the safe access to a very hostile environment. Building a shared understanding of the emergency becomes a priority, training interoperability and legislating tunnel protections and preparing the response with tunnel managers is key, but also understanding how the tunnel fire will evolve from the first instants to a fully developed one. Problems cannot be solved only solving the flow of resources to the hostile environment (HF), but coordinating multiple actors is the key (ML), building an understanding on the scenario on decision-makers (HILOF).

In an earthquake the time to save victims is very limited, and it needs the coordination of a lot of resources for a timely intervention, rapidly evaluating extensive risks and prioritizing the focus of efforts in time. The sustainability of the response system becomes a priority in the management system, together with focusing risk management (building codes, policies, validation, training architects...) into risk reduction, and preparing a coordinated response before it happens. Again, coordinating multiple actors and integrating earthquake safety into other policies (ML) is key as well as wisely choosing your battles and tempos when the emergency exceeds your capacities, while involving communities as agents of response, and learning from every new emergency (HILOF) is also a priority.

4.2.7.   Capability Challenges: Matrix of CCC&FCC

We have continued considering the Capability Challenges matrix but updated it. In the third cycle of the project, Future Capability Challenges (FCC) are more specifically addressed. Different scenarios in frequency, size and potential damage were approached using the webinars. They were scenarios that pose new challenges to overcome with the aim to front future collapse, both in emergencies and societies.

To distinguish CCC and FCC we have compared, what are the gaps that have been more consistently discussed in the third cycle from Challenges HF, HILOF and ML. UN challenge is fully about FCCs per definition.

The **updated Common and Future Capability Challenges Matrix** is included next:

Table 4. Common and Future Capability Challenges. CCC (shaded in white), FCC (shaded in blue) and partial CCC/FCCC (letters in blue).

	HF	HILOF	ML	UN
Incident Command Organization	Organize to sustain safe operations	Anticipate and prioritize avoiding the collapse of the emergency system	Build interoperability for a distributed decision-making based on a shared understanding of the emergency	Strategic management focused on proactively reducing sources of uncertainty and building robustness and resiliency.
Community involvement	Develop public self-protection and awareness	Involve communities and key stakeholders as active actors in risk management	Negotiate the values with communities before the emergency	Cultural change towards risk tolerance and resilience.
Knowledge Cycle	Train specific roles and risks and invest in a robust knowledge cycle	FRS empowered to innovate and build organizational learning	Build a shared understanding of the emergency, and train interagency scenarios	Focus on capacity building towards more resilient societies
Decision Making Cycle	Make operational decisions based on building an understanding of the emergency and its evolution	Choose a strategical scenario of resolution, and distribute tactical decision-making	Build a shared understanding of the scenario to synchronize decision-making	Create certainty and shared vision of emergencies.
Risk reduction	Focus encouraging self-capacities and safety	Negotiate solutions with stake holders for anticipated scenarios	Integrate risk prevention and safety into other policies and actors	Focus on governance and integral risk management.
Preparedness	Pre-plan a time-efficient, safe response, minimizing responder's engagement	Plan in a more integral way	Pre-plan interoperability and enhance synergies	Focus on governance and integral risk management.

Future Common Challenges (FCC) are directly linked to the general challenge of Uncertainty. During the webinars and workshop, it has been noticed that when approaching the future, experts easily discuss about HF and HILOF challenges but have more difficulties to address ML/MA and UN. This may be because they front more HF and HILOF scenarios than ML/MA and UN.

On-line participation may have played a part in this outcome as it has been found not to be as effective and practical in addressing these issues as face-to-face events used in the 1st and 2nd Cycle of Workshops. It has also been observed that it is easier to talk about the future with specific scenarios on mind than using a general scope.

But even considering this setback due to COVID19, challenges of UN situations seem to be linked to future scenarios while in the other extreme challenges of HF seem to be linked to nowadays scenarios. The more complex the challenge, the more FCC it contains.

Scenarios considered in the 3rd Cycle of the project were defined after the experts' contributions to the 5 on-line webinars carried out between the **9th to 13th of November of 2020**. After the webinars and surveys, a list of possible Future Capability Challenges was in place. During the last workshop, a deeper discussion on what those FCC meant was held. In this workshop, Associated Experts faced **2 unique future scenarios common to all TWGs** were created and addressed in all together: one with an 'abrupt' collapse and another with a more 'gradual' one. It was stated that, on the road to these **different scenarios of collapse**, some changes can be **abrupt** while others can be **gradual**. We can learn from the gradual ones to overcome the abrupt ones. So, in the third cycle there was an aim to identify gradual situations that lead us to the limits of the **range** in which we can succeed, detecting the existing **gaps** and training ourselves on moving from the lower end of to the upper end of the range. In theory, this will enable us to be more resilient in abrupt scenarios, bridging the gap between the 'known' and the 'unknown' (See section 'Reflections and Highlights'. Uncertainty for further explanations).

The more we can extend the range, the more we will expand our resilience, the less **fragile** we will be facing uncertain future. We have a strength ready today if we can look at, and learn, from existing examples: fragile societies and structures that have been able to resist and be resilient in the face of powerful changes. But it becomes equally important to detect the **indicators** that rapidly show when we are moving out of range a to find the proper moment to implement changes before it is so late, being aware of when a next step forward is needed.

The CCC&FCC matrix is a very powerful idea, as it contains the principle that so much can be learned from responders that have face all types of major emergencies, as when facing common challenges, many solutions (technical, procedural, organizational....) can give very good ideas on how to evolve. For example, Incident Command System, that tries to answer to incident Command Organization in front of ML+HILOF, has been successfully transferred from forest fires to all types of emergencies.

4.3.   Future and Common Capability Challenges. Description.

In blue FCC, in black CCCs.
HIGH FLOW OF RESOURCES IN A HOSTILE ENVIRONMENT (HF) CHALLENGES

INCIDENT COMMAND: Organize to sustain safe operations

1. **Quickly assess the emergency to dispatch resources and maintain situation awareness:**

   - Potential damages to victims and threats to responders, and the windows opportunity.
   - Type and number of resources needed / available in different timeframes/space frames.
   - Dispatch resources, plan safe access to the hostile environment, plan community protection.
   - Avoid the loss of information with shift changes, specializations, and levels of decision making (crews, commanders, centres of command, despatching centre).
   - Build trust.
   - Manage information, locate responders, threats and windows of opportunity,
   - Select and communicate key knowledge.

2. **Plan the strategy, tactics and operations, based on situation assessment and response options.**

    - Assess the emergency and its possible evolution, and our priorities and response options.
    - Set the objectives and the priorities prioritizing firefighter´s safety and community protection.
    - Adapt the distribution of different types of efforts in time and space to get the strategy, with the objective to maintain the sustainability of the work effort for long periods in order to get chosen objectives.
    - Set an integral control of resources, common operational picture, command structure, ...
    - Grant the provisional restoration of key critical services.

3. **Focus operations on safety and efficiency.**

    - Increase the window of opportunity for operations and its accessibility.
    - Increase the operative capacity to solve the threat / hazard. Widen the range of tools for different types of opportunities
    - Prioritize safety for firefighters.
    - Appoint a safety officer at the highest level of decision. Plan medical care in case of accident.
    - Communication is a key piece of safety. Extend communication coverage, select and prioritize messages
    - Risk 0 does not exist.
    - To decide operations in complex interventions it is necessary to take into account the balance between responders 'security, responder´s protection and interest involved in the emergency.

RISK REDUCTION: Focus encouraging self-capacities and safety

1. **Focus on self-protection and risk awareness of population.**

    - Encourage self-protection measures (education, subsidy, exceptions in regulations).

2. **Focus efforts on passive protection**, trying to contain or slow the spread of the emergency.

3. **Focus on active protection, for safe access and safe operations in the moment of the emergency for fire-fighters.**

    - Increase the window of opportunity for operations and its accessibility.
    - Increase safety for firefighters.
    - Increase the operative capacity to solve the threat / hazard.

COMMUNITY INVOLVEMENT: Develop public self-protection and awareness

1. **Train / educate / involve general population on risk awareness and self-protection** starting from scratch, in a basic and easy way

    - Train about knowledge of risk and appropriate behaviours, so that they understand the implications of their own decisions. Unrealistic expectations of safety coexist with unwillingness of population for prevention restriction.
    - Differentiate subgroups of population depending on vulnerability, accessibility, impact potential, etc. Specially target those more exposed and vulnerable.
    - Address all phases of emergency and the different levels of risk.
    - Train population as first-responders with the limits required to the situation. Consider the difficulties to manage volunteers.
    - Provide tools to facilitate decision-making for potential victims: checklists to evaluate potential risk to their properties, emergency kits...

2. Proactively **maintain the citizens continuously informed** during all the duration of the emergency.

   - Disseminate instructions to apply in case of risk, in order to strengthen the appropriate population reactions. Manage alarm systems.
   - Train first responders in using assertive communication to different targets. Do specific communications with the participation of other responders, stakeholders, politicians.
   - Expect sensationalism, excessive noise and fake news. Have a clear strategy to deal with them. Understand legal aspects of social media.
   - Invest on communication with specific profiles, key in communicating during emergencies, such as journalists, local and regional administrators, key stakeholders, other agencies.... Create specific channels and timings, spaces in the command area or specific roles in the command structures.
   - In an integrated way: at home, inside the community, at work, free time, ad campaigns, journalistic information
   - Search the most effective communication channels to disseminate selected messages for the population during and emergency (TV, radio, social networks, press conference...).
   - Generate multi-language apps, with standardized symbology.

KNOWLEDGE CYCLE: Train specific roles and risks and invest in a robust knowledge cycle

1. **Develop individual and team competences, knowledge and skills into selection, training, procedures, visits, demonstrations, drills, exercises, lessons learned...**

   - Understand profiles and roles, and the gaps on knowledge, competences and skills, and the opportunities to bridge them. Focus on learning outcomes.
   - Assign roles considering qualifications achieved and in development by everyone.
   - Know the guidance and standard operational procedures (SOP's). Use them on selection process, on practice training, etc
   - Do courses to learn. Study tools such as online training, virtual reality, certify self-training,
   - Visits and demonstrations to acquire local knowledge.
   - Invest in new specific technologies to solve specific problems... Don't let the technology become an obstacle. Focusing extremely on technological solutions could distort the resolution of the emergency.
   - Drills to acquire individual and crew´s skills
   - Exercises to train/evaluate flexibility, team building and performance. Involve evaluators and assessors. Train them. Include tabletop exercises, virtual reality,
   - Explain lesson learned to raise awareness.
   - Differentiate between operation, tactical, strategical, and chain-of-command competences. Do 'command post' tactical training to maintain a sustainable flow of tools and equipment, responders, in-out communication of information and orders, etc.

2. **Invest in developing a robust knowledge cycle in order to implement successful innovations**

   - Innovation implemented are understood as a changed behaviour in the arena of prevention, preparedness, response and restoration. Innovations range from lessons learned and best practices to new knowledge, skills and technologies (tools, capacities, techniques, outputs, processes, services, ...)

- Implement a lesson learned system, a bunch of explicit processes to gather innovations in the way things are done during emergencies, drills and exercises. Improve the understanding of local risks scenarios, gradual threats, etc.
- Identify key challenges and gaps to focus innovation efforts.
- Invest in networks of experts to exchange knowledge, experience and best practices.
- Discuss and demonstrate periodically the key challenges, best practices and lessons learned during the last period (season, year…).
- Exchange, test and adjust existing innovations and develop new ones. Use feedback/evidence from real incidents and from exercises testing them (evaluators, assessors, statistics...).
- Adjust training, guides, procedures, doctrine, and pre-plans introducing successful innovations, and explain them.

3. **Assign responsibilities to those involved in the decision-making process.**

- Information provided to make decisions in an emergency implies a responsibility.
- Trace knowledge used to make key decisions and assign corresponsibility to assessors.
- Certify models, specifically when there is a need to assume judicial responsibilities it is necessary to have robust models to help the decision-making.

DECISION-MAKING CYCLE: Make operational decisions based on building an understanding of the emergency and its evolution

1. **Select, gather, and harmonize relevant information focusing on building an understanding of the emergency.**

- Information can be a collection of data, images, ideas, resources that need to be processed to become relevant knowledge. Select, analyse, synthesize, interpret and transform information into significant knowledge in order to make decisions.
- Towards building relevant information on databases and GIS to compare and learn from emergencies, and strategies and practices of response. From locating responders and risks and its evolution, to identify and map exposure and vulnerabilities. Integrate satellite data or aerial means information (from helicopters to drones).
- Integrate when needed *knowledge* about human behaviour, patterns of individuals, communities but also responders and policy makers.
- Improve the ability to extract useful information from crowd sourcing, from the field and from other sources.
- Compile and validate dynamic data flows. Build common data repositories on key issues.

2. **Plan the emergency based on systematic assessment and reasoning.**

- Reasoning method: What can happen, how can it happen, what we want and how we can achieve it.
- Assess the scenario, its risks, threats and opportunities. Reassess continuously.
- Anticipate forecasted changes in the scenario, in the threats to firefighters' safety and damage potential.
- Interpret the actionable opportunities of shifting the scenario and evaluate the distribution of efforts needed to sustain operations.
- Interpret the possible flow of different types of resources
- Choose and prioritize objectives achievable with the available flow of resources in the next operational period

- Coordinate information on the planning, operations and progress of the emergency between those in the Command Post, those in the field in tactical and operational positions, and the Coordination Center
- The decision-making system should be based on maintaining a big-picture view, sensitive to operations, with a timely verification of too-much information, distinguishing noise from useful information to make decisions, and identifying targets and sources of information

3. **Invest in continuously distributing efforts and information in time and space (tactics), based on new information.**

   - Invest in tactical profiles, distributing resources in time and space to achieve objectives (tactics).
   - Track the objectives progress, as well as resources and impacts.
   - Adjust tactics continuously based on new information on the development of the emergency.

4. **Provide guidance and doctrine in front of specific hostile environments.**

   - Doctrine and procedures should focus on protecting firefighters and the rest of people but should not focus on avoiding and correcting legal conflicts.
   - Therefore, they should be simple and allow freedom and adaptability to reality.
   - Guides / procedures for a quick mobilization of resources to minimize total damages in a time-efficient way (mobilization, arrival, command, transfers and turn-overs, work-rest balance, briefings, documentation, maps, logistics, communication, cross-border procedures, division into zones and divisions, safety or resources mobilization protocols, organizational criteria and language, specific techniques, restoration to normality actions...)
   - Test before writing guidance and doctrine. Gather lessons learned in different emergencies, both on what worked and what failed. Perform small- and large-scale tests if possible. Harmonize relevant information on databases to compare and learn from emergencies, and strategies and practices of response.
   - Choose carefully what is set as a standard, understanding responsibilities both from who sets the standard and who implements it. Understand implementation issues on these standards in the field (there is always a distance between paper-solutions and real-world ones). Understand the unexpected effects on decision-making environment changes derived of implementing new guidance and standards.

PREPAREDENES: Pre-plan a time-efficient, safe response, minimizing responder's engagement

1. **Pre-stablish scenarios using statistics as a baseline and recent incidents and accidents to define which scenarios are probable.**

   - Train and practice based on some of them
   - Prepare key stakeholders' involvement in the emergencies.
   - Understand possible help from outside the regional system and how to integrate it.
   - Harmonize procedures with neighbours and key assistance, to integrate them into the command structure of the emergency. Share key lessons learned and best practices.
   - Plan communications, legal and economic issues, logistics...

2. **Plan mobilization, pre-positioning and operative for specific scenarios.**

   - Gather and share relevant information of selected local hostile environment, and its pre-planned response measures

- Package and pre-position modules of resources, equipment and logistics for quick transport, and easy tracking.
- Be sure that there are at your disposal a minimum of logistical resources and supplies to provide to the population and responders during long duration emergencies
- Increase the safety and operability in the hostile environment. Increase the window of opportunity of types of operational resources that can be performing necessary actions in a time frame.

HIGH IMPACT LOW FREQUENCY (HILOF) CHALLENGES

INCIDENT COMMAND: Anticipate and prioritize avoiding the collapse of the emergency system

1. **Prioritise to avoid the collapse of the emergency response system**

   - There is a need to shift the focus from minimizing potential damages to reducing the collapse of the emergency response system for the final scenario, considering different values, applying triage techniques.
   - Anticipate probable alternative final scenarios.
   - Prioritize to grant the availability of responders, logisticians, and other resources and key specialists (mobility, effort management, external aids, responders' health) and grant a shared understanding.
   - Plan the resources to be activated at a local, regional, cross-border and international scale. Pre-position them depending on risk assessment.

2. **Boost specialization in operations, intelligence, planning and/or communication to the public.**

   - Public information function. Develop a specific communication strategy to maintain credibility, including social media. Integrate feedback from the emergency.
   - Boost specialization in specific key thematic to gather knowledge, skills and experience in specific persons and profiles.
   - Psychological support
   - Integral control of resources.
   - Situation assessment adviser, knowledge-based cells, analysts and intelligence-cells functions to focus on key relevant intelligence to anticipate relevant changes, plan decisions linked to anticipated scenarios
   - Trace the level of corresponsibility of support actors into the decision-making process.

RISK REDUCTION: Negotiate solutions with stakeholders for anticipated scenarios

1. **Anticipate scenarios of low frequency, high impact events, to focus prevention efforts**

   - Base the prediction of scenarios on historical events and on statistics (baseline), including the modelling of the actual conditions (at local level) and the human factor.
   - Use a range of probable anticipated scenarios for pre-planning and prevention, from a local to a regional level, integrating different disciplines.

2. **Broaden the scope of the first responders towards the proactive management of risk:** risk knowledge, risk prevention, community self-protection, involving key stakeholders, risk communication….

3. **Negotiate expectations with critical stakeholders, and clarify expectations and responsibilities involved.**

- Build trust with key stakeholders that either have responsibility or have some type of direct or indirect control over the risk. Involve risk owners, control owners, technical experts and other stakeholders, including designers, enterprises, firefighters, authorities...
- Regulate the expectations of safety in front of anticipated scenarios during the response phase.
- Ask different agencies and stakeholders for their capacity to solve gaps.
- Negotiate with stakeholders with direct and indirect control over risk, relating specific prevention and preparedness measures with the accepted level of risk to build alternative strategical scenarios.
- Involve society in choosing between alternative strategical scenarios, including values and accepted level of risk
- Communicate expectations.
- Shift from performance standards to design standards when needed.

COMMUNITY INVOLVEMENT: Involve communities and key stakeholders as active actors in risk management

1. **Involve communities into driving a change of paradigm for society, from victims to actors in the emergency.**

- Change of paradigm. From 'We, authorities, will protect you' to 'You, citizen, should be actively involved'. Explain clearly that responders cannot protect everybody in case of major incident. These affirmations mean that you should be prepared to be self-sufficient concerning to your own protection and your community protection always inside the framework of the emergency. Be used to this sort of situations normalizing them
- Build trust involving communities and key stakeholders in risk management permanently. As large emergencies are infrequent, people rely on luck and responders to protect them. Preparation of scenarios, to discuss decisions and behaviour during the emergency, verifications, drills and exercises. This reduces the distance between expectations and reality between responders and communities.
- Plan and prepare the involvement of volunteers and other civil society members in the emergencies. The more daily protection the first responders provide to unaware citizens, the more vulnerable people become when first responders' capabilities collapse.
- Perform communication campaigns targeted to specific communities, with messages, exchanges and media carefully studied.
- Identify key stakeholders and increase their understanding about the risk, either those with power to create opinion and those that take key decisions.

2. **Involve key stakeholders, encouraging them towards an integral culture of risk awareness and resilience.**

- Policy framework encouraging people, stakeholders and communities to build resiliency to anticipated risk scenarios before, during and after the emergency, within an existing risk management framework.
- Translate the investment on prevention, self-protection and preparedness into risk, and negotiate accepted risk. That builds legitimacy, corresponsibility and trust.

- Building on and transform the memory of historical catastrophes. Consider community's lessons learnt, collective memory, community's values.
- Educate children and young ones as actors on the emergency, building risk awareness, tolerance and resilience.
- Involve journalist and mass media. Perform training on means for mass information (social media, smartphones, short videos, ...).
- Be prepared to provide massive alerts to population.
- To do mandatory exercises financed by the owners of high-risk activities.
- Training/educating the next generation of technicians that will take decisions about planning, education, management, risk culture and risk management. Enhance their scientific and technological culture, and their understanding of risks.

3. **Invest In credibility in the communications during the emergency.**

- Build trust explaining in a transparent way 'what can happen', explaining the final possible scenarios of the emergency.
- During the emergency, integrate society as a part of the strategy in front of collapse.

KNOWLEDGE CYCLE: FRS empowered to innovate and build organizational learning

1. **Empower Fire and Rescue Services to focus innovation efforts and implement successful innovations in the knowledge cycle.**

- A changed behaviour in the arena of prevention, preparedness, response and restoration must be driven by first-responders, collaboratively with industry, communities, stakeholders and/or research.
- Be aware of how those innovations that add operational value to solve key challenges have been chosen.
- Some criteria to evaluate the added value of new technologies. They should be useful; simple, intuitive and easy to use, easy to integrate and interoperable; robust, resistant, long duration, able to tolerate sever/harsh conditions; open access; easy maintenance, few logistical demands (fuel, electricity, connectivity...)
- Responders can invest in the development of specific needed new technologies (procurements of innovation, public-private network, testing technologies...); can be involved in the designing phase of new tools and services developed by industry or scientist; and can be end-users of existing products.
- Understand the processes that will change when you implement an innovation.
- Be aware that there are a lot of existing research, products and processes, and few of them will add significant operational value to emergency management, adding noise without holding any responsibility in the outcome of the emergency.
- A shift from the culture of errors and guilt towards lifelong learning and organizational learning practices. Briefings, lessons learned, sharing experiences and best practices, implementing and practicing new procedures...
- Innovation is slow, takes a lot of trials, requires a focus on minimizing noise to operation, produces new unexpected challenges and requires tolerance to frustration and to change. That translates into a general lack of bet for I+D+I in Fire and Rescue Service, which is a big potential to be unlocked.

2. **Build cost-efficient processes to manage specialist and build on existing talent to gather key knowledge and skills and transfer them to your organizations.**

   - Reduce the loss of experience (decapitalization) with the generational change, and with the shifts in positions, shifts in talent and shifts in the existing networks.
   - Invest in the existing talent in the organization to introduce best practices and lessons learned, internally and externally. It has a cost, in financial support, personnel, time, implementation procedures. Boost an exchange program to gather understanding in specific challenges and best practices, by shadowing, joint exercises, exchange of trainers, joint training ...
   - Build communities of practice of experts from different organizations around a thematic. Identify challenges and best practices and exchange experts to understand them. Accumulate experience in large events in specialists and experts in selected challenges. Share specific guidelines and procedures.
   - Boost multidisciplinary teams of experts either scientist, specialists, firefighters or stakeholders to focus specific and specific problems. Involve stakeholders in visits, training, lessons learned or exercises when needed. Connect with research and private enterprises in small projects around specific gaps and challenges.
   - Build processes to transfer specific knowledge and skills of experts into an increase in knowledge and skills of firefighters.
   - Map centres of knowledge and capabilities (theoretical, practical and interface) at an international level and considering the comparison of capabilities.
   - Encourage the creation of exchange of experience networks covering different sort of emergencies.
   - Focus on improving the cost-efficiency of organization learning.

DECISION-MAKING CYCLE: Choose a strategical scenario of resolution, and distribute tactical decision-making

1. **Proactively decide the strategy towards a chosen final scenario, accepting the cost of opportunity of the set priorities.**

   - Focus on rapid recognition of the scenario; on anticipation of the behaviour of the fire/water/chemical/radiation; on understanding capabilities of the emergency system; and on understanding the values of the society.
   - Build a vision of the emergency: Understand alternative final scenarios of possible values at risk, depending on opportunities used, and the cost in opportunities not used.
   - Set the strategy: the chosen scenario of resolution of the emergency It implies a set of objectives prioritized to achieve it, and an understanding of possible evolutions.
   - Be aware of critical points that can propagate the emergency, especially those vectors of propagation that could lead to domino effect.
   - Shift from reactive response ('we do what we can when a problems appears') to a proactive one ('we respond to things that we anticipate may happen').
   - Build systems (persons-tools-processes) to integrate and analyse information from different channels, to manage information overload, to evaluate and anticipate probable scenarios. The aim is to provide a shared understanding of the scenario and operations.

2. **Build an orderly systematic decision-making process to make tactical decisions to achieve assigned missions.**

- Tactical decision-makers are ordering the capacities used in time and space to achieve assigned missions, based on the shared vision of the scenario, the strategy and values. Tactical decision-making is distributed in the Command Post, in tactical moving positions in the field and maybe in other the coordination centres, depending on the spatial extension and evolution of the emergency.
- In the Command Posts, prepare the intervention plan for the next operational period and share it by radio/phone/face-to-face communication and during periodic planned meetings.
- In meetings discuss the intervention plan for the next operative period, and gather information from the field in meetings, in printed or electronic documents or specific designed platforms.
- Tactical decision-makers should systematically gather on-time knowledge in shared forms, whiteboards, GIS platforms, etc to facilitate on-time decision-making.
- Promote awareness. Identify and deactivate critical points that can propagate the emergency. Mitigate threats.

3. **Continuously distribute efforts and information in time and space, based on assigned missions (tactic) and operations.**

   - Prepare tactical and operational decision-makers to decide based on the vision, the strategy and values.
   - Measure and communicate the degree of achievement of missions assigned and propose alternatives.

PREPAREDENESS: Plan in a more integral way.

1. **Plan towards a more integral risk management**

   - In their planning, responders' agencies should include low frequency, high impact emergencies, those that are probable at long term, investing in knowledge and skills and being prepared by a flexible and modular approach (external and internal facilities, strategic communication plans, reception of logistical aid...).
   - At a national scale, promote context-specific guidelines on best practices in planning, preparedness and prevention.
   - Adapt the pre-plans to usable tools in the moment of the emergency
   - Adapt the legal framework on integral risk management. Plan the implementation of laws, norms, plans and procedures. Adapt the regulations to emergency situations.
   - Data protection legislation should facilitate the availability of information during crisis situations, in order to make easy to take decisions shared with multiple agents. It should also allow individual and organizational learning.
   - Build specific SOPs, guides and doctrine for specific scenarios with high impact.

2. **Incorporate specific support specific tools, profiles, communication and command posts.**

MULTIAGENCY/MULTILEADERSHI (MA/ML) CHALLENGES

INCIDENT COMMAND: Build interoperability for a distributed decision-making based on a shared understanding of the emergency

1. **Boost bottom-up harmonization approach between agencies and political entities** (regions, countries...) that need to collaborate regularly in emergencies.

- Aiming at increasing interoperability in cases of assistance, cross-border emergency, emergency with potential impact in the neighbouring area...)
- Harmonize information fluxes, roles and capabilities, processes, logistics, teams/modules*.
- Raising awareness and common knowledge on roles and capabilities from the different agencies and stakeholders in the emergency, and on cultural diversity and your role in the situation.

2. Boost top-down interoperability approach towards an integrated emergency management framework:

- Setting standards, common procedures, shared training and exercises, and guides.
- Setting common principles and procedures, building a flexible coordination, command and control framework, towards an ICS type, adapted to European reality.
- Standardizing modules and capacities at a European scale based not only on its interoperability, (self-sufficiency, logistical preparedness, coordination...) but also, on the quality of its operational ability to reach tactical and operational objectives, and to assess in decision-making, planning and logistical aspects. Increase the number and quality of teams/modules/capacities. Towards INSARAG standards for teams in other type of emergencies.
- Establish mechanisms to certify any standard, and link liabilities also to the certification provider.

3. Identify points of coordination to provide a shared understanding of the emergency.

- The aim is to provide a shared understanding of the emergency, the common objectives, the roles, each ones mission, the frame of interaction between actors and other coordination aspects of the emergency
- Establish different levels of <u>liaison officers and deputies</u>, translators; communication bridges; entrance points; and infrastructures.
- Identify <u>points of coordination</u> in the different zones: from local (hot zone, warm zone ...) to regional and to national.
- Establish the level of command, coordination and support to intervention and identify the standards for information exchange.
- Establish a systematic planning process, and coordination process.

RISK REDUCTION: Integrate risk prevention into other policies and actors

1. Societal safety should be an integral part of any policy, tracing responsibilities.

- Integrate strategic risk management into other policies. Economic, sustainability, social and ecological goals have an impact on societal safety. Societal safety should be an integral part of any policy.
- Build linkages between policymakers and emergency managers with regular meetings to integrate emergency challenges and needs in policies.
- Trace responsibilities. Prevention, preparedness and response actions are linked to potential consequences. The aim is to understand the alternative scenarios of resolution of the emergency.

2. Map existing networks and stakeholders at different scales.

- Identify key stakeholders with control on risk, who can increase it or decreased it when they plan, decide, or legislate in their field, directly or indirectly. Make them consistently aware of the impact of their activity
- Identify key stakeholders with knowledge on values at risk, who can assess these values at risk in front of alternative scenarios.

- Identify communities and stakeholder who can suffer the consequences of risk and make them aware.
- Map existing networks at international, national, regional and local level.

3. **Enhance synergies with key stakeholders who control, know or suffer the consequences of risk.**

- Prevention must include dialogues with risk managers and communities. Responders must provide a shared understanding of alternative scenarios of evolution of the emergency, and the opportunities and uncertainties that arise.
- Boost on in-site, face-to-face, frequent activities sharing a clear aim.
- Train values such as empathy, adaptability, proactivity, collaboration and leadership, and promote trust building.
- One example to enhance synergies are fire groups, including main stakeholders, translating decisions into risks. Those groups must build trust through permanent meetings and an agreed framework.

COMMUNITY INVOLVEMENT: Negotiate the values with communities before the emergency

1. **Negotiate with communities and key stakeholders before the emergency on the scenario of resolution.**

- Responders during emergencies make decisions that can have long term impacts beyond their knowledge and expertise. These decisions can define the future socio-economic and cultural landscape
- During the emergency specific knowledge of key stakeholders can be integrated in order to better understand the values at risk.
- Involve society into negotiating the accepted risks in front of different alternative scenarios of resolution of the emergency. Establish a dialog, share challenges, distribute decision making, and understand responsibilities.
- Build on Early Alerts to make communities aware of risk, encouraging self-action in the direction that favours the resolution of the emergencies avoiding noise, encouraging actions to identify and take care of those mor vulnerable and avoiding misinformation.
- Communities differ when choosing values and sometimes they respond to cultural, social, economic, and historical matters that are beyond the emergency scope. It requests a dialogue, that cannot be done during the emergency, about the alternative scenarios of resolution of the emergency and its implications.
- Focus on long term teams rather than individuals.

KNOWLEDGE CYCLE: Build a shared understanding of the emergency, and train interagency scenarios

1. **Boost the competences for key positions and key modules/teams/capacities in emergency management at a European scale.**

- Boost the harmonization of competences for specific positions such as different types of liaison officers, support to decision-making, support to specific operations... in emergency management at a local, national and European Level, involving formal and informal network of practitioners, disaster management schools, and its certification processes.
- Create an archive/catalogue of experiences, best practices and lessons learnt. Incorporate it to the data and knowledge of previous incidents existent platforms at a European level.
- Create opportunities for face-to-face, on-site visits on workshops on last events or innovation, joint training and practices, assistance or shadowing in case of major incidents, and exchanges.

- Understand roles, terminology, capabilities, decision-making and other specific processes, and do it before, during and after the emergency to all the involved.
- Once the standard roles of different actors have been trained and drilled inside each agency, organize multiagency joint trainings and exercises with the focus on decision-making, coordination and interactions between agents.
- Train in overlapped competences and limits of competences. Train the trainers of the different agencies. Share on-line training and exercises

2. **Provide a shared understanding of the emergency behaviour, and the emergency system options.**

- Understand roles, terminology, capabilities, decision-making and other specific processes on other responders. Focus on bridging compatibilities. Focus on *a shared language (terminology, framework, mind-set, procedures…), especially in MA/ML scenarios, to facilitate fluent exchange of information between agents, coordination and command & control, community involvement and interoperability'.*
- Create an archive/catalogue of experiences, best practices and lessons learnt. Incorporate it to the data and knowledge of previous incidents existent platforms at a European level.
- Once the standard roles of different actors have been trained and drilled inside each agency, organize multiagency joint trainings and exercises with the focus on decision-making, coordination and interactions between agents. Train in overlapped competences and limits of competences. Train the trainers of the different agencies. Share on-line training and exercises
- Boost standard competences for specific positions in emergency management at European Level, involving European Disaster Management Schools, and its certification processes.
-

DECISION MAKING CYCLE: Build a shared understanding of the scenario to synchronize decision-making

1. **Prepare common information management processes between agencies**

- Implies managing complex information and knowledge focusing on the multiple levels of decision-making.
- Fluxes of information between agencies in a multi-leadership context can be overwhelming, contributing to increase the noise.
- To overcome this challenge, we need to define what information, knowledge and decisions needs to be shared among agencies. Focus on acquiring and distributing the knowledge to achieve objectives, giving flexibility and autonomy in decision making.
- Invest on specific profiles managing information and specialists transforming it into knowledge and decision-making.
- Standardize fluxes of information and decision-making between private, civil and military environments, reducing bureaucracy
- Cross-border logistics and procedures standards, for aids and shared emergencies.
- Understand the terminology and information and decision processes and each agency´s role on it. Identify the sources, liabilities, and traceability of key information. Share needs and limitations from different agencies (format, procedures, legal aspects…). Define the evaluation and lessons learned process after the emergency.
- Create interoperable sharing platforms (GIS platforms, databases, cartography,). to circulate information to establish a common framework for decision-making.
- Standardize the shared information between the Call Centres, Dispatch Centres and the Command Post.

2. **Build a shared understanding of the scenario across responders to synchronize simultaneous decision-making at different levels.**

   - Recognize that during multi-agency / multi-region emergency, different cultures coexist. Agencies are making decisions at different levels (coordination, strategical, tactical, logistical, operational) and with different mandates (safety, security, health, restoration, environment, sustainability, economy....)
   - A shared understanding of the emergency facilitates a better synchronization of the simultaneous decision-making. Decision-making is distributed based on common objectives and assigned missions.
   - Identify the relevant knowledge and decisions (terminology, scenario, evolution, strategy, threats, procedures, lessons learned ...) that should be known by all agencies or all responders.
   - Decide the process to define a common emergency plan by operative period in a multi-agency / multi-region context. Agree on the process to share planning information.
   - Decisions are taken at different levels and by different agencies, and they should be building towards the agreed strategy and objectives. The aim is to boost velocity and efficient interaction between the decision-makers and implementers and managing complex information focusing on the multiple levels of decision-making.
   - Boost coordination, agreements and sae vision; from division scale in intervention, to specific thematic (fire, rescue, safety, security, displaced persons...) to coordination scales (emergency, local relevant incident, national, international aid), or by type of emergency actors (responders, authorities, stakeholders...) by, for example, agreeing on meeting schedules at different scales and thematic.
   - Share the plan of action. This can be done through whiteboards in the multi-agency coordination centre, in printed or electronic documents or specific platforms.

3. **Build a shared understanding of the scenario across responders to synchronize simultaneous decision-making at different levels.**

   - Recognize that during multi-agency / multi-region emergency, different cultures coexist. Agencies are making decisions at different levels (coordination, strategical, tactical, logistical, operational) and with different mandates (safety, security, health, restoration, environment, sustainability, economy....)
   - A shared understanding of the emergency facilitates a better synchronization of the simultaneous decision-making.

PREPAREDNESS: Pre-plan interoperability and enhance synergies

1. **Build strategic ownership during emergency preparedness with a multi-agency, cross-border and European perspectives.**

   - Towards a legal framework for cross-border help, emergency support, victim transportation, recognition of qualifications...
   - Enhance synergies between experts, including first responders, planners, engineers, specialized industries, land and infrastructure managers; between agencies and from regional, to national and international level. Share specialists and experts.
   - Plan strategic ownership at different scales, including, multi-agency and cross border scale. Pre-plan d negotiated with key agencies and stakeholders, aiming at sharing the view of the emergency, and the corresponsibility with the end result. Agreed chain of command, specifying roles and capabilities in advanced.
   - Establish agreements and structures for cross-collaboration between entities (private and public) with specific key intelligence on the risk, with those who have power of decisions on factors that modify the risk and with those who have influence on the management of the risk.

- European interagency round tables reviewing lessons learned (changed behaviours) by emergency systems after the large and complex emergencies for the last period of years. Aiming at specific recommendation of new policies, procedures, guides, innovation or standards at the decided scale (cross-border, multi-agency, European). Engage different types of decision-makers (coordination, strategical, tactical, operational...).

2. **Train interoperability on purpose at a multi-agency, cross-border or European scale.**

- Boost the exchange of experts in low and medium complexity scenarios, to train interoperability in more complex scenarios
- By monitoring and shadowing in small to medium complexity emergencies, planned periodic exchanges and shadowing, cross-border assistance, … Joint trainings, joint exercises, joint lessons learned…

HIGH LEVEL OF UNCERTAINTY (UN) CHALLENGES

INCIDENT COMMAND: Strategic management focused on proactively reducing sources of uncertainty and building robustness and resiliency.

1. **Focus on how unexpected collapse is fabricated.**

   - Study integral risk management at a large scale, building a wide short, medium and long term view, involving stakeholders, and focus on the interphase between different incidents, changes of behaviour, domino effects and uncertainties.
   - Understand probabilistic **forecast** of different scenarios, compare **alternatives**, and have **contingency plans**.
   - Focus awareness in those factors that can lead to collapse. Understand **known sources of uncertainty in the medium and long term** in which we can act, both in the scenario and in our operative. Many of these uncertainties may have low probability. Evaluate the cost of opportunity between these medium and long-term sources of uncertainty and the known certain risks.
   - Choose **alternative strategic scenario**s, including desired, accepted and unaccepted outcomes. Identify critical points and opportunities.
   - Be aware of small signals with potential to shift us from the chosen scenario (**key indicators**).
   - Understand the **drivers, challenges, and constrains** that make some best practices and lessons learned successful to extrapolate them to other scenarios, risks, and situations.
   - **Work on constrains** to reduce them, integrating research in real emergencies (**'emergency labs'**) or developing basic science that approach the drivers of the phenomena.
   - **Maintain a broad vision of the scenario** ('zoom out') but while considering specific areas and experts ('zoom in') that can provide a new perspective of the problem, sometimes even coming from different fields of expertise. Focusing on specific matters (e.g., manoeuvres) without having the long-term space-wide vision can lead to a biased view of the situation.

2. **Boost collaboration between research and responders.**

   - Boost a close **collaboration between research and responders**, directed to specific problems, concerning responders decision-making process, keeping in mind the drivers of change of behaviour and effects, and tools to respond to the emergency (for example, treatments):
     a. Redefine constrains.
     b. Integrate research laboratories as responders.
     c. Develop basic science concerning drivers of the risk phenomena.

3. **Boost resilience in command structures.**

   - **Train crews and commanders in decision-making and communication in uncertain, dynamic, unexpected scenarios**, adapting tempos and synchronizing activities with other agents. Cultivate this kind of mentality of awareness and creativity, and flexibilize existing procedures.
   - **Create confidence and trust in the IC structures**. In these complex situations where it is not always possible to fully understand the phenomenon, it is important to have the capacity to build trust, forged when what has been set out is achieved.
   - **Command structures need to be resilient**: adapted to complexity, focused on centralised strategic guidance, increasing knowledge-based tactical autonomy.
   - **Capitalize knowledge** by extracting the experiences of unfamiliar situations and the responses developed and consolidate them as lessons learned for future emergencies.

RISK REDUCTION: Focus on governance and integral risk management.

1. **Work on prevention in communities through adaptative management processes:**

   - Involve **key stakeholders** (risk owners, control owners...) in action-based strategies, considering integral risk management opportunities.
   - Build **strategic ownership**.
   - Develop **adaptative management processes**, to learn by doing.
   - Encourage the development of own skills and **community skills to be resilient** in front of uncertain risks, fostering habits focused on the adaptation to risk scenarios and on the **robustness in front of the risk.** Communities should get ready tools alternative to technology that allow them to be resilient when technology fails.

2. **After crises focus on moments that can promote change:**

   - Focus on **small window of opportunities** to change policies and governance processes. Be aware of the nature of politics and election cycles and the tendency to forget past bad things, taking advantage of the window of opportunity that appears after emergencies to avoid it.

3. **Create the framework to be able to work with agility during emergencies.**

   - Promote the growth of sustainable, **risk-decreasing activities** via policies, certifications, insurances...
   - Promote **quick adaptation** to changes in scenario through situation assessment and decision-making structures.
   - **Identify and reduce bureaucracy and other inhibitors that slow progress**. Being aware of the **inhibitors**, those elements that make difficult to reach our objectives or follow our strategy, can help on avoid losing the initiative during this sort of emergencies. These inhibitors can come from policies, bureaucracy, governance procedures, etc. But after emergencies, there is a 'window of opportunity' to work on this because the disruption that appears creates space to improve and change things. For example, SEVESO legislation has evolved after big accidents that after being analysed have led to improvements in the regulations (SEVESO I, SEVESO II).
   - Invest in strengthening strategies that facilitate communication and joint work. **Collaboration tables** to prepare for the collapse and to decide on values, for example, what we can sacrifice and what we need to save.

PREPAREDNESS: **Focus on governance and integral risk management.**

1. **Plan with the aim to be more resilient.**

   - Work with one or several possible collapse scenarios in mind.
   - Plan to **improve the resilience among responders to maintain their response capacity** during emergencies. But bearing in mind that a certain degree of flexibility is necessary in this type of emergency, it is important to avoid planning that creates such a rigid framework that it does not allow for flexibility.
   - **Pre-plans should be flexible, focused on indicators of key changes and providing tools for alternatives and contingency plans**.

2. **Build trust and credibility**; it must be prepared, trained and stakeholders should be involved.

   - Credibility is built, with transparency on the decisions to be made in such scenarios and achieving the results. Engaging society and key stakeholders on the decisions to be made. Prepare and be clear about the message**s** that are going to be issued in different scenarios, to transmit the same vision, even if it is through different messages but all along the same lines, and a speaker. To this end, it is useful to have previously worked on communication management (communication plan, trust in the organisation, human factor, etc.).
   - In such scenario, the current **systems of communication and social networks may collapse** (for example, the fall of the internet, monopoly of the message to generate noise for specific purposes outside the common good, etc.), so having a trusted person or group of people of reference to deliver the message may be key to avoid interests that are away from the resolution of the emergency.
   - **Trust is also built by interacting with the community and key actors before emergencies occur.** In a situation of this magnitude, it may be difficult to interact during the emergency, but even specific interlocutors who disseminate the message that corresponds to this common vision can help to eliminate external noise and focus attention on the actions that need to be taken to resolve the emergency.
   - **Train crews and commanders in decision-making and communication** in uncertain, dynamic, unexpected scenarios, adapting tempos and synchronizing activities with other agents. Cultivate this kind of mentality. Facilitate the improvement of existing doctrine.
   - Invest in **strengthening strategies that facilitate communication and joint work and to create collaboration tables to prepare for the collapse and to decide on values**; for example, what we can sacrifice and what we need to save.

3. **Develop and improve certain tools:**

   - Tools and mechanism to monitor that the operation/response progresses as planned.
   - Tools to massively alert population in real time.
   - Quick screening tools for triage.
   - Virtual reality to train responders.
   - It is necessary to have certified artificial intelligence (AI) tools and validated models that simulate the evolution of the scenario, both for the decision-making process. It is necessary to develop processes to assess, validate and/or certify the level of TRL and the operative application level of services and tools used by responders (EPIs, models of behaviour, AI, etc.). End-users should be an active part of this process.
   - Crowd-sourcing and multiform data integration tools.

COMMUNITY INVOLVEMENT: Cultural change towards risk tolerance and resilience.

1. **Boost a cultural change in risk tolerance and resilience.**

   - Communication in uncertain events (chained events, dynamic environments...) is crucial; it must be prepared, trained and stakeholders should be involved.

2. **Focus on credibility and resilience.**

   - Focus on maintaining and increasing confidence and credibility in uncertain scenarios that can lead to collapse. This credibility may have been created before, in different emergencies, but the current emergency itself is a moment to reinforce it. To achieve this credibility, what has been said that would happen, or that would be done, must be done. In other words, 'you have to do what you say you can do'. Reach population that has no trust in government authorities, but it can be done through non-governmental stakeholders.
   - Empower communities and stakeholders and recognize and partner with existing civil-society initiatives addressing critical issues.

3. **Be aware of the price to pay when choosing certainty.**

   - **Avoid losing the capacity for action**: In an uncertain situation, to avoid collapse, we seek to create certain scenarios of resolution so we chose our battles and efforts are effective In this way, we avoid losing our capacity for action and create the conditions for success in achieving the goals we have previously set.
   - **Have priorities previously agreed, work on the values to protect previous to emergencies:** Avoid losing capacity involves setting out options and choosing between them. This choice and the creation of certain scenarios can leave out some situations, because in every choice there is also a renunciation. **So, there is a price to pay when choosing something certain** in uncertain events. For example, in an extreme wildfire event, this choice may result in losing an area where it is uncertain whether we can   succeed, in favour of an area where we can act and hinder the advance of the flames.
   - **Explain uncertainty and involve potential sceptics, suspicions and disagreement: A part of society may be opposed to losing an area/land**. It is important to explain the uncertainty to society so that they can understand that there will be times when decisions will be made on the basis of previously agreed and shared values, and **involve them in the scenarios and decisions**, opening a dialogue on values and priorities, whenever possible, prior to emergencies.

4. **Focus on the short window of opportunity after emergencies.**

   - Community also involves politicians so if we want to involve the community they must be included as well. **After large disaster, there is a short window of opportunity to change policies and governance towards an integral risk management. Usually, restoration is a missed opportunity**.

KNOWLEDGE CYCLE: Focus on capacity building towards more resilient societies.

1. **Build doctrine for resilience in emergency services and societies.**

   - Ensure that doctrine gives space for safe decisions towards solving the incident in unexpected scenarios.
   - Solve the problem of communicating science in timely manner and to show uptake of knowledge due to traditional process.

- Recognize the most successful **innovation labs** in different capacities and thematic (criteria of success to solve key challenges) existent in the emergency framework. There are countries where practitioners have expertise in fronting new challenges so it is important to identify them because they can generate the knowledge and innovative ideas for countries that lack of focus due to their inexperience in these situations but that soon will front the same challenges.

2. **Promote adaptative management:**

- Promote resilience and **adaptative management** for society by fostering **'emergency laboratories'** (first aid, science society) in which different responders, science, and society merge in real situations in order to understand what the real situation is during an emergency and to find knowledge and innovations adapted to the specific characteristics of these uncertain situations.
- Shift from lessons learned on individual emergencies to **large-scale tests, on-the-go research focused on key emerging phenomena, with sensitivity to operations**.

DECISION MAKING: Create certainty and shared vision of emergencies.

1. **Create certainty through resilient strategies**

- Strategies shift from minimizing damages towards increasing resilience, choosing scenarios where efforts will work safely, reducing potential chain events, involving safely stakeholders, and reducing complexity.
- Focus on how collapse is fabricated. Prioritize maintaining or restoring initiative in decision-making, and on providing a predictable environment for operations. Understand and accept the prize to be paid in certain risks Build an organizational structure to overcome uncertainty, based on anticipating the scenario's probable evolution and the strategies to reduce possible sources of an uncertain collapse, and tactics to deal with it.
- Adapt warning systems and strategies to probabilistic forecasted scenarios.
- To reduce the uncertainty that could appear if the decision-making is taken with out-of-date information (**decision-lag**), it is necessary to lower the decision-making to commands on-field that have the real situation at sight, bet for a management based on objectives assigning missions to different teams that will need to synchronize between them (**mission-command**).
- Collapse. There are sequences that lead to catastrophes so detecting the critical points that lead to the final collapse could represent opportunities to operate/to action. It is necessary to negotiate ways to deactivate critical points for catastrophic scenarios.

2. **Provide an efficient, flexible flow of information for a shared understanding.**

- Manage information in scenarios with domino effect which are time-constrained, or scenarios of risk that could lead to collapse, in order to avoid disinformation that could result in to panic and to the system collapse.
- Identify the uncertain scenario and sources of uncertainty by way of **monitoring the situation**.
- Share **key intelligence** to facilitate synchronized actions and to maintain the initiative on a changing scenario.

3. **Improve technologies adapting them to new challenges and emergency response needs. Models show a discontinuity between past and future.** Most models consider elements observed in the past but projections into the future are scarcer. We must incorporate elements of what is to come and not only rely on the past, as we will be faced with new situations that have not been observed before. For this reason, it is also important to strengthen the human factor as a knowledge manager.

5. Reflections & Highlights

This section compiles reflections and highlights that have been collected throughout the different workshop cycles.

5.1. Capacity building towards societal resiliency

The more we protect, the less they protect themselves. The more a community is protected daily from small exposures, the more unrealistic expectations of protection held. This is, the more daily protection first responders give, the more vulnerable are people when first-responders capabilities collapse. It is the Protection-Expectations Balance (PEB). That often results in less investment in self-investment, increasing their vulnerability to this high impact low frequency scenario. This unrealistic need of protection increases the need of resources and approaches the system more to collapse. This directly impacts on the community self-protection, and it should be considered seriously to balance both perspectives: external vs self-protection.

There is a **lack of awareness from society of vulnerability**. Unrealistic expectations of safety coexist with unwillingness of population for prevention restriction. As large emergencies are infrequent people rely on the thought that the such events are unlikely to occur to them and, in case it happens, first-responders will be able to protect them from the impact and consequences of the event.

Solutions may come from, on the one hand, to have policies that raise awareness of the limits of organisations' response capacity, and on the other hand, to encourage people and communities to develop skills and resources to self-adapt to risk scenarios. **Strategic risk management** is separated **from other policies.** Economic, sustainability, social and ecological goals have an impact on societal safety. Therefore, societal safety should be an integral part of any policy.

5.2. 'Faith' in technologies

One of the results of the surveys was that when approaching technologies there exist two extreme visions: those who totally trust in technology (33%) and those who are sceptical:

Experts were asked different questions about technology. For the **response phase**, experts where asked to pic a statement that best represents their view on technology and innovation and **33,3%** considered that there is significant room for improvement and foresee technology and innovation revolutionizing the way; **18,2%** were sceptical of technological fixes and tend towards viewing innovation as scaling up current best practices and focusing more on exchange/transfer; and **48,5%** considered that while advancing technology and innovation will continue to play an important role, there is relatively limited room for improvement in operational.

For the **preparedness/prevention phase and restoration phase**, experts where asked to pick the statements that best reflects their view and **33,3%** choose that technology and innovation have limited potential to improve the preparedness/prevention and restoration; **54,5%** considered that technology and innovation can play an increasingly crucial role in better preparedness/prevention phase and restoration phase; **9,1%** Technology and innovation are largely irrelevant for these phases; and the rest (**3,1%**) thought that technology and innovation will play an increasingly crucial role in better preparing for, preventing and recovery.

The technology that should be transferred must be that a real use and is applied in a territory as a tool for decision-making in governance, management, or dissemination. Transferring lessons learned, working methodologies, examples of different management, etc. implies being able to explain why it works in that territory, what makes it possible (drivers) and what has had to be overcome (barriers) for it to work. Having a clear understanding of the socio-economic ecosystem and the management of the territory where the technology is applied is the most important thing to explain to other devices or territories so that they can assess its direct applicability or the need to adapt it to their own context.

One should not try to transfer something that one does not know if it will work; it is a cost for those who receive it and a discredit to its promoter. Investing in understanding and explaining why it works in one place and what capacity it might have to be implemented in another is the most important part of ensuring that its transfer is the result of the willingness of other countries to import this technology, rather than the sole desire to export a tool on the part of its promoter.

5.3. Successful innovations are introduced by those who face new challenges

Emergencies are increasing in complexity faster than our capacity to innovate. There are different factors that contribute to this situation. The increasing complexity of society creates new challenges that cannot be overcome with old perspectives. These new challenges foster innovation because those who face new situations usually need to innovate to overcome them, but it needs time to develop and disseminate them. In addition, the information era is changing the structure of knowledge and decision-making.

Traditionally, innovation (understood as a new or changed entity that realizes or redistributes value) has been understood to follow the next cycle:
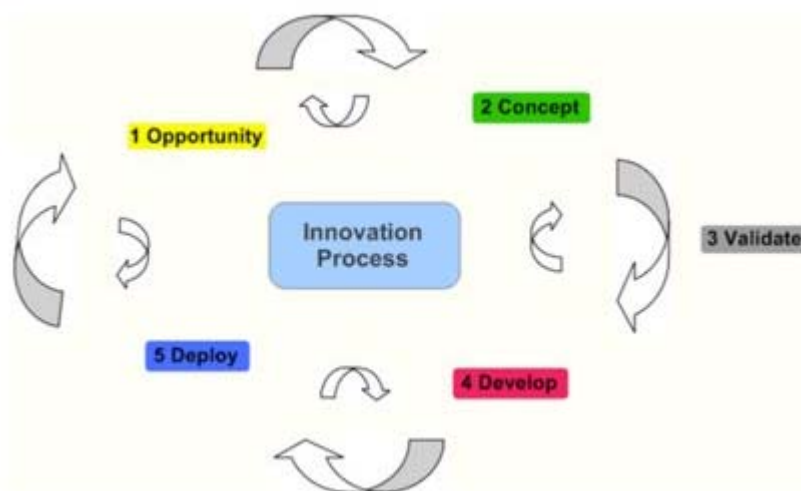
In this framework, novelty and value are determined by interested parties which has different consequences. First, researchers usually understand innovation as something that occurs in research centres, deployed by publishing a paper or a deliverable, and using pilots or prototypes. Secondly, the market tends to understand innovation as something deployed by selling a product or service. Finally, practitioners understand innovation in a wide sense (a product, service, process, model, method…) and as something successfully deployed. To be deployed this innovation must be worth changing the way they usually do things or, on the contrary, is not worth using because of the profound changes that many of them require in organisations.

> "*Creativity is any act, idea, or product that changes an existing domain, or that trasforms an existin domain into a new one...What counts is whether the novelty her or she produces is accepted for inclusion in the domain*"
>
> Mihaly Csikszentmihalyi. Psicologyst

It must be remembered that organisations prioritize to build trust, confidence, and robustness in their actions, so in emergency situations, trying things out for the sake of experimentation is not an option. Different proposals are emerging that try to change this perspective, but there is still a long way to go (See the next example: Public Sector Innovation Facets – Observatory of Public Sector Innovation: https://oecd-opsi.org/projects/innovation-facets/). But they also need to be flexible in order to allow innovative people to have room for growth. The figure of the **talent scout** must also be strengthened within organisations to be able to give encouragement to innovative people.

In emergency world, **most innovations come from other fields with similar challenges**. First responders themselves, when faced with repeated challenges, generate new solutions or look for them in other fields. So small teams with scientists and responders focused on solving a specific challenge can be a good way to proceed. This will need to be accompanied with sufficient network for the solutions to grow and spread. It is worth it to remember that reality is a good validator, but it needs attention and data.

So, as seen above, innovation in emergencies does not exactly correspond with the traditional model of the cycle of innovation described in the first paragraph of this section. Nor does the knowledge cycle correspond exactly to the knowledge cycle in other fields (See section 'Definitions' for further details).

Emergencies are a **source of knowledge** and responders frequently need to be **creative and innovate when facing new challenges** coming from new emergencies. But big emergencies do not exist daily so responders cannot acquire all the necessary existent knowledge and at once be updated experiencing all the new situations each year they front globally around the world with global change effects during all his/her individually by using their own time of work. On the contrary, organizations can share knowledge and bridge the gap between the individual and collective using proper knowledge cycles [4. Mutlileadership/Multiagency environment; Knowledge Cycle].

Emergency knowledge cycle (See section 'Definitions') does not exactly correspond with other models of acquiring knowledge used in formal learning, science, or industries. Sometimes this can cause gaps between science world and practitioners knowledge acquisition because the second tend to learn by doing, experiences, exchanges, and direct questions to trusted actors (usually other responders that face same challenges) to learn.

For this reason, it would be worth it **to share the knowledge cycle with scientists with the aim to guide the world of science to the real needs** which may firstly require to **map centres of knowledge and capabilities (theoretical, practical and interface) at an international level and considering the comparison of capabilities** to detect where to invest.

Emergency labs can help in this process. Emergency lab can be understood as the action of bringing experts from different areas (research, industry, etc.) or risk decision-makers (e.g. land planners) to emergencies so that they can see first-hand in which situation decisions need to be made.

For actors who have control over risk, this allows them to be confronted with the consequences of decision-making (decisions they take before and after emergencies); facilitates that they are consulted on the values to be protected, saved, etc. (triage) during emergencies and to be involved in decision-making at some point.

For the actors who generate knowledge and invest in technologies applicable to emergencies, their participation in emergency labs allows them to be put in front of the real situations in which these products will have to act, far from the laboratories and in the face of the specific constraints that exist in emergency situations.

In both cases, F&R services benefit by the presence of experts who can contribute directly with their knowledge and help in the emergency.

Adaptative management can be remarkable when approaching new challenge in uncertain frameworks. It consists of following a structured, iterative process of robust decision-making in the face of uncertainty. The aim is to reduce uncertainty over time via system monitoring. The main idea is to learn from the actions that are taken and use the knowledge as a basis for the next steps or emergencies that follow. In new situations that no one has faced before, this resource can be of great help and contribute to create certainty step by step, as situations are faced.

Large-scale exercises make it possible to integrate many stakeholders and to set up complex situations. These exercises may incorporate actors from different fields and emergency managers are put in the situation of having to interact with multiple agencies and leaderships. In addition, these exercises allow them to jump into unusual situations and practice the challenges that may be encountered.

Stronger guidance from practitioners towards efficiency in front of evolving challenges can be a pillar for innovation. This guidance can be fostered by addressing different issues:

- Overcome the entrance barriers that practitioners face for proposals.
- Develop recommendations to foster high quality research acknowledging practitioners' role.
- Methodological framework for continuous updating of European Research Agenda.
- Exploitation of synergies between existing facilities available for testing, demonstration, exchanging and training under operational conditions.
- Changes in public procurement policies fostering innovation.
- National Contact Points (NCP) that ensure the entry of all representative stakeholders.

5.4.   Standardization vs Harmonization

Harmonisation allows for the integration of solutions that already work in organisations, but they maintain the flexibility to foster creativity, well-understood 'improvisation' and the ability to deal with uncertain future situations but adapted to the different conditions and challenges of each region and organisation.

When a process of harmonisation of the capacities of emergency systems is undertaken, common needs and shortcomings emerge across Europe. Industry can take advantage of this gap and carry out investments to offer products to cover these needs and provide solutions to the gaps. So, they can meet. But, when this harmonisation does not exist, needs are fragmented, and market opportunities are small. In this case, innovative products become more expensive and do not cover all the needs of end-users.

The process of standarization is much less flexible, and reduces creativity and adaptability. Also, any standard set need to imply responsibility, and that those posing the standard need to be liable when this standard is used and doesn´t work properly.

Legislation should be developed but with caution, facilitating the challenges ahead and avoiding creating major problems. It is important to regulate responsibilities in emergencies for all the actors involved, not only responders. It is also significant to regulate standards feedback process for the end-users for citizens' involvement. And responders should be integrated in the elaboration of all this legislation, not only that which refers to the emergency but also the preparedness or recovery because it conditions the scenario in which the responders work. But at the same time, it is important to reduce bureaucracy which causes slow progress in situations in which there is a need for urgency. As a specific case, during emergencies, data protection legislation should facilitate the availability of information for decision-making in a context of emergency.

5.5.   Asymmetries in decisions (Moral Risk)

When there is asymmetry between who has the authority/liability, who has the knowledge and who receives the consequences, problems arise. This asymmetric can be recognized by different elements:

- Risk is managed by an ecosystem of actors at different scales, with different responsibilities, knowledge, and impacts.
- Key stakeholders involved take decisions but do not receive the consequence of their decisions in terms of risk.
- There is a lack of strategic ownership. From self-preparing as agencies, regions, countries...to proactive shared preparedness.
- Lack of joint responsibility on the whole value chain. Traceability.

There is a lack of joint responsibility on the whole value chain. Decisions are centralized in one actor, usually responder, that frequently, in addition to resolving the emergency, must consider aspects beyond its expertise. Furthermore, the problem increases because of the absence of traceability on who must contribute with information to facilitate decision-making by giving their perspective on the characteristics of the impacted elements and values at risk, on liabilities and pre-emergency and post-emergency decisions that affect the response phase environment and on future implications of the decision. One of these key actors are policy makers.

Asymmetries does not only appear in the emergency arena. In economics, moral hazard occurs when an entity has an incentive to increase its exposure to risk because it does not bear the full costs and impact of taking that risk.

5.6. Networks remain independent of formal processes

Responders' networks often function through networks of trust, reference persons acting as nodes and flows of mutual needs that mark the interaction. Being integrated in a network often provides them with knowledge, support, interaction with other members with the same needs, concerns, and challenges; and all this in an environment of mutual trust that seeks to address the same objectives: to solve emergencies. So, these networks do not need projects, regulations, or processes to structure them, so to join this sort of structures, members must a sense of getting something in return (knowledge, contact with specific experts, etc.). What these networks need are trustworthy people who, on a one-to-one basis, get in touch with each other to achieve a common goal e.g., to face the same challenge.

Individually, experts participate in networks or events (workshops, webinars, etc.) when they have something in return. Usually, experts are asked to participate in a lot of events but many times they are not economically rewarded by their participation. This participation frequently includes preparing presentations, sometimes revising documents and always an invest of time, at least during the participation itself. Reward comes from the knowledge acquired, the opportunity to discuss and share ideas with other experts, or the chance to listen to interesting new ideas or different perspectives. So, the incentive to participate in workshops comes when experts receive more than they contribute. And this does not always happen. Therefore, to bust the sustainability of networks is important to bear in mind what sort of return will have those who are asked to participate.

When the situations we face are new, there is often a learning process of trial and error, of assessing alternatives and choosing the ones that are thought to be best, even a certain process of hesitation before tackling them. It is therefore important that these networks are in an environment where they can **discuss safely and in confidence, away from the noise and scrutiny that actors who are not involved in decision-making** may have and seek for their own objectives and benefit, which may be far from the common good. These networks have nodes that are both 'innovators' and 'hubs', who have some trust from individual 'innovators' because they give back new knowledge, information, etc. Networks shift and change continuously, as well as experts and hubs: new nodes born, others disappear; but the network continues growing, evolving, or shifting.

FIRE-IN project is an example that reinforces these statements. The experts involved in the different scenarios are recognized experts, both form formal and informal networks. FIRE-IN partners have become the focal points in a network of experts.

So, in this framework, some __recommendations__ can be made:

- Innovations, once they exist, can use the **networks** we have mentioned to spread. It is also important to promote figures that boost innovation (hubs, *talent head-hunter*, etc.) within organisations.
- We need changes in values and society to facilitate a different **Culture of Innovation**. Innovations can change the scenarios in which we move and will move in the future, even raising ethical questions, and condition the future that we will face.

- It would be interesting to have a measure of the **ability of a solution to solve key challenges**. It will be also useful to detect changes in values and culture that facilitate innovation scenarios. But what is certain is that successful technologies are those that respond to existing challenges, so those who front these challenges (responders) can say a lot about their success and help on their improvement.

- It is important to detect the **processes that bring innovations to the surface** as well as the constraints. It is necessary to incentives, policies and practices are needed that facilitate the emergence of relevant innovations and that consider the cycles of adaptability and change in the face of new challenges.

5.7.   Restoration phase, a short window of opportunity

Restoration tends to be the less approached phase in emergency cycle. In the different workshops done in this project, restoration has also had a minor representation. That is because experts did not tend to discuss about this phase, so the collection of results does not include many results about it.

But is worth it to remind that after emergencies there is a short window of opportunities. This restoration does not only involve the environment impacted by the fire. There is a chance o change policies and governance after large disasters towards an integral risk management. And Systems only truly change then. Budget and doctrine changes is linked to media coverage.

Restoration of normality, a missed opportunity. After emergencies there is a short window of opportunities. Restoration always goes after them and does not only involve working on the environment impacted by the risk occurred. After large disasters, there is a chance to change policies and governance because, on one hand, many actors become aware of the risk and, on the other hand, the event itself generates spaces to work in (e.g., physical changes in the environment, shift from theories to realities, social awareness of risk, etc.).

This opportunity should also be used to adapt to existing challenges and seize the moment to create more resilient areas and structures. Often, the impact creates a certain destabilisation and flexibilization of both physical and organisational structures that can be used to improve them.

It is also necessary to take an important step towards processes and solutions to accompany the return to normality (recovery). This is a growing demand from the population and is not being approached to a level that communities perceive as sufficient.

5.8.   Uncertainty

In scenarios with a high degree of uncertainty usually it appears a lack of focus on different issues. Firstly, there is a lack of focus on **building robustness in front of the unexpected**, which is an important point to avoid collapse.

Secondly, there is a lack of **adaptative management** (See section **Innovation comes from those who face new challenges**) so this is transformed into more difficulties to create certainty by applying the knowledge learned by facing each emergency. Those organizations focused on responding to certain risks that have not incorporated this adaptative perspective can be less successful in overcoming fast evolving situations with a high level of unexpected developments. When this happens, these organizations have proven to be specialized but inflexible in the face of change.

Finally, there is a lack of focus on **how collapse is fabricated**. This leads to focus on responding to those risks that are certain and causes that, in front of complex emergencies, there exist an overreliance on technological models and past local events. To overcome this, there is a need for a range of projected scenarios focused on relevant actionable challenges, based on experiences at a larger scale, transversals risks, etc. because complex systems must be understood at another scale.

'Unknown, knowns': That is, we address what we are aware of ('knowns') that we do not know all about the situation, the process or similar knowledge ('unknowns'). Here there is an awareness of the situation, but we do not have enough knowledge to know why it is happening, we don't know the drivers, the constraints, the process itself, etc. Here we can act to create certainty because at least we are aware that we do not know everything, we are aware of the situation we are in, even if we do not understand it.

It was explained that from the field of HRO this situation is defined as 'how uncertainty is fabricated', from economy they search for 'sources of uncertainty' while from FIRE-IN the issue is approached from the 'Strategic scenario' perspective.

'Unknown, unknowns': That is, both we are not aware, and we do not have enough knowledge to know about what is happening. This situation is worse than the previous one because we are not aware of the situation, and we do not know the origin of what is happening. For this reason, it is more difficult to move for action in this framework.

It was explained that from the field of HRO this situation is approached from 'robustness in front of unexpected', from military scope they search for 'disciplined autonomy' while from FIRE-IN the issue is dealt from 'improvisation' and 'empowering decision-making'.

6. Recommendations

This section aims to give advice EU and policymakers, to focus innovation efforts to fit, and to provide the EU and policy makers a framework to develop innovations into solutions that fit challenges and solutions. The recommendations included in this section aim to bring together the most significant points identified throughout the process followed and explained in this deliverable. But for more details or more concrete actions it is recommended to review the entire deliverable because throughout the text many ideas have been given that can help to the same end. The main recommendations are:

- **F&R EXPERTS IDENTIFY MAIN GAPS TO PRIORITIZE, ON PREVENTING AND PREPARING LARGE EMERGENCIES THAT CAN CAUSE COLLAPSE.**

  o When first responders are required to identify the capability gaps in front of large emergencies, **they focus on specially on preparing for those emergencies that can cause collapse** on safety for responders, resources, decision-making capacity

  o by building knowledge to focus decision-making and by involving communities, stakeholders and policymakers as active actors,

  o These focus in preparing for emergencies begins **by understanding the accumulated experience of decision-makers on emergencies** that exceeds the capacities of responders, threatening its collapse, and the focus and organization of this decision-making structures, before, during and after the emergency.

  o It continues by building knowledge to **focus decision-making to prepare risk scenarios** with communities, stakeholders and policymakers, and with multiagency and multileadership actors, negotiating decisions and tracing its consequences into integral risk management.

- **EMPOWER F&R EXPERTS / AGENCIES / NETWORKS WITH EXPERIENCE ON LARGE EMERGENCIES SHOULD ACT AS HUBS OF INNOVATION TO IMPROVE PREPAREDNESS. Emergency labs.**

  o F&RS are the last frontier in front of high impact, low impact, highly uncertain and complex risks. The focus of first responders should be on those emergencies that have a high impact and are more uncertain (HILOF and UN), as well as building interoperability to provide and receive help in these scenarios (ML). Expertise in these kinds of emergencies is the key bottleneck, so those who have should consciously act as hubs of innovation, to improve preparedness, involving communities, stakeholders, other first responders, policy-makers... in different networks with different objectives.

  o Boost proactively focus on reducing sources of uncertainty that may lead to collapse (in resources, in decision-making process, in safety for responders...). Involve communities and key stakeholders into strategic decision making and on robustness and resiliency in decision-making and risk management structures.

  o Existing networks of responders need to be boosted, formal ones but also informal ones. Boost informal networking policies and look for the ones that are providing

recognized innovations in the system. The aim is to identify innovations, detect solutions, identify new gaps, and create knowledge sharing.

o Focus F&RS into involving other responders, research and market into specific projects looking for best practices, innovative knowledge, facilitating decision-making, etc.

o Focus F&RS into involving communities and key stakeholders as active actors in risk management.

o Identify and invest in Emergency Labs for different thematic, grounded on operations, innovations, and networks of practitioners from different scales, and with different types of profiles. Invest into adaptative management.

o Compare responder´s policies and its outcomes. Responder´s have different patterns of organization, of resources investment, of experience accumulation on decisors, … That have different results. But data formats, definitions … are really different, and not thought to be exploited. Statistics and AI are a pending innovation to be properly introduced.

o Involve end-user in projects of research and innovation from the first steps. Involving different end-users in projects right from the research phase facilitates coordination. Increased a professionalised and harmonised NCP system that may ensure high quality research, understands the opportunities that responders bring to the whole cycle of innovation, and facilitates the entry of all stakeholders required for the entire R&I cycle

o Promote the sense and need of innovation in the whole risk cycle. Boost the need to have R&D&i departments inside or linking F&RS and invest in this area. Link innovation to the consequences during the emergencies and to the ground. Facilitate their participation. Promote sustained R&D inside the F&R organizations, independent from European and National R&D projects.

o Future operations improvements should focus on specifics that have not yet been incorporated and that are key to face specific challenges.

- **A CULTURAL CHANGE IS NEEDED IN EUROPEAN SOCIETIES IN ORDER TO BE ABLE TO DEAL WITH MAJOR EMERGENCIES** (of a global nature and the result of globalisation).
  o It has been a trend in recent years in the European Union that society has left it in the hands of the governments and organizations its self-protection. Public services have been very effective in resolving small emergencies but have proved incapable of taking on this protection on a large scale. It is therefore time to return this capacity to citizens in order to generate more resilient societies. In this case, what governments and organizations should focus on is to provide the tools to their citizens.

  o Focus capability building efforts onto societal resiliency. The community is a part of emergency management. Communities should be trained and involved in landscape-scale risk, where they should expect to become active actors in emergency management.

o Policies that have a major impact on society safety in front of major events must incorporate safety. From environmental conservation and fire or flood in the landscape, to electrical critical infrastructures in landscape-scale risk, to industries policies. Identify the most relevant risk catalogue and integrate the key actors in managing these risks and in receiving its consequences.

o RISK GOVERNANCE SHOULD BE BASED ON TRACEABILITY. There should exist traceability of the impact of asymmetric decisions. This is to be able to identify who is making a profit of the situation and who is suffering the consequences. In uncertain scenarios, when the uncertainty of decisions is traceable, this becomes into certainty about the challenge to face. Traceability allows to assess the degree of symmetry, that is, the balance or imbalance of the situation. So, sum up the benefit obtained from some stakeholders should be balanced with the traceability of the impact or with compensation. This traceability should be found on the scale of the whole scenario. Traceability in HF, HILOF i MA/ML will involve being able use probability to define the limits of capacity of organizations, how many times decision-making will fail or success, etc. Traceability in UN will not be based on probability but on the identification of the sources of fail and success. For example, if an organization has uncertainty when uses humidity to assess the fire behaviour it must be explained and making this evident boost traceability of the actions.

- **EUROPEAN/NATIONAL POLICIES SHOULD FOCUS SPECIFICALLY ON EXPECTED HIGH IMPACT-LOW FREQUENCY-MULTILEADERSHIP SCENARIOS, AND ON HIGHLY UNCERTAIN SCENARIOS,**

    o Correctly diagnosing the focus of safety policies at European and National level means understanding the high impact-low frequency-multileadership emergencies at a European/National level, but also to focus on uncertain scenarios. It implies to build a catalogue of large-emergency-based-risks to focus on at a European/National level, to correctly diagnose the main challenges and capability gaps placed by those emergencies, and preparing for those scenarios

    o To increase the capacities focused onto these type of high impact, highly uncertain emergencies inside Europe/Nation (flooding, earthquakes, large forest fires), they should be considered a key objective in policies, from economic policies to conservation ones, from industrial policies to urban and landscape management ones. Understanding and measuring the impact of those policies is key for appropriate, balanced, integral risk management. Building traceability is key.

    o These emergencies cannot be solved only by placing interoperable modules in place and investing on coordination capacity, but by specializing and improving knowledge and decision-making processes, by involving communities and stakeholders, and by increasing interoperable cross—border, multiagency preparedness, and by increasing operational capabilities standards measured by outcomes in reducing the threads/hazards and achieving tactical objectives

    o European/National policies should grant an appropriate framework for countries/regions to face these challenges. Not only building interoperability by increasing top-down interoperability of modules, but also interregional interoperability, a common framework for multiagency structures (ICS type). It´s not enough to be able to put interoperable modules in place, but capacities of these modules to solve the threads/hazards effectively should increase, not to the minimum

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available offered by national agencies, but through harmonization of procedures and knowledge to increase the minimums, by better differentiating capabilities in front of different challenges inside the type of emergency, and by selecting where and when standards on capacities should exist, requiring measured outcomes in knowledge and efficiency.

o   There is a need to change how solutions are assessed to really respond to existing needs and challenges and not to the traditional innovation cycle that has assessment parameters focused only on the results obtained in research, industry, pilots, and exercises outside of real scenarios. Creating indicators of success that take this into account can help.

Framework to develop innovations into solutions

1. Invest in developing a robust knowledge cycle in order to implement successful innovations.
2. Empower fire and rescue services to innovate and build organizational learning.
3. Create opportunities for face-to-face, on-site visits on workshops on last events or innovation, joint training and practices, assistance or shadowing in case of major incidents, and exchanges.
4. Boost European interagency round tables about innovation reviewing lessons learned (changed behaviours) by emergency systems after the large and complex emergencies for the last period of years.
5. Recognize the most successful innovation labs in different capacities and thematic (criteria of success to solve key challenges) existent in the emergency framework.
6. Boost 'emergency labs' as sources for finding innovations.
7. Develop small teams with scientists and responders focused on solving a specific accompanied with sufficient network for the solutions to grow and spread.
8. When considering innovations in a field, apply the Matrix of FCCC/CCC to identify innovations that can be useful from other fields with similar challenges.
9. Boost stronger guidance from practitioners towards efficiency in front of evolving challenges as a pillar for innovation. This guidance can be fostered by addressing different issues:
a. Overcome the entrance barriers that practitioners face for proposals.
b. Develop recommendations to foster high quality research acknowledging practitioners' role.
c. Methodological framework for continuous updating of European Research Agenda.
d. Exploitation of synergies between existing facilities available for testing, demonstration, exchanging and training under operational conditions.
e. Changes in public procurement policies fostering innovation.
f. National Contact Points (NCP) that ensure the entry of all representative stakeholders.
10. Correctly define liabilities about standards.
11. Spread innovations by investing in networks and figures that boost innovation (hubs, talent head-hunter, etc.) within organisations while investing in detecting the processes that bring innovations to the surface.
12. Promote changes in values and society to facilitate a different Culture of Innovation.
13. Create indicators of success for the innovations.

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7. Policy brief on current and future common capability challenges

1. General Scene

Crises, disasters and catastrophes are unavoidable, and out of the capabilities of emergency systems to control. They can be fast-paced, and highly uncertain, and threaten the collapse of the emergency management service, as well as the social and economic fabric of society. They are infrequent, however, in order to prevent, be prepared for them, respond and restore to a more resilient state, it is required a different set of skills, processes, policies and paradigms from a wide range of actors and sectors interacting at different scales. Most of these actors and sectors are unaware or unresponsive of their impact in these state of crisis and episodes of emergencies

Consequently, a range of <u>scenarios and challenges must be anticipated</u>, allowing us to understand the gaps in the capabilities of Fire & Rescue Services, Emergency Systems and Society as a whole.

This policy brief is made from the point of view of emergency managers, who have already responded to crises and disasters, facing infrequent and complex scenarios full of uncertainties. It gathers and synthesises wisdom from experts in different thematises, many of whom are building new capacities in their own organizations and emergency systems.

As a concept, emergency managers are not end-users of research and industry, but we have been leading many of the innovations that are changing how the next major complex emergencies will be managed on different thematics, from forest fires, to earthquakes, to large floods, etc

2. Policies to strengthen capabilities to face key challenges and gaps

In front of a wide range of crises and disasters that can have a high impact on society, exceeding the capacities of risk and emergency management systems, we can identify a set of new challenges driving the adaptations in policies needed.

High flow of effort in hostile environment	High impact, low frequency (HILOs)	Multiagency / multileadership	High level of uncertainty
A fast response to all new threats and the capacity of sustaining efforts in time is key	These are emergencies exceeding firefighters' capacities to defend values, and have a high impact in society.	Multiple decision-makers (=leaderships) at different levels and from various agencies, with overlapped competences, even unknown and unclear stakeholders.	Due to its complex interaction, emergencies can be unpredictable.
There is a need to operate safely inside a hostile environment.	With very few opportunities to acquire and maintain the needed expertise, due to low frequency and responders' fragmentation.	Complex integration of different interests, decision-making levels, communication system, cultures, languages, …	A high pace dynamic evolution of simultaneous events with unexpected consequences and opportunities overcomes the information and decision making channels,
This is business as usual, and **policies** (and innovation efforts) are directed at processes to **maintain a safe operative effort in time to defend values, and public awareness of risk.**	**Policies should develop capabilities in F&R organisations, key stakeholders and communities to accept losses and learn to prioritize proactively, and to accumulate experiences.**	**Policies should develop capabilities in the emergency systems, to integrate decision-making at different scales and scopes, and build interoperability.**	**Policies should develop capabilities in society, towards governance and cultural change to focus on reducing uncertainty and build resiliency.**

Faced with these challenges, that are beyond the day-to-day ones, fire and rescue experts are focused on key gaps in the capabilities of their organisations, systems and societies.

- **Adapting the Emergency Organisation to new challenges**: Crisis and disasters require a different way of organizing the emergencies from usual business, changing the focus towards sustaining a safe operational environment, avoiding the collapse of emergency system and reducing sources of uncertainty. It is also required to build interoperability of systems and actors.

- **Introducing adequate Innovations**. In front of infrequent emergencies that require new ways of operating, the creation, copy and the transference of key innovations is the cornerstone which will permit improve the way to face it. Experts are focused on building a more robust knowledge cycle in their own organisations and their formal and informal networks of practitioners and research, to create, copy and transfer key innovations. This process means that it is needed the identification of new skills, partners, processes, tools, capabilities and so on, as well as, the implementation in form of new roles, tools, materials, tactics, doctrine, training, policies…

- **Involve communities and stakeholders in risk management**. Those who will receive the impact of crises are unprepared for what will happen, for their self-protection and their active role in risk management. Risks are managed by a wide range of actors who will not always receive the impact of their decisions or actions, many of whom are unaware or unresponsive to the effect of them over the others. Experts have been repeating on and on the need of a cultural change in risk awareness and risk management to build resiliency.

Regarding building these three key capabilities in their organizations, emergency systems and societies, experts focused on involving key actors on risk reduction (before, during and after the emergency), on optimizing the decision-making processes and on planning and preparing for challenging scenarios.

3. Recommendations and policy implications

We need changes in the innovation framework and in the risk culture

Increasing resources and capabilities to defend values and work in hostile environments will not solve the problem in front of challenges that exceeds our capacity to protect society. We need a change of perspective. **Emergencies are increasing in complexity faster than our capacity to innovate.** New challenges foster innovation because those who face new situations usually need to innovate to overcome them, but it needs time. In order to increase the pace of innovation in front of infrequent, dynamic, complex and emerging threats that cannot be fully experimented the innovation framework should adapt to be more dynamic and flexible.

Fire & Rescue Experts, who have lived and have gathered some knowledge and have authority in major emergencies**, are already focusing on, and leading innovations** to strengthen tightly focused capabilities. Not only have they to change their own organisations and systems, but also they need to **push towards a cultural change** from unaware and unresponsive communities and key stakeholders.

Emergencies have become a **source of knowledge** where responders frequently need to be **creative and innovate**. **Emergency managers** tend to learn by doing, by experiences, exchanges, and direct questions to trusted actors (often others who face similar challenges) to learn. They tend to navigate among uncertainties and generalities, avoiding noise, and selecting very carefully on key gaps that offer opportunities of change with big impact, as they understand the nuances in the job-to-be done. For these reasons, it would be worth it **to share the emergency knowledge cycle with scientists and stakeholders.**

Navigating in the middle of liabilities, administrative processes and lobby interests adds complexity to identifying, creating, improving or transferring innovations on real-life.

Stronger focus on innovation lead by practitioners with science and stakeholders towards tightly focused gaps can bring efficiency in front of evolving challenges and be a pillar for innovation.

Innovation shouldn´t be focused on technology and lab research. Emergencies became a **source of knowledge** where responders frequently need to be **creative and innovate**.

In order to adapt policies to support innovation in front of such infrequent, impactful, complex and uncertain, as well as dynamic scenarios, we need to focus efforts on four group of policies, which will build a collaborative framework among practitioners, researchers, industry and stakeholders,

1st group: Identify very tightly the GAPS to prioritize, on preventing and preparing large emergencies that can cause collapse.

Source: https://importanceoftechnology.net/how-technology-promotes-religious-belief/

Innovative responders can guide the focus on scenarios, challenges and gaps that may have an impact in the next emergency.

Networks of stakeholders can **negotiate decisions and trace consequences.**

Recommendations:

- **Focus on the challenges posed by major crisis and emergencies** that are possible. Choose those that have a high impact on society, where fragmented fire services hardly accumulate experience. Lack of experience threatens the capacities of prevention and emergency systems to defend values, due to the collapse of mandatory prevention measures, decision-making, safety of responders and/or resources. Focus on complex scenarios, with a set of actors making overlapping decisions, or in highly uncertain, fast-paced, dynamic environments.

- In this challenging crisis and emergencies, **understand the accumulated experience and innovation of decision-makers.** They can focus the specific **risk scenarios and key capability gaps,** where an opportunity to act overlaps with high potential of change in the emergency.

- Build specific **knowledge and innovation efforts focused in key gaps in small specialized network**s, led by innovative first-responders. Involve researchers, stakeholders, cross-border responders, policymakers or communities as active actors, and prepare with them risk scenarios, **negotiate decisions and trace its consequences** into integral risk management. Focus on risk reduction, preparedness, interoperatibility and operational capabilities.

- Responders have to make front to the new challenges before new technologies arrived, day in day out, therefore, innovations created by responders should be the base for the innovation and guide for the industry as they show the current existing gaps. Improve knowledge and solutions on reducing **sources of uncertainty** that may lead to collapse during the emergency management.

- **Restoration** as an opportunity to adapt areas and structures, processes and solutions, policies, governance by promoting their resilience

2nd group: Empower fire and rescue experts with experience on large emergencies and innovations on them.

Emergency knowledge cycle

Make an effort to identify **innovations handled by those who face the challenges. Empower them,** to act as hubs of innovation.

After a major incident there is a small window of opportunity to compile knowledge and introduce change to prepare for new incidents. Prepare for it.

Transfer implemented innovations. Invest in understanding and explaining why it works in one place and what capacity it might have to be implemented in another.

Recommendations:

- **Information alone does not help decision-making**, even if there is a lot of it. On the contrary, can lead to inaction or decision-lag. It must be translated into knowledge to become wisdom to be used in decision-making.
- Boost **informal networking policies** and look for the ones that are providing recognized innovations in the system: to identify innovations, detect solutions, identify new gaps, and create knowledge sharing.
- **Focus on fire and rescue networks, involving also** risk management stakeholders, and research into specific projects looking for best practices, innovative knowledge, facilitating decision making, etc. as active actors in risk management.
- Identify and invest in **Emergency Labs** for different thematics and be able to compare responders' policies and its outcomes from different scales, and with different types of profiles.
- Invest on **adaptive management** methodologies when approaching new challenges in uncertain frameworks. To reduce uncertainty over time via system monitoring, without falling to defensive attitudes.
- Boost and invest in opportunities to **develop R&D&I departments inside F&R services**, as a way to facilitate the integration of the first responders from the beginning of the research process.
- Invest in **understanding and explaining the context why it works** in one place and what capacity it might have to be implemented in another, what drivers makes it possible and what barriers it should overcome. It's the most important part of ensuring that its transfer is the result of the willingness of others to import this technology.

3rd group: a CULTURAL CHANGE is needed in European societies in order to be able to deal with major emergencies.

The more a community is protected daily

The more unrealistic expectations of protection it held

Moral Risk – asymmetries in who knows, who decides, and who receives impacts – **places incentives in decisions away from those who receive the impacts of risk and those who knows about the risk.**

Societal safety should be an integral part of any policy

Recommendations:

- Incorporate **societal safety** in the policies that have a major impact on communities to face the crisis management.
- Focus **capability building efforts onto societal resiliency.** Communities should be trained and involved in landscape-scale risk, where they should expect to become active actors in emergency management. Return this capacity to citizens in order to generate more resilient societies and provide them the tools.
- Increasing the risk awareness of the communities promoting a risk catalogue and integrating the key actors in managing the risk with the aim to give them the capacity to **face consequences of the impact** of the catastrophe.
- Base risk governance on traceability of the **impact of asymmetric decisions**, especially when the decisions of one stakeholder will impact on the responsibility and capacities of another.

4th group: European/national policies should focus on challenge scenarios and their windows of innovation

Policies should answer to the challenges for which they are designed

Recommendations:

- Diagnose the main challenges and capability gaps of the large-emergency-based-risks using a **catalogue of large-emergency-based-risks** at a European/National level.
- **Highlight infrequent, complex emergencies with high uncertainty in decision-making** inside Europe/Nation (flooding, earthquakes, large forest fires, pandemics, NBRQe accidents, etc) to increase the community capacities focused on it.
- Consider those emergencies as a key topic to balance discussions between the different policies approach that impact on them, from economic to conservation policies, from industrial to urban and landscape management policies. Build **traceability for understanding and measuring of the impact** of those policies for appropriate, balanced, integral risk management.
- Boost **harmonisation of procedures and sharing knowledge** to increase efficiency of the interoperability modules. That should be done by the selection of capabilities used to make front to different challenges on each type of emergency, then select where and when standards on capacities should exist. Focus on theses selected capacities to create policies that allow countries/regions to build top-down and interregional interoperability as a common framework for multiagency structures (ICS type).
- Promote the **creation of indicators of success in the implemented solutions'** monitoring process to guarantee that these solutions really respond to the existing needs and challenges real scenarios.

PROJECT IDENTITY

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Recommended readings:
D1.4.-Report-on-current-and-future-common-capability-challenges-CCCs-and-FCCCs-3-5.pdf (fire-in.eu)

Appendix 1: Third cycle webinars (WB) results

TWG A. Search & Rescue & Emergency Medical Response

FIRE-IN WP1 – 3rd cycle - Webinar/Workshop Reporting Template	
Title:	**Workshop TWG A**
Document version:	**v01**
Workshop date:	**09.11.2020**
Workshop participants and affiliation	See attached list
Submission date:	
Submitted by:	
Reviewed by:	
Presentation 1	
Speaker [Name]:	**Prof. ing. Stefano Grimaz**
Title of Presentation:	**Innovation in disaster risk reduction and resilience**
Affiliation:	**University Udine. UNESCO Chair on Intersectorial safety for disaster risk reduction and resilience**
Summary of Presentation 1	

The presentation focused on how face the future critical situations which the changing world will bring and what paradigms and capabilities should be boost from the point of view of the innovation in disaster risk reduction and resilience.

A changing world will bring us new challenges. These will arise different emergencies and the way to deal with them has to evolve in order to develop tools and strategies to face them. These changes is promoting that the emergency models change. In a close future, we will have to face up a new sort of emergency system: The Complex Systems. These new systems come to coexist with the old ones, insofar as the interrelations among the ambits of the society are more and more complicated.

Due the high level of interaction within the Complex Systems, the level of uncertainty increases dramatically, until the point that in similar scenarios the solution could be different when the contexts diverge.

Resilient Management is the cornerstone for building a new system and reduce the uncertain for the future. Without models to follow to face up the complex emergencies, the resilient process calls to be understood the demand to find the best solution, if necessary, inventing with creativity or adapting solutions from other ambits.

Key questions. May the solution be in an interaction between science and stakeholders to develop innovation to help to stand victorious? Should we change the approach the complex emergencies or the old method for simple and complicated emergencies is still appropriate? How should we manage the complexity, uncertainty and the resilience? How have we to tackle scenarios without a non-lineal evolution?

Challenges to face up: Instable environment, new ecosystems, climate change, new technologies, collapse of the well-known models….

Summary of discussion:

Facing up new kind of complex emergencies entails the challenge that the models, which to date had been given good solutions, will no longer be useful anymore. Preparedness and multi-disciplinary work will be key to control the increase of uncertainty and provide a new sort of solutions to tackle the new emergencies.
It will be hoped that the society play an active role in facing up the emergencies and it will be time to forget the passive role.

Presentation 2	
Speaker [Name]:	**Marc Castellnou**
Title of Presentation:	**Global wildfire events: Complex Challenging system. New capabilities for a new culture**
Affiliation:	Bombers GRAF. Generalitat de Catalunya

Summary of Presentation 2

*We come from an emergency system based on a classic response to the emergency, the point of view of the civil protection. When we are overwhelmed, the action migrates to **defensive actions**. When thinking in **tactical goals** we use tools to choose where we are going to fight and where we are not going to do it. The system is based on the **window of opportunity**.*
*The weak link is that not all the opportunities have the same value and here appears the vulnerability of this system. When we do not consider the **cost of opportunity**, we are doomed to failure, since the outcome will be the collapse.*
*To reach the success the system has to be focused on strategic thinking, having as a new target to fight against the uncertainty and establishing the new value: **Common Good**.*
This shift to the new plan should permit us to have a holistic point of view. A global vision and an interdisciplinary take of decisions will be key to manage the new wildfire.
The cornerstone of the process is the managing of the uncertainty, with actions that change it to certainty.
We have to change the point from defending the landscape problem to manage the future landscape.

Summary of discussion:

***[Optional]* Improvement opportunity / Future Capability Challenge:**

If already possible summarize and derive future capability challenges:
Future Capability Challenge #1
Geological warning system (earthquakes/ tsunamis) in the Mediterranean Sea needs to be improved
Future Capability Challenge #2
Preparedness of the population by plans, trainings etc. for tsunamis needs to be enhanced.
Future Capability Challenge #3
Building codes should be updated considering the cases of tsunami.
Future Capability Challenge #4
Emergency plans should update, developed, including evacuation plans based on local necessities down to communal scale.
Future Capability Challenge 5#
Train the population on earthquake and tsunami behavior and
Future Capability Challenge 6#
Train the population on tsunami plans on personal/ family scale

Further comments:

 As identified by your TWG / associated experts

> *The aspects from the projects (DG ECHO financed) related to tsunami warning systems were also brought up in the discussion including the Kos Exercise (* https://www.youtube.com/watch?v=BC2lOcg-z9M&feature=youtu.be)*:*
> *https://ec.europa.eu/jrc/en/news/tsunami-alert-system-shows-life-protecting-potential*
> *https://drmkc.jrc.ec.europa.eu/Overview/Newsletter/Newsletter-21*
> A post-tsunami survey was done and is attached to this summary.

Further questions:

> *As identified by your TWG / associated experts*
> *A list of parameters that will allow guiding the process of evacuation (weather horizontal or vertical) could be useful for the local planning process.*

TWG B. Structure fires crisis mitigation, prevention & protection

Keynote Speakers	
Margaret MCNAMEE	Lund University
Quentin DE HULTS	Modern Building Alliance.
Ruggiero LOVREGLIO	Massey University

Partners		Associated Experts	
Giovanni FRESU	CNVVF	Guido ZACCARELLI	Zaccarelli Consulting
Natascia ERRIU	CNVVF	Jasmina KADIJA	Zagreb Firefighter Ass.
Andrea BONETTO	CNVVF	Nelson ANTUNES	National Fire School
Wilfied STEFIC	ENSOSP	Kim LINTRUP	Frederiksborg Brand Fire Service
Sebastien LAHAYE	SAFE	Martin PLISKA	Fire Rescue Brigade of Moravian-Silesian Region
Carles GARCIA LLEIVA	CFS	Ricardo WEEWER	Institute for Physical Safety
Marta MIRALLES	CFS	Francese X. BOYA	Institute of Public Security of Catalonia
Piotr TIOFILO	SGSP	Iolanda DEL PRETE	Buro Happold
Petr OSLEJSEK	CAFO	Gabriele VIGNE	JVVA Fire and Risk
Georgios SAKKAS	KEMEA	Ronan VINAY	SDIS 44
Danai KAZANTZIDOU	KEMEA	Wojciech WEGRZYNSKI	Building Research Institute
Florian NEISSER	FHT	Aurelien SABOURDY	SDIS 87
Karin MROSEK	FHT	Marcin ANSZCZAK	State Fire Service
Mariona BORRAS	PCF	George MICHALATOS	ELIPYKA
		Virgilios MARONIDIS	ELIPYKA

Title:	**Create resilient communities capable of dealing with the fires of structures that will characterize cities in the decade 2030-2040.**

Background

Much of the researchers' forecasts say that the expected population increase will produce a society that will tend to concentrate in cities in increasingly tall buildings to save territory.

In Europe, however, the population will tend to decrease but an increase in the elderly and overweight people is expected, with the consequent problems in the evacuation in case of fire of people who are not completely or slightly autonomous.

In addition, new energy, communication and construction technologies will bring new materials into the buildings with possible new risks in the event of a fire.

o **Protection systems for curtain walls**
In order to reduce the consumption of land, the increase in population will necessarily produce an increase in high-rise buildings in inhabited centers, which must take into account not only the construction characteristics of the materials but also the management of people with reduced mobility and difficulties in access of rescuers.

o **Renovation of existing buildings**
The need to improve comfort in existing buildings, especially from the point of view of thermal and acoustic insulation leads to the introduction on the market of new materials whose fire behavior is not perfectly known, especially for rescuers

o **Energy self-sufficiency of buildings and use of renewable energy sources and large energy accumulators**
The development of the use of renewable sources and electric mobility will also lead to a revision of the construction models of buildings, with the creation of large energy storage units and charging stations inside the building. How will the fire risk change? What new multirisk fire scenarios will rescuers face?
What support can new technologies and artificial intelligence provide for the management of fire scenarios in increasingly complex buildings with the presence of new risks related to the aging of the population and the presence of new materials? For example development:
- o a standard that allows easy control of safety measures and the use of related information to improve operator safety and rescue operations
- o or of security solutions based on information and communication devices and systems and development of criteria for measuring the effectiveness of these measures.

Three Challenges

1. What are the challenges we will face over the next 10-15 years in terms of fire safety? Is the growing need for fire safety economically, socially and ecologically sustainable? What is the balance point?
2. How to harmonize safety standards in different countries?
3. How can the following problems be dealt with from a technical point of view?.
4.

Key perspectives: Presenters	
Speaker:	Prof. Margaret McNamee
Title of Presentation:	Fire safety and sustainability in the built enviroment
Affiliation:	Lund University, School of Engineering (Swerige)

What do we mean by "sustainability"?

Fire safety challenges of green buildings

Resiliency and SAFR© Buildings

Global population growth, urbanization and globalization

Creating a truely sustainable and safe built environment

What do we mean by "sustainability"?

- A sustainable society meets our present needs without compromising the ability of future generations to meet their needs(Brundtland Report, 1987)
- Sustainability requires a holistic approach at the system level
- Multifacetted: Economic, Environmental and Social
- Sustainable built environment targets a variety of sustainability objectives to reduce overall environmental impacts
- Numerous high-profile fires in buildings with green attributes emphasisethe need the consider fire safety and sustainability

Fire safety challenges of green buildings

- The majority of new structures are expected to be green by 2021
- There is a potential for 'competing objectives' with respect to sustainability and fire safety
- Building regulatory system (building code, fire code, electrical code, standards) facilitates achievement of both
- Potential for fire hazards and risks with introduction of new materials, systems and features (e.g., ESS), for which fire performance may not be well understood, especially in complex systems (e.g., façade systems)
- Extra-regulatory mechanisms (e.g., rating schemes) may inadvertently introduce unintentional risks / hazards, especially existing buildings
- Recent study for NFPA Fire Protection Research Foundation found more than 100 materials, systems and features with fire safety challenges in green buildings and green building attributes

Resiliency and SAFR Buildings

Ability to prepare and plan for, absorb, recover from, and more successfully adapt to adverse events

- *Planning up front to minimise future loss, disruption and cost*
- Resiliency in built environment –buildings that are able to with stand the 'typical' and 'extreme' loading, expected over the lifetime of the building, and deliver expected life safety, mechanical stability, and weather-related performance.
- Buildings should be sustainable and fire resilient

Global population growth, urbanization and globalization

- Changing age distribution(demography), increased population with reduced mobility
- People living longer in their homes

- Later age for pension
- Increased urban density – increasing number of tall buildings, more elderly or infirmed in their homes or places of work
- New building practices and materials, need for better understanding of toxicity and eco-toxicity of modern materials
- Increasing international interconnectivity and vulnerability

Creating a truly sustainable and safe built environment by considering both sustainability and fire resilience objectives

Speaker:	Mr. Quentin de Hults
Title of Presentation:	Building renovation and fire safety: perspective from construction product manufactures
Affiliation:	Modern Building Alliance (Belgium)

The Modern Building Alliance presents an original framework with a comprehensive and structured list of elements for the consideration of Member States in their regulatory approach to ensuring fire-safe buildings.

This framework aligns with the EU subsidiarity principle and aids in structuring the exchange of information and best practices between Member States within the **European Fire Information Exchange Platform (FIEP)**, established by the EU Commission in October 2017.

Closely linked to the 7 layers of fire safety in buildings, this holistic approach considers and clarifies not only the building design and construction but also technical installations and fire safety management throughout the building's lifetime. The proposed framework includes clarifications of the roles and responsibilities in the value chain.

The seven layers are:

- Prevention
- Detection
- Early suppression
- Evacuation
- Compartmentation
- Structural Safety
- Firefighting
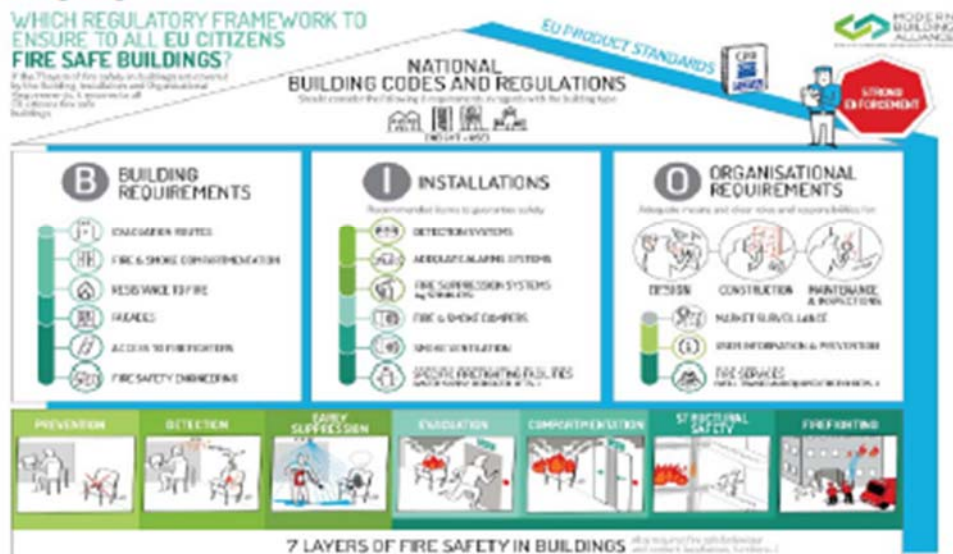
This project has received funding from the European Union's Horizon 2020 Coordination and Support Action programme under grant agreement No 740575.

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Ensuring the fire safety of building is a complex issue requiring competent professionals with clear roles and responsabilities, who are involved during the building design, construction and maintenance phases.

Fire safety must be an inseparable part of the energy transition. There is insufficient awareness, knowledge and competency regarding the new fire hazards associated with energy transition.

Fire safety of facades:

- Use large scale system testing as basis for all system
- Consider all elements of the system
- Ensure unambiguos description of system components via harmonized specifications
- Define the extended application of large-scale test

Speaker:	Dr. Ruggiero Lovreglio
Title of Presentation:	A.I. and new technologies supporting Fire Safety
Affiliation:	Massey University (New Zealand)

What is the difference between Actual Reality and Virtual Reality
The possibility to train first responders with Augmented reality and Virtual Reality
Augmented reality as a support of evacuation
The use of Artificial intelligence for analyzing Fire Behaviour and Evacuation
The use of big data to monitoring people during emergencies to rescue them

In his presentation, dr. Lovreglio presents some applications of Augmented Reality and Virtual reality developed to train people and responders in several emergency situations.
Another application presented is the use of Artificial Intelligence to analyse Evacuation Behaviour.
Where we going in the future (2020-2050):
- AR and VR is getting cheaper and cheaper
- Smart buildings and Smart cities
- Big data can use to monitoring people
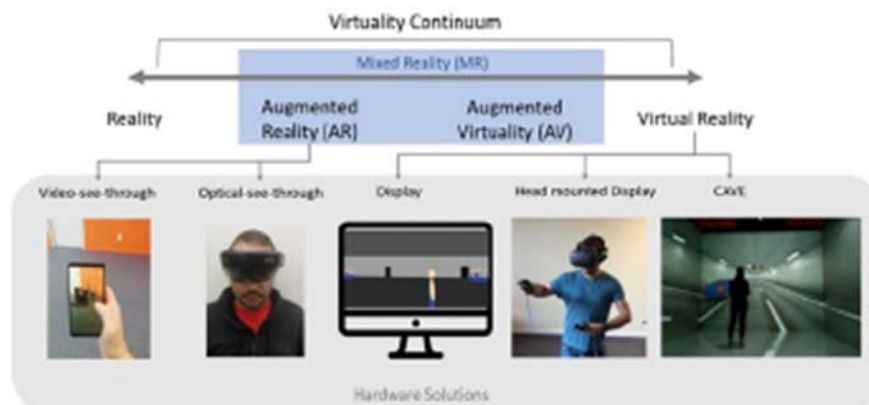
In conclusion the speaker presents his point of view about next steps of the use of AR and VR .

Key perspectives: Discussion

Key perspectives proposed by presenters

The discussion was started by the discussion moderator (Piotr), who briefly summarized the presentations and set out the scenario for discussion. The modern world is very complex with many technological and societal revolutions happening at once. Maintaining high fire safety level for people becomes more and more challenging. At the same time a rapid development in new technologies offers many opportunities to improve the level of fire safety for many people.

The discussion included the following issues:

- **Education**: education is very important, but we need to know what are the hazards of the future to educate the right things. What about energy storage systems in the home? what about cheap electrical equipment from ALI express without any fire safety requirements? this is an increasing fire cause. Kids should know about that too... how about charging Li-ion batteries? Therefore, fire investigation should continuously provide knowledge to actualize the education.
  Would we teach them to "stay put" as it happened in the Grenfell Tower (for example)? Those basic aspects should get our global consensus first. Teach how people can understand the danger, the risks, be aware of what is crucial: to lead the company for the future.

- **Complexity of the buildings** is going to increase and full compliance with fire safety codes may be challenging. A possible way forward is to apply more Performance Based Design (PBD) rather than Prescriptive Design, but to achieve that we have the duty to share our knowledge and be all (fire officers and industry practitioners) on the same page. PBD will likely give us the chance to achieve innovative designs with improved fire safety performance and benefits relating to sustainability (economics, construction speed, carbon footprint, aesthetics).

- **Sustainability of technological solutions**: It takes time for new ways at looking at things to become established. Green buildings have taken since the 1980s to become mainstream. The idea of using resilience will also take time to establish in this context

- **Gathering right kind of information and unifying collected data**: Regarding passing data information on buildings to the emergency services, the EU Commission is working on the concept of building digital logbook that will contain information on buildings on topics such as energy, renovation, etc... This could also be used to include information for fire rescue services. Making a better use of statistics, embracing probability. We see an increase in Informational chaos, noise.

- **Many technologies are available**: Technology can go forward, and designs of buildings, new materials, but if we do not do anything with education from young age of people, they will never know how to behave, they will always do something wrong, be in panic etc.
  We need to look for real enabling technologies, we have to think with different types of Technologies Blockchain technology could help share classified / sensitive construction information to help first responders respond. Other technologies could be used to obtain information about the fire inside.
  Complex technology in the building is a problem => building manager / owner might have difficulty taking care of systems => 10% of complex equipment is in good condition => durability is important.
  Most are inspired by new technologies but a very simple solution should be thought of => we can combine the two

- **Using modern communication methods for engaging community via telecommunication.**

Utilizing the fact that we are connected. The rise of multimedia, social media, and the Internet of Things, leading to the exponential growth of information with a large fraction of the population linked by cell phones

- **Asking right questions** regarding fire safety and identifying real problems
  Whether complex solutions are the right way forward. Early awareness of problems before it is widespread

- Understanding **cost-efficiency** of proposed solutions on national level
- **Resilience** must lead to better education, selection of relevant information for first responders
- **Networks** like FIRE-IN are relevant because you can discover solutions even if it is not applicable in your country, it is possible to integrate part of it or something similar

It was a **common agreement** in discussion that the technology is very promising but the education and fire prevention is often more important.

Related Common Capability Challenges

	High flow of effort in hostile environment	Low frequency, high impact	Multi-agency / multi-leadership environment	High level of uncertainty
Incident Command Organization	Focus on sustainability of safe operations	Prioritize the reduction of vulnerability and increase interactions with the public	Distribute decision-making	Strategies choosing safe scenarios, and maintaining credibility
Pre-planning	Pre-plan a time-efficient, safe response	Negotiate solutions with stakeholders for anticipated scenarios	Plan interoperability and enhance synergies	Focus on governance and capacity building towards more resilient societies
Guidance instruments	Establish procedures and guides	Standardize capabilities in front of pre-established scenarios.	Establish an interagency framework	Build doctrine for resilience in emergency services and societies
Knowledge cycle	Train specific roles	Learn about possible scenarios focusing efforts in key risks and opportunities	Build a shared understanding of emergency and train interagency scenarios	Focus on integral risk management
Information management	Information cycle.	Manage key information focused on decision-making	Define common information management processes between agencies.	Provide an efficient, flexible flow of information for a shared understanding
Community involvement	Develop public self-protection to minimize responders exposures	Prepare population for the worst scenario before it happens.		Cultural changes in risk tolerance and resilience
Technology	Use technology to assess risks and minimize responder's engagement	Simulate complex scenarios	Technological tools to support data sharing	Get a clear picture of the risk evolution

Further questions:
Solve ethical issue in using big data
Develop methodology to include safety and sustainability simultaneously
Investigate new materials fire performance
Develop fire safety standards by using a large-scale testing system

Keywords:
Education, Aging, Sustainability, Resilience, Performance based design (PBD), New materials, Large scale testing, Augmented Reality, Virtual Reality, Energy transition

TWG C. Vegetation fires crisis mitigation

FIRE-IN WP1 – 3rd cycle - Webinar/Workshop Reporting Template	
Title:	**Workshop TWG C - What disaster fires tell us about global change and future landscape fire challenges.**
Document version:	**v0.2**
Workshop date:	**14th December 2020**
Workshop participants and affiliation	1. **Lindon Pronto** (PCF, ES / EFI, DE) 2. **Sébastien Lahaye** (SAFE, FR) 3. **Marta Miralles** (CFS, ES) 4. **Marc Castellnou** (CFS, ES) 5. **Giovanni Fresu** (CNVVF, IT) 6. **Georgios Sakkas (**KEMEA, GR) 7. **Vassiliki Varela** (KEMEA, GR) 8. **Mariona Borras** (PCF, ES) 9. **Juan Caamano** (PCF, ES) 10. **Nuria Prat** (PCF, ES) 11. **Wilfried Stefic** (ENSOSP, FR) 12. **Florian Neisser (**Fraunhofer, DE) 13. **Alex Held** (EFI, DE) 14. **Rob Gazzard** (Forestry and Wildfire, UK) 15. **Craig Hope** (Fire Service South Wales) 16. **David Caballero** (PCF, ES) 17. **Laurent Alfonso** (PCF, ES) 18. **Jean-Paul Monet** (SDIS13, FR) 19. **Fabio Silva** (ANPC, PT) 20. **Carlos Trindade** (Civil Protection Mafra, PT) 21. **Angela Iglesias** (MITECO, ES) 22. **Gavrlil Xanthopoulos** (DEMETER, GR) 23. **Vasileios Kazoukas** (Hellenic Fire Service, GR) 24. **Miltiadis Athanasiou (**DEMETER, GR) 25. **Jelmer Dam** (IFV, NL) 26. **Val Charlton** (LANDWORKS, ZA)

Submission date:	**Feb 10 2021**
Submitted by:	**Lindon N. Pronto, Pau Costa Foundation**
Reviewed by:	
Presentation 1	
Speaker [Name]:	Jean-Paul Monet, SDIS Bouches-du-Rhône
Title of Presentation:	Addressing future response challenges of civil protection in Europe: Toward harmonizing command systems?
Affiliation:	SDIS Bouches-du-Rhône
Summary of Presentation 1	

Ad hoc Notes:

questions of efficiency; how to proceed on European level; Observations/Suggestions; Technical standards; Best practices (SOPs, SCTPs, SCCPs); Standardization activities; "technical practices"; Differentiation between Command & Control practices and technical practices/standards; Experiences from UCPM activation in Sweden; international situation (ICS, INSARAG, NATO …); NATO close to ICS and/or vice versa; UN INSARAG less vertical; NATO framework used in Sweden; big problem: each country has its own C&C system; integration needed in the case of international aid; harmonization needed; identification of common aspects; common backbone as an idea; experimental training in 2020 (DG ECHO tender); trials on the backbone: international aid in Italian context (Swedish etc. …); Integrate Experts in your Command structures; "How many section do you want in your Incident Command post?"; Slightly change the selection of attendees and the organization of the courses; Moving UCPM framework from Coordination to C2S: European Command System?; Monitoring and evaluating quality of interoperability; respect of sovereignty; wish of first responders vs. political/diplomatic perspective; If we want to bridge the gaps we need efforts on political scale;

Summary of discussion:

Ad hoc notes:

Question Juan Caamano: 1) why do you think ICS isn't fitted for European communities; 2) How deep do you think the system should go? ICS is linked to a training system. Learned from MODEX in Croatia - still many differences; Standardize and modernize - for the field; Should we go that deep?

Answer JP Monet: we have to enrich it (ICS); due to new fire behavior; long term perspective needed; Planning is important; the main discrepancy in the American organization - for wildfires, where you have a very fast developing situation you need a direct line between the Incident Commander and the sectors (?); that is not the case in

ICS; We have to be inspired but do not copy and paste; at first national systems need to be standardized.

Standardization on technical issues for Civil protection; standardization on capabilities is good; focus on capabilities instead on tools; we are very late in standardization; maybe in 20 years we are ready.

Question/comment Val Charlton: South Africa adapted the ICS; looking at types of fires (type 3 mainly); training courses: team for each province - that worked extremely well; Civil Defense, Police and Armed forces are probably not using the same.

Question/comment Rob Gazzard: using the Australian approach; huge value; focusing on a wide range of risks; build resilience in general; Used it this year the first time for wildfire; next steps: training modules; side level working with fire services; Australian system not that much different from US or New Zealand; ICS Australia was intuitive.

Question/Reflection Angela Iglesias: harmonization is great for Spain (different regions), here people don't like the word harmonization - they think they need to do it only in one given way; same Command System would be good, but it is not easy or not even possible; Coordination - that is the key; Questions of responsibility; Role of Liaison officers; Civil protection training - great idea: you have to be flexible, be open minded and get into the organization you are sent

Comment Rob Gazzard: Coordination is a key in the Australian system; like a Lego brick - you can it built it up / modify it

JP Monet: Difficulties of interoperability within countries; we must have a chief; I don't like that word of coordination; We have a way - instead installing a system - find common aspects; You have to be readable by the incoming teams; harmonization

Presentation 2	
Speaker [Name]:	David Caballero, PCF
Title of Presentation:	Community awareness and self-protection – lessons learned, present efforts and future challenges for citizens and responders
Affiliation:	PCF
Summary of Presentation 2	

Ad hoc Notes:

Challenge 1: megafires and extreme fire behavior; unprecedented scenarios; difficult environments for first responders; uncertainty; example: Mati fire, Greece; extreme fire behavior in populated areas; unexpected situations; we need to be prepared for this; we need protocols in place; challenge 2: risk perception and risk awareness; People are reacting late; Poor commitment with prevention; New technologies AR/VR; Story-telling helps; Serious games; challenge 3: Community prevention; collective vulnerability (vulnerability of a community); isolated cells of inhabitants; broader picture needed (patterns; developments); New urban designs needed; connections for fire and at the same time disconnections/fragmentations of the urban/suburban design; consequences of decisions on one lot on the neighbors; challenge 4: prevention and risk mitigation; self-protection; vulnerability as individuals; more fire resistant lots and houses needed; preparation of houses itself; Gardens; creating challenges for firefighters; challenge 5: surrounding environment; transitional areas needed; Naturalized landscapes; improving control by firefighters; insights of fire ecology; prescribed burnings; grazing sheep; challenge 6: water availability; water management; Vegetation moisture; soil protection; moisty greenery needed to be more resistant vs fire; challenge 7: early and safe evacuation processes; quick approaching fires as a major challenge; contextual awareness; example: Mati; people forced to shelter in place (older people); shelter can be a trap; challenge 8: houses as shelters: houses can be design as shelters instead of traps; self-protection; active sheltering; Checklist for weak points of houses (WUIVIEW project); reinforcing houses

Summary of discussion:

Ad hoc Notes:

Carlos Trinidade: Full management (?)

David Caballero: No. People resist changes. Narrow spatial domain. The first thing the populated landscape (WUI) … the fuel is part of the environmental, Administrative level, technological level, … six components, four phases of disaster risk management, three dimensions of (?); We have to adapt to these changes. The first step is to convince people. Jump into the political and administrative level. Wooden houses are not prepared - be careful if you use wooden houses (also questions of the surroundings)

Note from the chat: it is also about maintenance of houses.

Presentation 3

Speaker [Name]: Marc Castellnou, CFS

Title of Presentation: Fire-use for preventative land and fuel management and response

Affiliation: Catalonia Fire Service

Summary of Presentation 3
Ad hoc Notes: *How do we confront the reality; struggling fire community; old outcomes of research but new, overwhelming fire realities; models are not working anymore; California fires; low pressure systems in fire situations; fire has been a disturbance in our systems; Global disturbance; Ecosystems not adapted to climatic changes; We need models for our management; we need to go ahead; adapting to new climate situation; reducing uncertainty; create change by yourself; tiny prescribed burning programs in Europe; usually just educational; We need 30% of our landscapes managed; we are stopping fires but at dramatic costs; only solution: landscape management; acceptance of fire regime; we need to teach our society / our communities; follow the change!; adaptation needed; there is not a big organization responsible; the old tactics worked short term but not long term; we should keep training our firefighters and society but we also need to change our approaches; accept the fires we can accept, stop the fires we need to stop; we need to know more; comparison to COVD-19 situation - vaccines are good but we need to adapt - same for wildfires; creating the landscape of tomorrow - that is needed; Central Europe - the Karpatians, Black Forest; Pyrenees; the Alps will face it;* *We must admit that current models don't work anymore, and we are blind as firefighters. Models and simulation systems are out of date.* *How do we manage the landscape to cope with these megafires? Our ecosystems are not adapted to the new wildfires. Firefighters need new models capable to predicting the huge amounts of energy of these new fires. We have to help our forests to reduce this uncertainty. Fire use programs are needed in Europe to manage our landscapes, not only as a tool to train first responders. The current fire use programs are not achieving the expected objectives: society has to admit the fire regimes and the use of fire as a tool to manage our landscapes. Looking at the long-term, we need to create resilient landscapes, 'we cannot choose if an area will burn or not, we can only choose in which intensity it will burn'* *We need to change our ICS. We are selling safety, but we don't know if we can provide it, fires are changing rapidly.* *We have to create the landscape for tomorrow*
Summary of discussion:

Ad hoc Notes:

Question Sébastien Lahaye: Very good raising the alarm; What could or should be the role of Fire and Rescue services? I am not sure of that. Not sure if Firefighters should drive that change. We need to empower the population and policy makers.

Marc Castellnou: (connection lost)

Vasileios Kazoukas: I think that we cannot find the solution alone. But we should be part of it. And also, for the standards. I still do not see a mechanism. There is no information for the average firefighter - what are the lessons learned, what were problems to implement standards; At least we are in the loop; small steps; Make some suggestions; Maybe a next generation of a Driver+ project or the portal of FIRE-IN; "Stop, give us a tool for real gathering of information"; An iterative process; Evaluate the lessons learned and then check how to improve a standard; We need to be part of the process

Marta Miralles: Reflection on what was Sébastien was saying; What happen in Portugal, Grenfell Tower, Australia - what we have seen is that fire and rescue services have pointed out that these scenarios are possible and that they need resources; Managing expectations from politicians, from society, from scientist.

Marc Castellnou: The answer to Sébastien; We are the ones facing the challenges. We know what we can do and what we can't do; Matters of resources, matters of management; Not the one leading the solutions but pointing out what happens and what are the limits. We can assess what we can or cannot do with new technology; The biggest mistake is a distance between planning and operations; We have to be more planners of what we can do. We are the ones that know! We are struggling with problems, which science cannot fully explain yet. It is not a matter of technology. Total change of paradigm and we need to find our part here.

Gavrlil Xanthopoulos: Some regions are in tougher situations than others; we need to keep the interest; long term perspectives - if not you will be proven wrong; If we look at costs - these are not linear. You have to invest a lot. And these resources are taken away from other fields (e.g., Forestry); Have we been wrong in asking for more money to be better in firefighting? We need clear thinking trying to really understand where we are going. WUI is a major issue - all this need to be studied carefully but also debated on political level. There are many politicians who have no clue or no interest. If you look at research proposal on EU level, they are not sufficient (?). … The changes are coming faster than we are able to change policies. We need an integrated way.

Marc Castellnou: We have to decrease the fires (effects) - we need to be part of building the landscape. If there is a system making the decisions are not part of it, it is a problem. It is not about more resources. We need to open the discussion. It is about surviving the change - not stopping the change. I agree when Europe is opening a Call they are totally unrealistic. It is not possible. We need to change the whole paradigm.

Lindon Pronto: Landscape Management, managing the fuels is what I hear everywhere. Where are we in the future - will we also need fire prevention forces instead of only firefighting forces?

Marc Castellnou: We need to think big. We need a mission command approach. Fire services need to include Fire ecology. We have to put money into the landscape. We have to stop fighting flames. We need to look at numbers of landscape hectares made resilient not looking on hectares burned.

Carlos Trinidade: We need to put value in the communities; we need to change the landscape and circumstances - poor people in some regions; we need to create value in the land. People will take care of the land when there is value. If we can change this to another type of value … protect the land (tourism, taxes, investments). We should not think in land management only. This is not only in Portugal. Work the territory. Then you solve the wildfire problems.

Miltiadis Athanasiou: It would be very important for the politicians, firefighters and researchers, to create a common language. It is expected to be one of the difficult tasks in the upcoming years since it requires difficult decisions. It is hard - if not impossible - for the communities and countries to achieve quick and sudden changes. Let's try to think about our aspects and introduce positive attitudes. The problem we are dealing with is not only a matter of the characteristics of the WUI. We need to manage the landscape and find ways to feed our policies with input from the tactical level, also.

Laurent Alfonso: Two main ways to manage a better landscape management. Policy makers and other hand I really believe in the powerful input of citizens. We have to play with these two levels.

Jean Paul Monet: My idea is that this harmonization to tackle all hazards - not only wildfires. The management is still the same. We have to install an all-hazard system.

Vassiliki Varela: I fully agree that land management is important. Firefighting is not the only aspect. Technology can offer solutions. A common language to work together. This type of project is a good opportunity to exchange - as we do now. We need to communicate better in future. But this is a good step.

[Optional] **Improvement opportunity / Future Capability Challenge:**

If already possible summarize and derive future capability challenges:

Based on presentation and discussions, some future challenges could include

Future Capability Challenge #1

Need for more pan-European harmonization and standardization, particularly with respect to command and control structures (e.g., ICS) and technical compatibility (to ensure smoother operations) under the increasingly common scenario of cross-border aid/ response and when multiple countries are experiencing simultaneous large fire events

Future Capability Challenge #2

Need to create and plan more fire resilient landscapes and societies – some of the key aspects are fuel management, evolving risk perception/culture, and designing more fire-resilient structures (to enable sheltering in place).

Future Capability Challenge #3

Fire management approaches need to be based on future worst-case scenario projections instead of remaining static and in-step with yesterday's science; we need to anticipate the future challenges – for example fires in Alpine region

Future Capability Challenge #4

First responders need to be appropriately trained and equipped to deal with current and future fire suppression needs – outdated, insufficient training and consistent under-funding of resources make the job more difficult and dangerous – we need a paradigm shift at landscape level, but first responders will still need to do their job

Further comments: Summary of main webinar themes (assessed by TWG-C Chair – L. Pronto)

Top themes expressed in terms of current /expected challenges and required approaches.

- *Command and control structures must be harmonized at national level before cross-border aid can be effectively rendered; ICS is favorable approach, but needs adaption maybe – what about "European Command System"?*
- *Competency-based Training and technical standardization extremely important*
- *Current and expected trends in extreme fire behavior and high-level of uncertainty plus high impact matrix requires new proactive broadscale approaches- not our present reactionary response*
- *Risk perception and community engagement must greatly expand to meet oncoming challenges – a culture of reliance on first responders cannot continue; a greater commitment to prevention work must be established*
- *Self-protection is important emerging discussion: people, houses, infrastructure, and surrounding landscapes need to be equipped or designed to also withstand fire; issue of shelter in place*

- *Landscape level changes need to be invested in – from a greater understanding and application of fire ecology, to grazing practices, to soil, water, and fuel management*
- *Limitations plus overreliance on water supply and emerging challenge- especially outside Mediterranean area*
- *Limitations of current models – the fire behavior we are seeing today defy many of the prediction tools we have; our tools we have today is based on older science; today's management approaches need to be based on projected future conditions (e.g., climate change)*
- *Current prescribed burning efforts are near-trivial compared to the scale at which is needed at landscape level; fire use programs need big expansion and to meet more objectives simultaneously – for instance as hands-on training for firefighters*
- *Need to anticipate and integrate into management tomorrow's challenges – like fire in newly fire prone regions*
- *Firefighters/responders are at their limits and "flying blind" in some instances – are in increasing danger because command structures also at their limits to be able to ensure safety*
- *There is an element to "surviving the changes and challenges instead of "fighting them" – paradigm shift needed to look at number of hectares made fire resilient – not only focus on how many hectares burned*
- *Landscapes need value recognition or creation – so that people will prioritize taking care of these areas (e.g., abandoned land)*

Further questions:

As identified by your TWG / associated experts
Val C   Have we really unpacked and tackled the "Stay or Go" realities in an extreme incident?   What education measures, and what structural changes to landscapes and dwellings need to be made before "stay" is truly a safe, viable and acceptable option. Are local shelters the in-between option?

TWG D. Natural disaster crisis mitigation

FIRE-IN WP1 – 3rd cycle - Webinar/Workshop Reporting Template

Title:	**Workshop TWG D**
Document version:	**v01**
Workshop date:	**12.11.2020**
Workshop participants and affiliation	See attached list
Submission date:	**19.11.2020**

Submitted by:	Iris Schneider, THW
Reviewed by:	Florian Neisser and Georgios Sakkas
Presentation 1	
Speaker [Name]:	Dr. Georgios Sakkas
Title of Presentation:	Scenario Tsunami in the Mediterranean Sea
Affiliation:	KEMEA, Greece
Summary of Presentation 1	

The presentation focused on the summary of the **definition of a tsunami**, *the Tsunami risk in the Mediterranean Sea and the main* **characteristics of the tsunami on 30 October 2020 affecting Samos**, *Greece. Additionally, the information process from the alert to sending the information to the general public related to that incident was shown.*

Summary of discussion:

The questions revolved around the actual time gap of the tsunami taking place and the warning time of the population. Additionally, it was remarked that instead of moving to higher ground some persons took videos and photos. Thus, the danger is not felt by all inhabitants affected and some more awareness training might be useful.

Presentation 2	
Speaker [Name]:	Dr. Gerassimos Papadopoulos
Title of Presentation:	Preparedness and Response phases: tsunami risk, warning system and potential challenges for first responders due to a tsunami in Greece
Affiliation:	Tsunami expert, COST Tsunami Project AGITHAR
Summary of Presentation 2	

The **tsunami warning systems are connected with the public awareness** *(how to react to tsunami messages). The tsunami warning system can be described in three steps:*

Step 1: immediate earthquake determination (2-5 min automatically) which,

Step 2: analyse the tsunami and

Step 3: disseminate the tsunami warning message.

In the Mediterranean area are 5 centers operating with this system that can send simultaneously three types of messages e.g. email, fax and GTS (global telecommunication system used by

meteorological organisations). The alert message is sent to the operation centres, Emergency Response Coordination Center (ERDCC) of the EU etc. The duty of the messaging system is only to send the information to the civil protection and not further – this is the job of the civil protection organisation.

At the example of the Samos earthquake from 30 October 2020 the system in action was shown. It caused two waves whereas the second caused massive flooding. The chronology of the response indicated the reaction of the respective civil protection side timewise. Based on this, the processes that went well and those that can be improved for this event was discussed by Dr. Papadopoulos:

For the first time in Greece the general public was warned of a possible tsunami, a good first step!

To do:

- *It **still has to be explored if and how the warning messages helped the local population** because they are not really trained how to behave to those messages via 112. It was actually the first time that an alert on a tsunami was sent out via the 112. So here is a challenge in raising public awareness.*
- *The **first responders should also be trained how to react** to challenges by tsunamis.*
- ***Lessons learned: In each region** of Greece should be an operational centre be established which is not the case and thus the response on local level currently could not be everywhere as efficient as possible.*

Summary of discussion:

Tsunamis are not yet fully explored as natural hazard in the Mediterranean Sea*:*

- *The time when the tsunami hits the coast is very relevant regarding losses and damages.*
- *The warning time in the Mediterranean Sea is very short in the example 13 minutes from the earthquake to the tsunami travel time to the coast, thus a thorough preparedness is vital.*
- *It was remarked that the SMS information is not exhaustive (reaching e.g. not yet tourists)*
- *Not only the reception but also the training how to behave after receiving the message for the general public is vital.*

How to evacuate best (horizontal or vertical) was discussed intensively:

*The **vertical or horizontal evacuation depends on the urban planning** (risk assessment for earthquakes and tsunamis) and **also on the tsunami run up expectation** (the distance to penetrate inlands depending on the respective shoreline). Vertical evacuations demand e.g. like in Japan specific buildings (**tsunami safe but there are no building codes for that so far).***

There must be agreements with the owners in advance to open the buildings to the public.

=>Thus, the evacuation it is a procedural and institutional problem.

For a small tsunami like Samos a horizontal evacuation is highly recommended.

Presentation 3

Speaker [Name]:   **Assoc. Prof. Dr. Vicki Kouskouna**

Title of Presentation: Earthquakes and cascading phenomena

Affiliation: **National and Kapodistrian University of Athens, Greece**

Summary of Presentation 1

Preparedness is vital for tsunamis *including the likeliness of earthquakes causing tsunamis and the information on action plans and evacuation centres. Risk communication is important for awareness rising as well as preparation for the general public.*

Best practice for tsunami awareness trainings*:*

A few things have to be considered in training the general public:

- *An earthquake simulator can train on self-protection measures like "Seisomopolis''.*
- *Earthquake education has to differ between groups e.g. families, students and persons with special needs.*
- *To avoid post traumatic effects after the training is necessary to have debriefings e.g. with games and books for students/ pupils.*
- *After the training, a family emergency plan can be taken home to be filled in by the whole family.*
- *An earthquake suitcase as mobile laboratory is a simple but effective preparedness measure. The suitcase contains models and graphs to show the earthquake and effects.*
- *It proved to be useful to have a train of the trainer approach with table-top exercises to touch upon the resources for multiplying trainings e.g. for youth workers and teachers.*

There is an additional threat related to tsunamis **the destruction of critical infrastructure to tsunamis and also for NATECH** *(Natural disasters and subsequent technical accidents).*

Summary of discussion:

Awareness' of the public has the highest priority*:*

Preparedness and plans are vital also in very touristic areas e.g. the Italian coast and thus evacuation plans need to be in place indicating e.g. evacuation roads.

There is a difference between the maximum wave 8 m mostly off coast and the real inundations. One meter can be a much higher inundation height if measured close by the shoreline.

The "Seisomopolis" was a European project but is closed due to economic crises but the plans are to restart with a **shake table to** *be used for educational reasons.* **Travelling labs/ suitcases can take up the idea of simulations in a lighter version reaching easier the target audience.**

Educational programs should be mandatory for natural hazards: *There should be mandatory sessions of mandatory awareness sessions starting from primary schools to universities. Currently in Greece the fire fighters provide sessions but they are not mandatory.*

The greatest challenge in a tsunami situation is to explain the community not to help directly but to leave everything and everyone in need behind to secure themselves. *To achieve certain behaviour therefore the simulation centre is very important also via VR. Experimental education is the most important.*

It is difficult to deal with persons that do not follow the orders. So far, no general solution has been found for this.

The insurance sector might be interested in funding to mitigate earthquake and tsunami risks.

The first hours (16-20 hrs) after a natural hazard we should not rely on technical solutions since few or even no technology could be used out of experience in Israel e.g. the cellular system fails most likely. **One of the greatest challenges is not having technologies based on Wi-Fi and electricity for the first responders**. *There are exercises designed to specifically tackle the response without technology (without laptops and cellular phones only radios) like realized in Israel.*

Presentation 4
Speaker [Name]:   Prof. Dr. Heinrich Bahlburg
Title of Presentation: The bearing of post-tsunami research on mitigation and preparedness
Affiliation: **University of Münster, Germany**
Summary of Presentation 2

Mitigation of a preparedness for tsunami hazards require long term records *to establish event magnitudes and recurrences intervals.* **Post –tsunami surveys and paleo-tsunami studies are crucial for determining the long- and short-term tsunami hazards** *threating coastal civilisation. The combination of post-tsunami surveys combined with studies of paleo tsunami deposits as sole evidence of past tsunamis allows for establishing long term records exceeding the historical dimension.*

Important factors for the risk tsunamis are causing are the run-up distance and the height of the waves. *Post-tsunami surveys contain data that is vital for tsunami planning and determining the long- and short-term tsunami hazards.*

Summary of discussion:

The terminology of heights and inundation needs to be clear. *Tsunami waves have a very destructive intervention and the post tsunami surveys are very important to determine long- and short-term tsunami hazards.*

Scenario Description:

(if possible try to address a) technological, b) economical, c) political, d) legal, e) environmental and f) social aspects).

The scenario of the tsunami in the Mediterranean Sea showed a range of activities that went well and some that need to improve. It is the most costly and deadly natural hazard.

a) *Tsunami warning system in the Mediterranean needs to be improved by more operations centers e.g. in Greece but technical relief solutions might not work thus this is a major challenge for first responders.*
b) *Tsunami damages increase when they hit industrial areas due to the increased density of the waves and might carry hazardous materials thus prevention and preparedness measures should be in place.*

c) *Training specifically with simulation is recommended and demands public funding.*

   a) *Building codes also for earthquakes and more specific for tsunami safe buildings for possible evacuation should be mandatory for coastal buildings. Specific contracts with owners for that situation should be established respectively.*
   b) *Industrial plants in risk zones should have emergency plans in place as well as preventive measures according to the risk.*
   c) *Awareness training should be mandatory in schools up to universities in risk prone areas. The greatest challenge is to convince people other than helping to leave the area for their own safety.*

[Optional] **Improvement opportunity / Future Capability Challenge:**

If already possible summarise and derive future capability challenges:

Future Capability Challenge #1

Geological warning system (earthquakes/ tsunamis) in the Mediterranean Sea needs to be improved

Future Capability Challenge #2

Preparedness of the population by plans, trainings etc. for tsunamis needs to be enhanced.

Future Capability Challenge #3

Building codes should be updated considering the cases of tsunami.

Future Capability Challenge #4

Emergency plans should updated, developed, including evacuation plans based on local necessities down to communal scale.

Future Capability Challenge 5#

Train the population on earthquake and tsunami behaviour and
Future Capability Challenge 6#
Train the population on tsunami plans on personal/ family scale

Further comments:
As identified by your TWG / associated experts
The aspects from the projects (DG ECHO financed) related to tsunami warning systems were also brought up in the discussion including the Kos Exercise (https://www.youtube.com/watch?v=BC2lOcg-z9M&feature=youtu.be*):*
https://ec.europa.eu/jrc/en/news/tsunami-alert-system-shows-life-protecting-potential
https://drmkc.jrc.ec.europa.eu/Overview/Newsletter/Newsletter-21
A post-tsunami survey was done and is attached to this summary.

Further questions:
As identified by your TWG / associated experts
A list of parameters that will allow guiding the process of evacuation (weather horizontal or vertical) could be useful for the local planning process.

10.00 – 10.10 hrs	Opening Remarks Project FIRE-IN 10 min (Lahaye)	Sébastien Layhaye	Project Coordinator
10.10-10.30 hrs	TWG Lead Presentation (Work till present, aim of the webinar, further steps)	Iris Schneider	TWG D Lead
10.30-10.45 hrs	Scenario description	NN tbc	JRC
10.45- 11.00 hrs	General overview of mega earthquake and induced tsunami in Greece and the Mediterranean: Simulation of the 365 AD earthquake (general overview, earthquake and	George Sakkas	KEMEA

	induced phenomena, cross-border level)		
11.00-11.15 hrs	Preparedness and Response phases: tsunami risk, warning system and potential challenges for first responders due to a tsunami in Greece	Gerassimos Papadopoulos	Tsunami expert, COST Tsunami Project AGITHAR
11.15- 11.30 hrs	Preparedness: Earthquake and cascading phenomena: a) Awareness raising: Addressing the general public, adult groups, schools, etc. Community involvement – training - challenges. Building codes and cumulative damage.	Vicki Kouskouna	National and Kapodistrian University of Athens
11.30- 11.45 hrs	Coffee break		
12.00- 12.15 hrs	Recovery: Scenario based introduction into the specific challenge of a future tsunami a global retro perspective analysis and tool box	Heinrich Bahlburg	University Muenster
12.00- 12.30 hrs	Q& A	Iris Schneider	THW
12.30- 12.45 hrs	Wrap up and Outlook	Iris Schneider	THW

Expert List (Attendees)		
Judith Kirschner	CERIDES	Cyprus
Kim Lintrup	Danish fire and rescue service in 30 years the last 23 years as chief fire officer	Denmark
Jean-Fréderic Biscay	ENLP (Valabre)	France
Wilfried Stéfic	SafeCluster	France
Christian Illing (Dr.)	THW (DARENet project coordinator)	Germany
Gerald Walter	Fraunhofer Int	Germany
Karin Mrosek	Fraunhofer Int	Germany
Malte Daniels	THW	Germany
Danai Kazantizidou	KEMEA	Greece
Dimitris Maillaros	Head of the Civil Protection for the Region of North Aegean	Greece
John Tsaloukidis	KEMEA	Greece
Kostas Zinnelis	Hellenic Fire Corps	Greece
Chaim Rafalowski	Magen David Adom	Israel
Alessandro Annunziato	JRC	Italy
Gianmario Gnecchi	CNVVF, risk advisor	Italy
Marzia Santini	JRC	Italy
Nabil Salhani	Department of civil protection	Lebanon
Lindon Pronto	Pau Costa Foundation	Spain

Speakers

Prof Dr. Bahlburg	Universität Münster (Germany)	Germany
Prof Dr. Gerassimos Papadopoulos	Intergovernmental Coordination Group/NE Atlantic & Mediterranean Tsunami Warning System/UNESCO (Greece)	Greece
Dr. Georgios Sakkas	KEMEA (Greece)	Greece
Dr. Vicky Kouskouna	University of Athens (Greece)	Greece
Sébastien Lahaye	SAFE Cluster (France)	France
Iris Schneider	THW (Germany)	Germany

TWG E. CBRNE crisis mitigation

Associated Experts

Nr.	Organisation	Name, Surname	Country
1.	Fire Rescue Service of Czech republic - Population protection institute	Col.RNDr. Alan Gavel	Czech Republic
2.	IRIS –Industrial Risk Safety solutions	Dr. Hannes Kern	Austria
3.	Unidade Militar Laboratorial de Defesa Biológica e Química	Lt. Col. Júlio Carvalho	Spain
4.	JRC	Pierre Kockerols	EU
5.	Fire Brigade Zagreb	Sinisa Jembrih	Croatia
6.	Provincial Headquarters State Fire Service in Bialystok	maj. Marcin Anszczak, EngD	Poland
7.	Fire Service Lithuania	Rimantas Steponavičius	Lithuania
8.	Institute of Optoelectronics Military University of Technology (ENCIRCLE)	Bartlomiej Jankiewicz, Ph.D.	Poland
9.	Magen David Adom	Chaim Rafalowski	Israel
10.	Estonian Rescue Board	Heiki Soodla	Estonia
11.	Estonian Rescue Board	Toomas Kääparin	Estonia
12.	EU project LINKS	Dr. Dieter Nuessler	Germany
13.	State fire and rescue service of Latvia	Kristaps Kolbergs	Latvia

Speakers

Nr.	Organisation	Name, Surname	Country
1.	Global Fire Monitoring Centre (GFMC)	Prof. Dr. Johann G. Goldammer	Germany
2.	Generalitat de Catalunya	Antonio Gómez Lobo	Spain
3.	Fire Brigade Milano (CNVVF)	Edoardo Cavalieri d'Oro	Italy

Project Partners /moderators, representatives of project partners/

Nr.	Organisation	Name, Surname	Country
1.	CAFO	Petr Oslejsek	Czech Republic
2.	CAFO	Martin Nekula	Czech Republic
3.	CAFO	Eva Betlachova	Czech Republic
4.	CNVVF	Luigi Palestini	Italy
5.	SAFE Cluster	Sebastien Lahaye	France
6.	CFB	Marta Miralles	Spain
7.	PCF	Mariona Borras	Spain
8.	KEMEA	Georgios Sakkas	Greece
9.	Frauenhofer	Florian Niesser	Germany
10.	INDEV	Olivier Salvi	France
11.	CNBOP	Joanna Sadowska	Poland

AGENDA

Time		Session description	Speaker
Until - 10:00		Connection to webinar	
10:00 - 10:10	10'	Welcome + Introduction (technical questions)	Petr Oslejsek
10:10 -10:20	10'	Fire–in project overview	Sebastien Lahaye
10:20 – 10:30	10'	Objectives and methodology of 3th cycle of workshops	Marta Miralles
10:30 - 10:40	10'	Results from 1st and 2nd workshops of TWG CBRNE	Petr Oslejsek
10:40 - 11:00	20'	Presentation of scenario – multi-risk emergencies with CBRNE	Petr Oslejsek
11:00 - 11:15	15'	Forest fires in specific conditions – Chernobyl area	Johan Goldammer
11:15 – 11:30	15'	Resilience of Milano Fire Brigade in COVID-19 conditions	Edoardo Cavalieri d'Oro
11:30 – 11:45	15'	Resilience of Cataluña Fire Brigade in COVID-19 conditions	Antonio Gomez Lobo
11:45 - 12:30	45'	Discussions about scenario and challenges	Petr Oslejsek
12:30		Conclusions	Petr Oslejsek

Link to webinar: https://global.gotomeeting.com/join/242713669

Outputs from webinar

Title:	Emerging threat: CBRNE global disaster
Background	
Description of the uncertain scenario and the critical capabilities/processes to be discussed.	
Three Challenges	
Description of key challenges and perspectives. - **How to analyse risks effectively and prepare plans more quickly** - **Recognise global CBRNE disaster** - **Evaluate and compare risks**	
Key perspectives: Presenters	
Key perspectives proposed by presenters - **Resilience** to situations associated with emergencies in specific conditions - **Difficulties in prediction** of impact – create **procedures SoP** - Impact in economy- foresight models - **Cooperation between regions and states**	
Key perspectives: Discussion	
Key perspectives proposed by presenters - Self-protection - Protection of risks groups - Procedures for managing different levels of intervention – FIRST RESPONDERS - Use of media capabilities	
Related Common Capability Challenges	
Select related Common Capability Challenges from the matrix if adequate. Global goals - **Unique DTB system of uniform evidence of free medical devices** - Education of people about situation and risks - Media management - Standardisation terminology in risks - **Education based on the knowledge of individual countries** Local goals - Internal individual testing of people within the organizations where they work - **Local system of own hygiene and measures in connection with the nature of the environment** - Specific vaccinations - **Local data system with connection to central data system**	
Further questions:	
Keywords:	
Education, vaccinations, skills, cross-border cooperation, media, SoP, resilience	

The webinar will be follow by a physical or online workshop in which we will discuss other common challenges to future CBRNE global disasters.

It can be expecting that with regard to the situation of COVID-19, the issue of joint calls will be discuss in one joint online workshop with the involvement of all TWGs.

Appendix 2: Third cycle Surveys

TWG A. Search & Rescue & Emergency Medical Response

No survey was conducted at TWGA.

TWG B. Structure fires crisis mitigation, prevention & protection

FIRE-IN WP1 – 3rd cycle - Webinar/Workshop Reporting Template	
Title:	Survey TWG B
Document version:	V1.0
Survey date:	Aprile 2021
Submission date:	9 June 2021
Submitted by:	Giovanni Fresu (CNVVF)
Reviewed by:	Marcello Marzoli (CNVVF)

After the webinar held on 10 November 2020, in line with the decisions taken by the WP1 meeting, a survey was proposed with the aim of consolidating the results of the webinar.

The survey, built on a common basis for all five TWGs, was sent to all participants in the three workshops (Rome 2018, Prague 2019 and the 2020 webinar), for a total of 52 associated with the projects (partners and experts).

Overall, 27 people out of 52 replied to the survey, corresponding to 52% of the participants in the workshops.

Figure 1- Countries of origin of the participants

The survey consists of 5 sections:

1) Overview of the participant
2) Type of organization for which they work
3) Type of research conducted
4) Scenario and Future Common Capabilities challenges
5) Main topics and keywords

1) Overview of the participants

The most represented categories among the survey participants are: first responders (9 corresponding to 33%) and fire engineers (5 corresponding to 18.5%). Researchers, emergency managers and professors / trainers are also well represented.
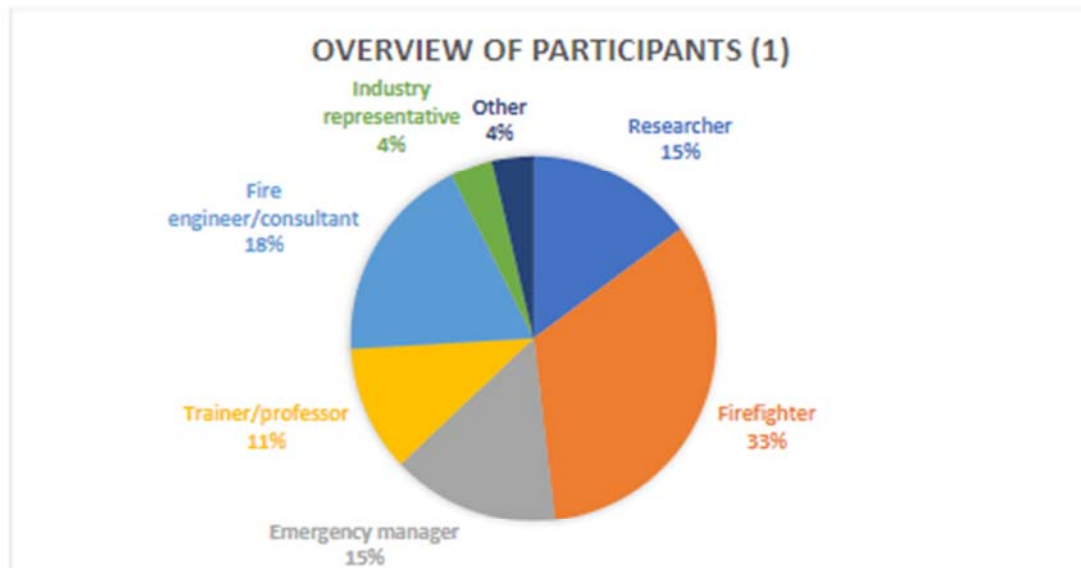
2) Type of organization of the participants

The companies the participants work for are 74% legal person and 26% natural person. Furthermore, 74% of the companies are of the non-profit type.

The companies / organizations are public bodies (59.3% of the total), private entities (18.5), small-medium enterprises (11.1%) and NGOs (11.1%).

OVERVIEW OF PARTICIPANTS (2)

- Natural person
- Legal person
- Non-profit
- For profit

OVERVIEW OF PARTICIPANTS (3)

- Private entity
- Public body
- NGO (non-governmental organization)
- SME (Small and medium-sized enterprises)
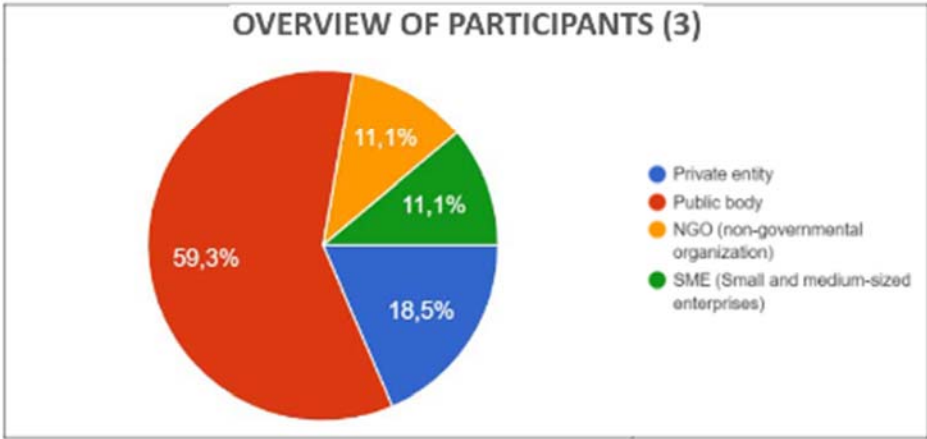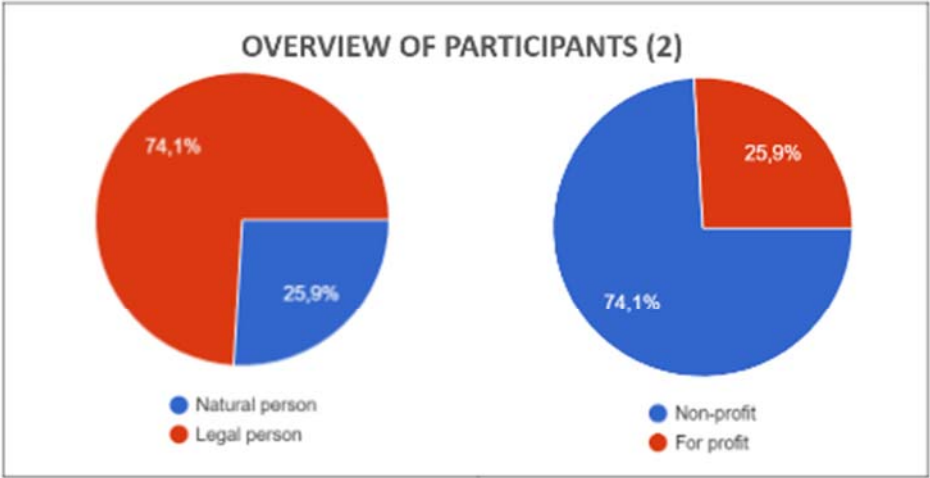
The geographical area of influence of these companies / organizations is well distributed, international (37%), national (33.3%), and regional (29.6%).

OVERVIEW OF PARTICIPANTS (4)

- Local
- Regional
- National
- International
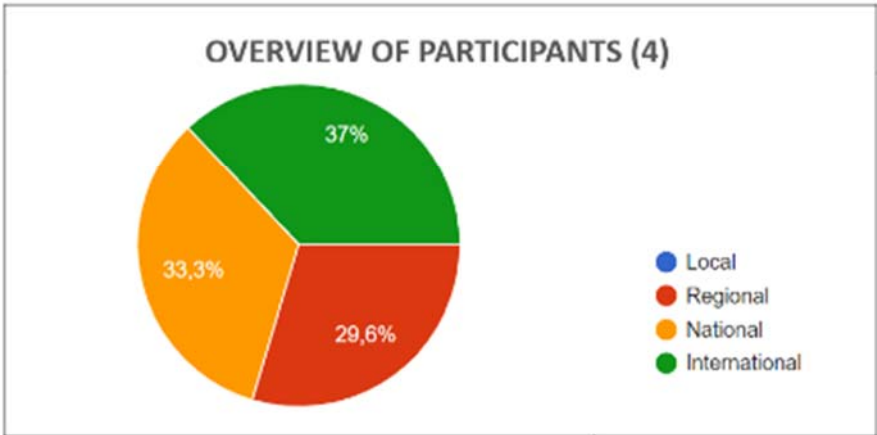
3) Type of research conducted

In line with the type of participants, the type of research the participants conducted is mainly practical (59.3% of the total), half practical and half theoretical for 22.2% of the participants, only 7.4 theoretical, while 11% do not carry out any type of research.
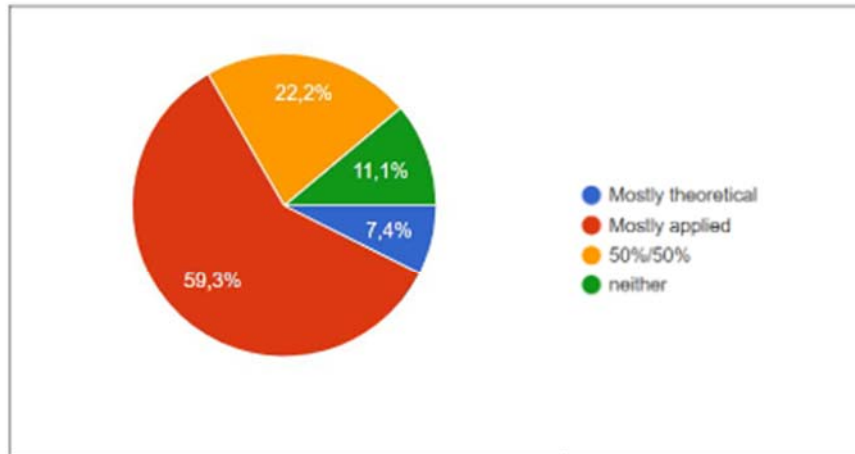
4) Scenario and Future Common Capabilities challenges

In the fourth part of the survey, the participants were asked to express themselves on the scenario proposed at the webinar on future challenges in the field of Fire safety.

In particular, according to the Likert scale methodology, it was asked how much they agreed with the hypothesized scenario.

As many as 92.6% agreed with the hypothesized scenario, and out of these around 41% totally agreed. Only 7.4% said they were neutral with respect to the question. No one disagreed.

How much do you agree with this prediction?
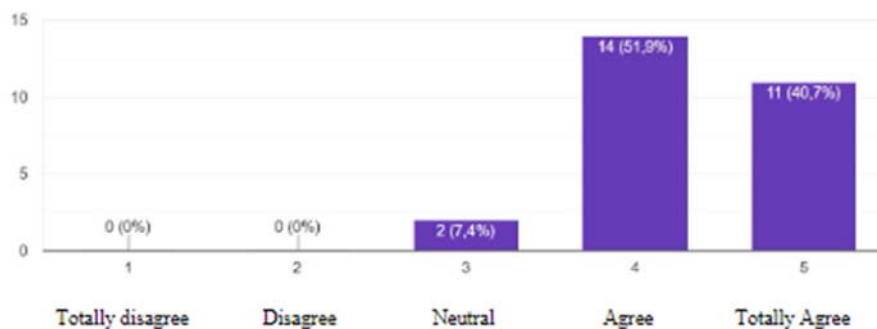
5) Main topics and keywords

In the fifth part of the survey, it was asked to the participants how important the keywords, identified during the webinar, were to define the challenges in terms of fire safety in the future (2030-2050). The eight keywords, for the purposes of the analysis, were divided into two groups, socio-economic and technological.

In the socio-economic group the keywords that received the greatest approval were "Education", with 81% of participants who considered it important or very important and a mean of 4.33 / 5, and "Resilience" with 92% of approval and a mean of 4.22.

Keywords	Very Unimportant	Unimportant	Neutral	Important	Very Important	Mean
Education	1	1	3	5	17	4.33
Aging	0	1	7	12	7	3.93
Sustainability	0	1	3	13	10	4.19
Resilience	1	0	1	15	10	4.22

Socio-Economical keywords
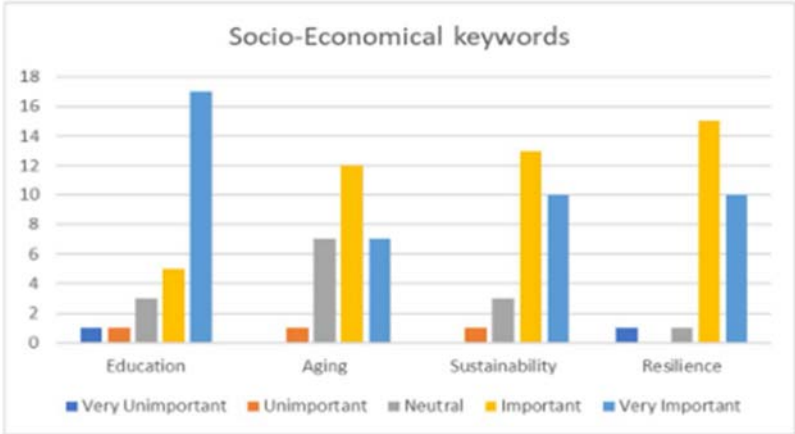
In the technological group the keywords that received the greatest approval were "Performance Based Design", with 81% of participants who considered it important or very important and a mean of 4.15 / 5, and "Large scale testing of new materials" with 81% of approval and a mean of 4.04.

Keywords	Very Unimportant	Unimportant	Neutral	Important	Very Important	Mean
Performance based design (PBD)	0	0	5	13	9	4.15
Large scale testing of new materials	1	0	4	14	8	4.04
Energy transition	1	1	5	10	10	4.00
Virtual Reality and Augmented Reality	1	2	7	11	6	3.,70
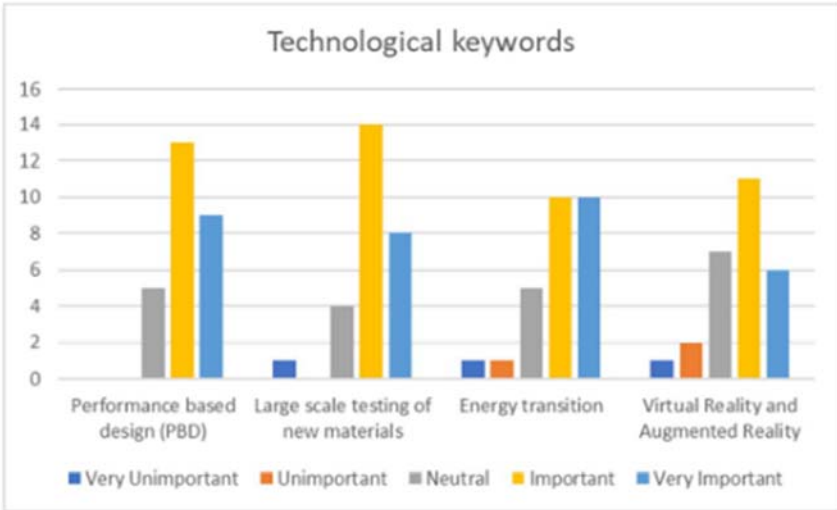
Technological keywords

The second question to the participants, relating to the proposed scenario, was on how much they agreed with the four main topics to be debated in the final part of the webinar.

The topic that received the greatest consent is "Need to investigate new materials performance" with 96% of participants who considered it important or very important and a mean of 4.48 / 5.

Afterwards, the topics "Develop fire safety standards by using a large-scale testing system" and "Develop methodology to include safety and sustainability simultaneously" were selected by 21 (78%) and 22 (81%) experts, evaluating them as important and very important respectively, reporting a mean value of 4.21 and 4.15 out of 5.

The theme "Solve ethical issue in using big data" was much less appreciated, being considered important or very important by 55% of the participants, with a mean value of 3.55.

Main topics discussed	Very Unimportant	Unimportant	Neutral	Important	Very Important	Mean
Solve ethical issue in using big data	1	3	8	10	5	3.55
Develop methodology to include safety and sustainability simultaneously	2	1	0	12	12	4.15
Investigate new materials fire performance	0	1	0	11	15	4.48
Develop fire safety standards by using a large-scale testing system	1	0	5	7	14	4.22
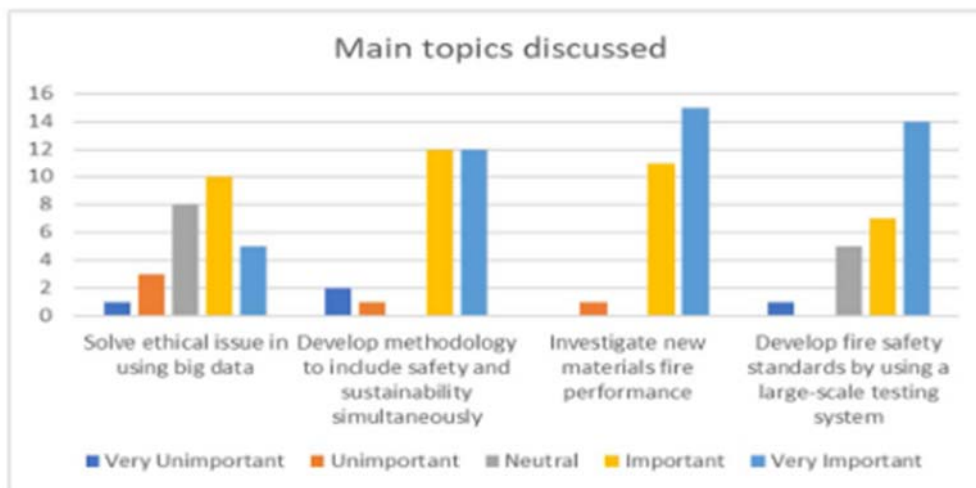
TWG C. Vegetation fires crisis mitigation

Surveys included in the document

TWG D. Natural disaster crisis mitigation

FIRE-IN TWG D- Natural Hazard Mitigation

8 responses

Publish analytics

Questionnaire on the Scenario of Tsunami in the Mediterranean Sea as future threat- follow up on the workshop 12 November 2021

...kground

8 responses

- Practitioner (fire fighter, THW, ambulance service...)
- National Authority
- NGO, private organisation
- SME
- Other
- End User (fire fighter, THW, ambulance service...)
- end user (fire fighter, THW, ambulance service...)

Characterise your organisation

8 responses

Natural person	0 (0%)
Legal person	1 (12.5%)
Non profit	3 (37.5%)
For profit	0 (0%)
Private Entity	0 (0%)
Public Entity	4 (50%)
NGO	0 (0%)
SME	0 (0%)
Other	0 (0%)
public entity	1 (12.5%)

Geographical scope of your organisation

8 responses

- regional
- national
- international
- local

87.5%
12.5%

Copy chart

What type of R+D+I (Research/ Development/ Innovation do) you develop?

8 responses

- mostly theoretecial
- mostly applied
- 50/50
- none

12.5%
12.5%
75%

What is your engagement with FIRE-IN so far?

8 responses

- active participation in workshops/ conferences
- registered on the e-platform as Associate Expert
- follower on social media
- other (please specifiy)

12.5%
87.5%

Copy chart

The scenario of future threats used was the scenario on a tsunami in the Mediterranean Sea. Tsunamis are rare but have devasting effects, if affecting highly populated areas and infrastructure. In some cases the environment can be polluted due to so called black tsunamis, that take hazardous substances from industrial plants in the current with them. The main characteristic of the situation is that the time period from the warning to the actual tsunami hitting the cost is generally only a couple of minutes. Since the events are rare the local population is not necessary aware of how to react best in this crises situation. What is the key challenge you rate the most?

7 responses
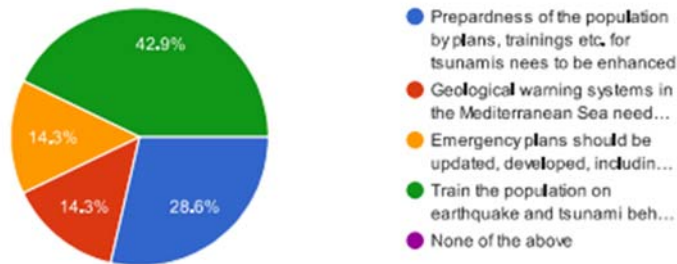
Pie chart legend:
- Prepardness of the population by plans, trainings etc. for tsunamis nees to be enhanced
- Geological warning systems in the Mediterranean Sea need…
- Emergency plans should be updated, developed, includin…
- Train the population on earthquake and tsunami beh…
- None of the above

Chart values: 42.9%, 28.6%, 14.3%, 14.3%

If you chose in the previous question -"none of the above" please elaborate

0 responses

No responses yet for this question.

In this scenario some key drivers, constraints or resistants affecting key emergency management capabilities related to this challenge have heen identified.
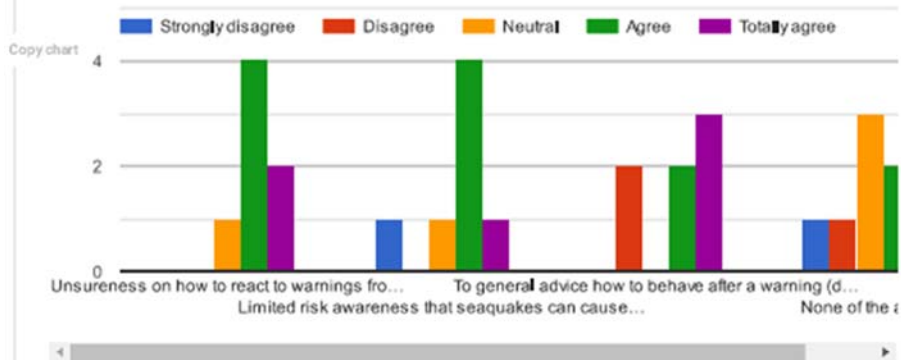
If you chose "none of the above" in the previous question please elaborate

0 responses

No responses yet for this question.

Would you see earth observation data as useful to enhance the situation updates from official side?

4 responses
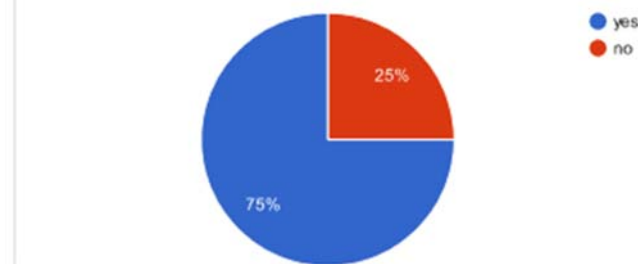
Would you see social media scanning as useful to enhance the situation updates from offical side?
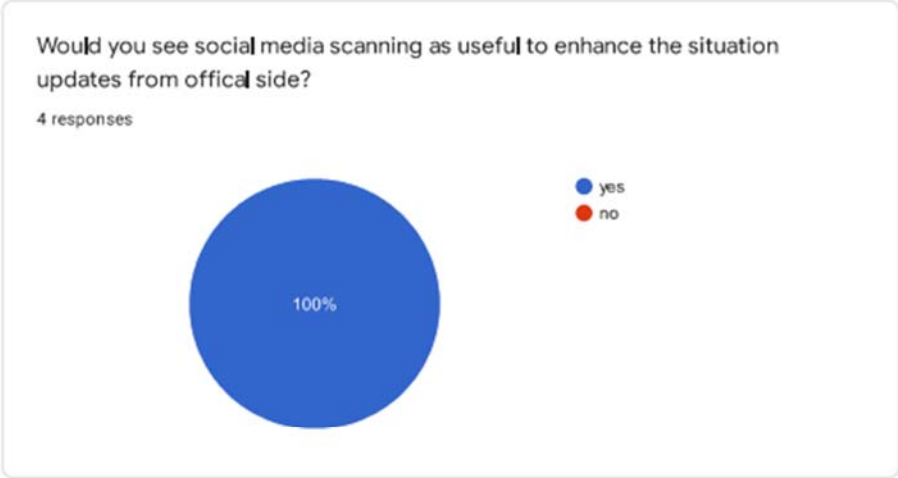
4 responses

Would you see a combination of earthobservation and social media scanning as useful to enhance the situation updates from official side? Or only one of those two options? And if so why?

4 responses

Because decissions are made better if you have the fully picture

ث

Both are needed (if the network functions after a devastating Tsunami)

Not sure

Copy chart

Might it be useful to use AI (artificial intelligence) in the possible training of the first responders and the public?
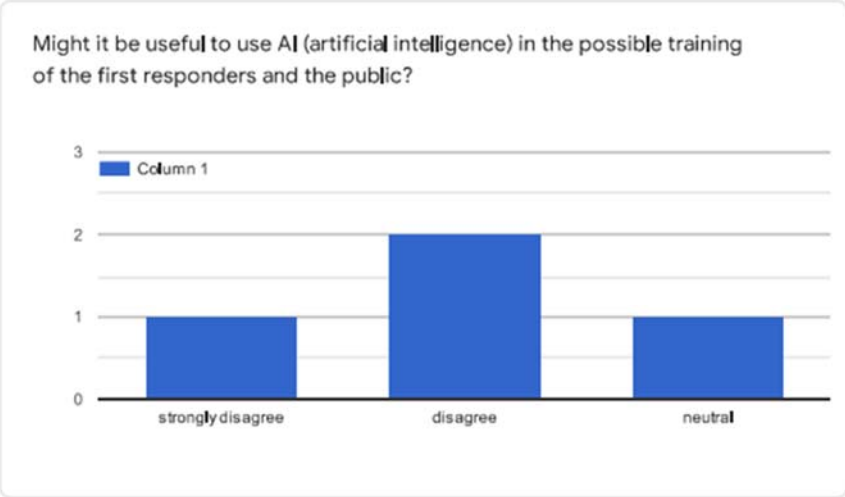
If you agreed with the suggestion in the question above please elaborate

1 response

Training is vital and boring lectures dont help

TWG E. CBRNE crisis mitigation

An online survey was distributed to webinar participants and other AEs to identify more common capability challenges. The questionnaire is currently in evaluating process.

Online survey via GoogleForms template:

Specific questions:

1. **How important do you see preparing and planning for multiple risks emergencies?**

High important   Low important

2. **What will be next global disaster (How have changed your thinking about future global disaster connected to specific CBRNE threats). Try pointing probability of each disaster.**
   a) Nuclear disaster (Power plants)
   b) Chemical disaster (chemical plants, transportations)
   c) Infection disease spreading
   d) Long-term environment contamination (see, river contamination, large accident on see, long-term contamination of water sources by chemical substances)
   e) Terroristic attack using CBRNE substances
   f) Other

3. **What will be characteristic for future global CBRNE disaster? Pleas identify importance (1 low-5 high).**
   a) affect countries, continents
   b) have hundred thousands of victims, have millions affected
   c) Rise up massive migration/relocation
   d) will be characteristic by multiple threats/risks
   e) paralyze health system and First responders
   f) medical staff and First responders will solve other emergencies on background of global disaster with limited support from neighbouring countries/regions/unions
   g) will be driven by influence of media and social media
   h) will generate tensions and changes in politics and country leaders (improving power of radicalism and extremism)
   i) will generate unwillingness of populations for prevention restriction
   j) will be accompany by shortages of basic foodstuffs and sources
   k) will be driven by global leading countries with concentration of sources/productivity (PPE, test, vaccine, antidotes etc..)
   l) Will have massive impact in Economy, Employment and traditional life values
   m) will create environment for specific attacks – cyber attacks

4. **On meeting, we have identify some key challenges for future global disaster. How is important discuses of these challenges?**
   a) Risk assessment (how to recognise incoming disaster timely)
   b) Cooperation between regions and states (self-preparedness vs common preparedness)
   c) Preparing of population (improving resilience)
   d) Standard operation procedures (multiple risks emergencies)
   e) Improving of first responders resilience
   f) Other

5. **What will be indicators for early identification of future CBRNE global disaster?**
   a) Duration
   b) Number of victims/injured

c) Affected area
d) Environmental impact
e) Economical losses
f) Restriction of personal right and freedom
g) Interest of media

An online survey was distribute to webinar participants and other AEs to identify more common capability challenges. The questionnaire is currently in evaluating process.

Online survey via GoogleForms template:

Specific questions:

1. **How important do you see preparing and planning for multiple risks emergencies?**

High important   Low important

2. **What will be next global disaster (How have changed your thinking about future global disaster connected to specific CBRNE threats). Try pointing probability of each disaster.**
a) Nuclear disaster (Power plants)
b) Chemical disaster (chemical plants, transportations)
c) Infection disease spreading
d) Long-term environment contamination (see, river contamination, large accident on see, long-term contamination of water sources by chemical substances)
e) Terroristic attack using CBRNE substances
f) Other

3. **What will be characteristic for future global CBRNE disaster? Pleas identify importance (1 low-5 high).**
a) affect countries, continents
b) have hundred thousands of victims, have millions affected
c) Rise up massive migration/relocation
d) will be characteristic by multiple threats/risks
e) paralyze health system and First responders
f) medical staff and First responders will solve other emergencies on background of global disaster with limited support from neighbouring countries/regions/unions
g) will be driven by influence of media and social media
h) will generate tensions and changes in politics and country leaders (improving power of radicalism and extremism)
i) will generate unwillingness of populations for prevention restriction
j) will be accompany by shortages of basic foodstuffs and sources
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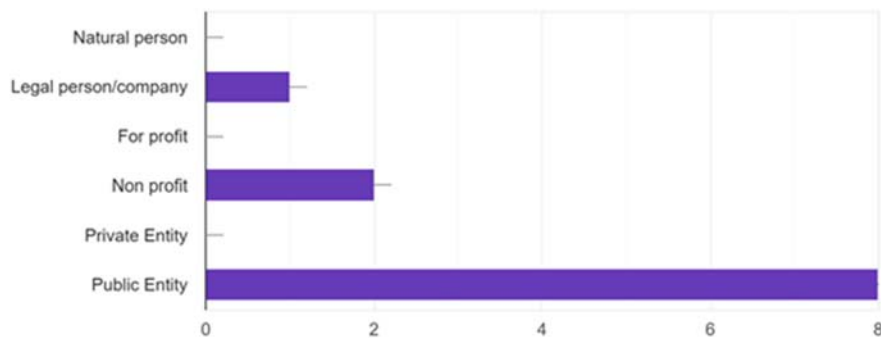f) Restriction of personal right and freedom
g) Interest of media

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    b) Number of victims/injured
    c) Affected area
    d) Environmental impact
    e) Economical losses
    f) Restriction of personal right and freedom
    g) Interest of media

Evaluation of online survey

Number of responders: 10

    1. Area of responders activities:
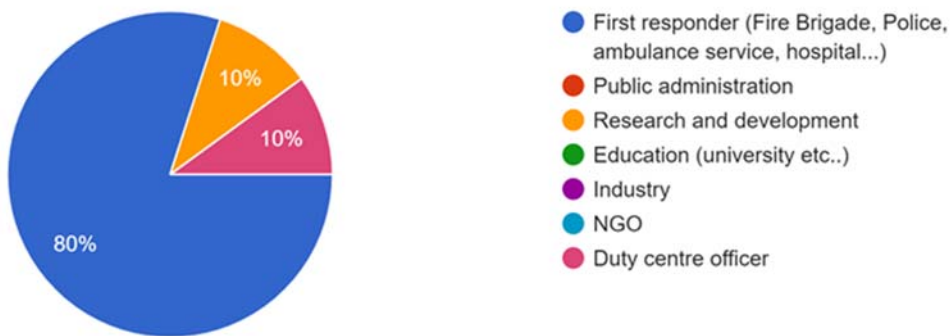
    2. Characteristic of responder's organisations

    3. Geographical scope of responder's organisations

- ● international
- ● national
- ● regional
- ● local
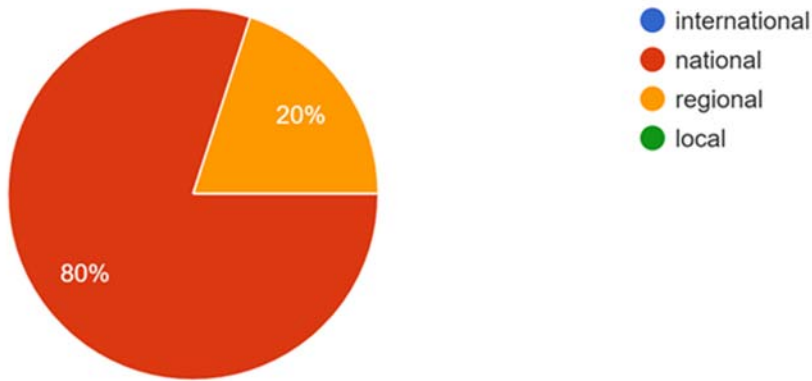
4. R + D + I activities of responders

- ● mostly theoretical
- ● mostly applied
- ● 50/50
- ● none
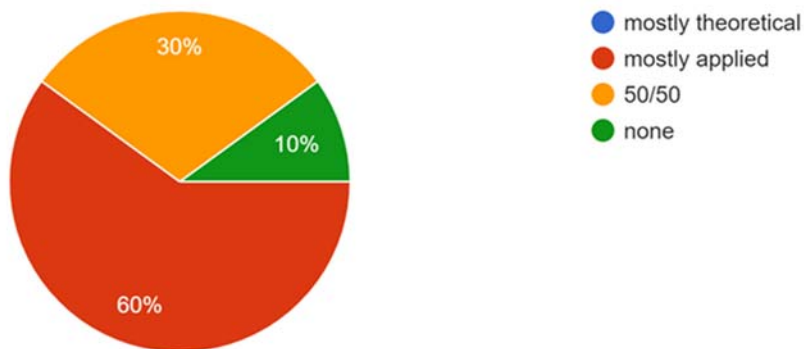
5. Engagement of responders in Fire-in project

- ● active participation in workshops/ conferences
- ● registered on the e-platform as Associate Expert
- ● follower on social media
- ● partner
- ● one conference in Praha
- ● Conference
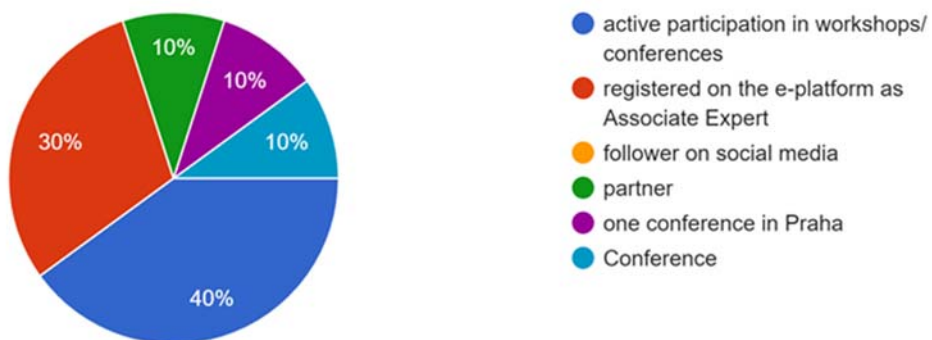
6. Importance of preparing and planning for multiple risks emergencies

HIGH   LOW
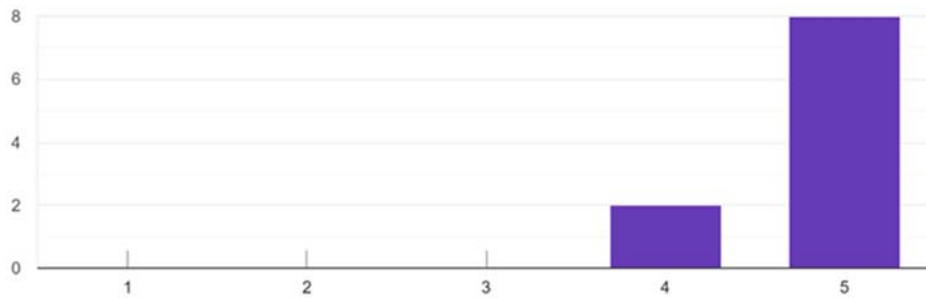
7. Probability score of future CBRNE disaster
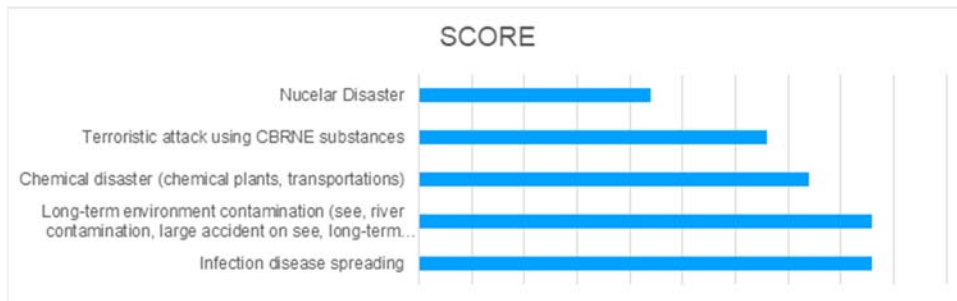
Other possible future CBRNE disasters: CBRN combined with CYBER ATTACK, Industrial accident in conflict zone
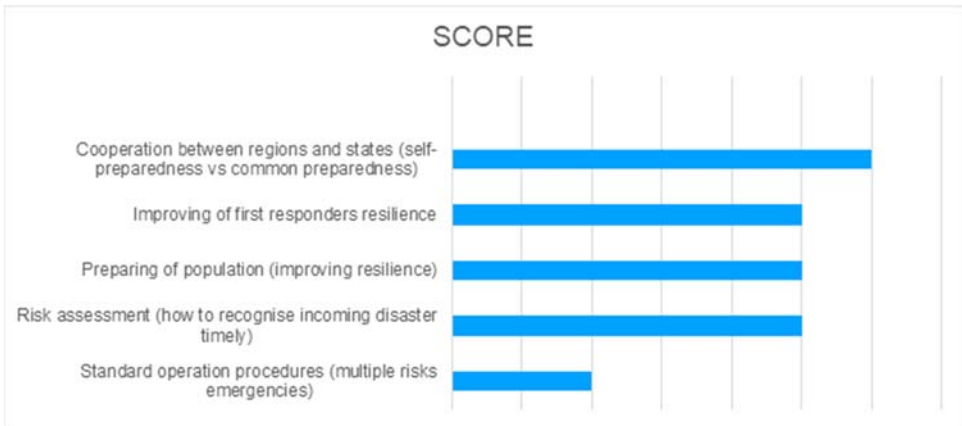
8. Characteristic of future CBRNE disaster
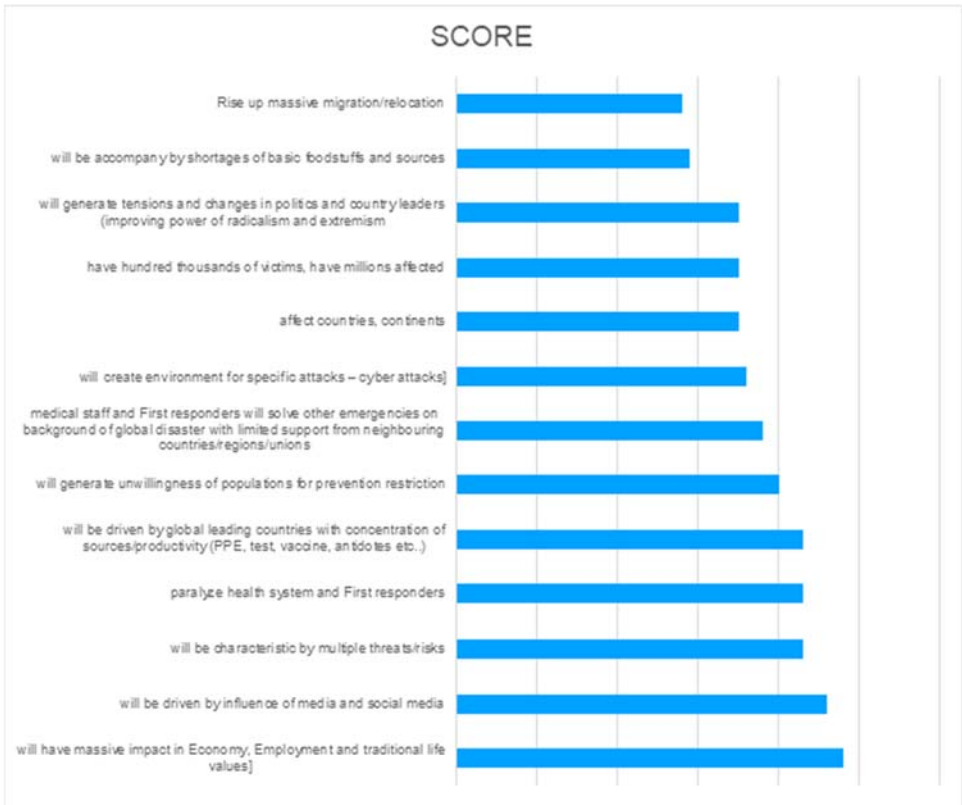
9. Key challenges for future CBRNE global disaster

10. Indicators for early identification of future CBRNE global disaster

This project has received funding from the European Union's Horizon 2020 Coordination and Support Action programme under grant agreement No 740575.

114
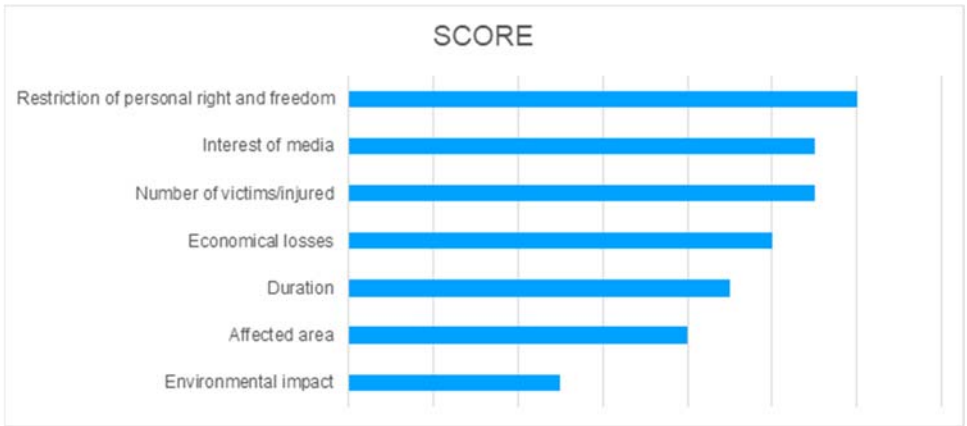
Appendix 3: Workshop Future Scenarios Description

After the webinars, when searching a logic of among capacity to find common trends, it was made evident the difficulty to focus in concrete items because either scenario was so different that it was difficult to reach them, and even inside any TWGs' thematic, different scenarios could be faced with many different challenges. The next example aims to clarify this issue.

Example:

From a SAR & EMR (TWG-A) perspective, scenarios in caves or earthquake scenarios differ substantially, and challenges become equally different, going from sustaining operations to a low frequent multileadership scenario.

From structure fires crisis mitigation, prevention, and protection perspective (TWG-B), there are big differences when approaching a fire in a tunnel between two countries or a high-rise intelligent building because challenges go from a hostile environment with multileadership in the former to a low frequency high impact scenario for the latter.

But when facing challenges from a general perspective, for example when facing HILOF, in all scenarios there is a need to prepare communities and responders to make decisions, to avoid collapse of something that will exceed their capacity. And this is appliable to different scenarios at once (from the high-rise building to the wildland urban forest fire, or to the earthquake) because it depends on the existence of population in the hot zone, especially when they are not injured. And one of the ways to avoid this collapse is to get population (communities) involved in their self-protection, as agents of the emergency.

After the webinars 2 different scenarios were defined:

List of future scenarios prepared with experts.

Scenario	Title
1	Europe successfully adapts to the knowledge economy (2040)
2	European particularism and protectionism in a tense global situation (2040)

TWG A SCENARIO

Global scenario (pitch):
Improving innovation circuits around practitioners, facing the next 10 years of increasingly complex emergencies management in the era of information and uncertainty.

Specific scenario developed with research:
Next ten years the complexity of the challenges faced in emergencies will grow. We'll see every time more low-frequency, high impact events with multiple leaderships; we will face new uncertain, dynamic scenarios. These challenges cannot be overcomed with old perspectives. They will be the drivers of innovation in emergencies. How are the emergency capabilities been changing in front of new challenges?

New challenges foster innovation, but it needs time, knowledge and expertise to develop. What are the best policies and practices to foster innovation focused on operational gaps and strengths?

Also, new technologies, processes and sources of innovation, as well as changes in the flow of information are starting to transform the ecosystem of innovation. It brings more noise and uncertainty, a greater need for talent, for multidisciplinary teams, flow of ideas and innovations between teams and thematic areas, … What is the influence of social network, Big Data, Internet of Things and Artificial Intelligence in the network of innovation?

Successful innovations emerging from this new ecosystem of innovation are those that respond better to the challenges posed by new emergencies. So, both a sharp focus on the job-to-be-done and a constant adaptability to unstable changes are needed. How innovation happens and how it is successfully implemented in the emergency management arena?

All this requires in the near future changes in the structure of knowledge and decision-making between research, practitioners, industries and social agents; shifting the flow of trust in the networks, and the participation of the community. What type of interactions are the most successful to fit new challenges faced by practitioners to new solutions? How do we understand the role of practitioners, research and industry in the innovation implementation network?

How can innovation processes be made more efficient in the world of emergencies? Which agents, which forms of interaction, in which opportunities should we focus on? Which constraints should we consider? Which ethical issues should we address?

TWG B SCENARIO

Target of the scenario

Create resilient communities with the capabilities to deal with fires of type of structures that will characterize cities in the years 2030-2040.

1. Specific scenarios

Most of the researchers' foresights predict that the expected population increase will produce an increasingly urbanised society, that will tend to concentrate in cities clustered by taller buildings to save territory.
In Europe, however, the population will tend to decrease, while it is expected an increase in the number of elderly and overweight people, which will impact on the evacuation procedures and tools to be employed in case of fire to ensure the safety of vulnerables (e.g., completely or partially impaired people).
In addition, new energy, communication and construction technologies will bring new materials into the buildings with possible new risks in the event of a fire.
As a consequence, what are the challenges we will face in the next 10-15 years in terms of fire safety?
Is the growing need for fire safety economically, socially and ecologically sustainable? What is the balance point?
How to harmonize safety standards in different countries?

How can the following problems be dealt with from a technical point of view? o Protection systems for curtain walls

In order to reduce the consumption of land, the increase in population will necessarily produce an increase in high-rise buildings in inhabited centers, which must take into account not only the construction characteristics of the materials, but also the management of vulnerable people, e.g., with reduced mobility and difficulties to access from rescuers.

o   Renovation of existing buildings

The need to improve comfort in existing buildings, especially from the point of view of thermal and acoustic insulation leads to the introduction on the market of new materials whose fire behavior is not perfectly known, especially for rescuers

o   Energy self-sufficiency of buildings and use of renewable energy sources and large energy accumulators

The increasing adoption of renewable sources and electric mobility will also lead to a revision of the construction models of buildings, with the creation of large energy storage units and charging stations inside the building. How will the fire risk change? What new multi-risk fire scenarios will rescuers face? What support can new technologies and artificial intelligence provide for the management of fire scenarios in increasingly complex buildings with the presence of new risks related to the aging of the population and the presence of new materials? For example, development of:

o   a standard that allows easy control of safety measures and the use of related information to improve operator safety and rescue operations or of

o   security solutions based on information and communication devices and systems and development of criteria for measuring the effectiveness of such measures.

TWG D SCENARIO
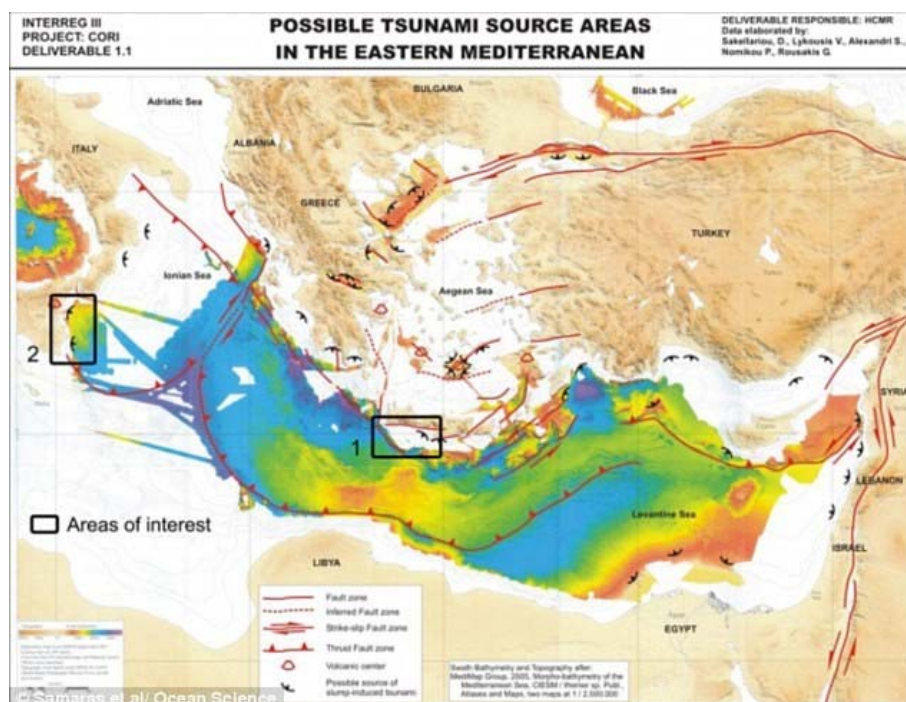
Global Scenario:
Europe is prone to different types of natural hazards ranging from extreme weather phenomena (heat waves, extreme rainfalls, etc.), to flash floods and geological hazards (eartquakes, landslides, tsunamis, volcanoes, etc.). As Europe is generally highly populated, hazards can turn into disasters, if the prepardness is not robust enough. Therefore also future scenarios with high impact potential but low probability of occurence have to be taken into account.

Specific scenario developed research:
Geological hazards of a certain intensity that are not so likely to happen but its occurence and their cascading effects are devastating, are threats for the future that have to be addressed since they will raise a joint effort within and outside the EU borders to mitigate effects. One of those events with a hugh potential for devasting effects is a earthquake in the Mediterranean Sea generating a tsunami. From the start of the year 2020 up to late summer around 50 earthquakes with magnitudes (Ricther scale) $4.5 \leq M_L \leq 6$ have been recorded in the Eastern Mediterranean Sea. Thus a major earthquake in the Mediterranean Sea of 7-8 on the Richter Scale (e.g. a replication of the 365 earthquake in Crete or the 1303 earthquake between Crete and Rhodes) is just a question of when it will happen, thus the look in the future is needed. If it takes place it will cause a tsunami that affects large coastal lines with a hugh damage. There are around 480 million people living in the countries sourrounding the Mediterranean Sea and numerous industrial facilities.
Models on prediction exist, but it is difficult to asses the exact risks for the individual countries and a prediction when such an event will take place is not possible yet.

Multinational response and cross-border cooperation:
An event at this scale asks for multi country assistance from in and outside the EU. Extreme damage and structural damages compared with a heavy toll on the population have to be faced in a short time with multiple incidents and places affected.

Preparedness of the society (citizens and state mechanism):
Additionally, the population's preparation and engagement to situations associated with tsunamis and short warning time is a challenge that gains momentum in the future. How is the preparedness and engagement to bring to a higher level with innovations and requests for innovations?

Operational doctrines and harmonization:
In such hazards the operational doctrines and the response mechanism are stretched to their limits, how can they be adopted facing those hazards? E.g. Standard Operations Procedures (SOPs) focus so far on the specific risks associated with the scene of the intervention, not with an immediate impact on the functioning of the rescue services. How to increase the resilience of rescue services, hospitals etc. in case an emergency paralyzes employees or the organizational system?
How can we harmonize operations in a multinational environment with the innovations we have or should have to mitigate risks more effectively?
Is the response mechanism ready to deal with such large events? Is traumatized or not? Can it cover multiple points of intervention and how fast? Are current SOPs sufficient to cover such events?

Cross-hierarchy and cross-sector issues:
From local to regional to national and European or international level. Who is in charge in such an event?

TWG E SCENARIO

In the future, emergency events can be expected, which will take place in specific conditions and will be characteristic by multiple risks. Emergencies with a combination of specific risks with a global impact will be typical. In the case of CBRNE, these may be pandemics, contamination by radioactive or chemical substances in several countries or continents. Under the conditions of these threats, other incidents will take place, both of a natural and manmade. For example, events in areas contaminated with radioactive substances - Fukushima, Chernobyl. These need not only be accidents at nuclear power plants, but also, for example, accidents or intentional damage to radioactive material storage facilities. Events associated with the release of hazardous substances, floods, earthquakes with the need to move a large number of people in the area affected by the pandemic

Fukushima area 2011   Chernobyl forest fires 2020   Ukraine 2020 – floods in COVID-19 area

Global challenges

How to assess risks?
Most model events in the past were based on one dominant risk with a relatively short time effect and local impact. How to analyse risks more effectively and plan for preparedness?

How to improve cooperation between regions and states?
The impact of the emergency was modelled at the level of regions or individual states. Regional, cross-border or international assistance could be used. However, they can reduce the specific risks of providing this assistance, for example by restricting the movement of people and depleting capacity. How to improve mutual cooperation between regions and states in the event that large areas are affected or the movement of people is restricted?

How to prepare the population?
How to prepare the population and how to increase its resilience to situations associated with emergencies in specific conditions - contaminated territory, pandemic area?

How to improve Standard operations Procedures and resilience of First Responders?
Standard operations procedures focused on the specific risks associated with the scene of the intervention, not with an immediate impact on the functioning of the rescue services. How to increase the resilience of rescue services, hospitals etc. in case an emergency paralyzes employees or the organizational system? How to adjust the organization of First Responders permanently operating in the danger area? How to design buildings for rescue services to be resistant to specific risks? How to implement new technologies that will allow more effective intervention, reduce the danger to those intervening? How to adjust the procedures for rescue, evacuation and provision of medical care in case of combined risks?

Appendix 4: Third cycle workshop (WS) methodology

An on-line Workshop (WS) was held on the 15th of September (on-line). The **objective** of the workshop was to advise EU on a strategic agenda to focus efforts on the main challenges in emergency management in front of novel emerging threats and an uncertain future.

The following generic question was posed to focus this objective: `*Up to the 2040s the frequency, size and potential damage of emergencies will keep on changing, gradually or abruptly, posing new emerging threats to future societies. What are the main challenges and capabilities in which to invest to develop an agile resiliency?* `

The TWG leaders proposed different experts for the WS. TWG-A leaders managed the contact, the approach of the WS to the experts and the confirmations.

ATTENDEES	Organisation
Patty Geelhoed	Institute for Physical Safety
George Boustras	
Gerassimos Papadopolous	International Society for thePrevention and Mitigation of NaturalHazards
Luigi Palestini	CNVVF - Italy
Marta Miralles	CFRS
Edgar Nebot	CFRS
Carles Garcia	CFRS
Alan Gavel	FRS –PopulationprotectionInstitute
Laia Estivill	PCF
Florian Neisser	Fraunhofer
Fábio Silva (FEPC)	FEPC
Lindon Pronto	PCF
Mariona Borràs	PCF
Célia Conde	PCF
Marc Catellnou	CFRS
Alex Held	EFI
Peter Moore (UNFAO)	
Gianmario Gnecchi	Vigili Fuoco
Claudia Berchtold	Fraunhofer
Nico Hybbeneth	THW
Giovannni Fresu	CNVF

The methodology used was a simplified modification of the **NATO FATE-Method - Futures Assessed alongside socio-Technical Evolutions** methodology recommended by Fraunhoffer.

Before the WS day, a **preliminary list of challenges** was sent to participants to address the debate and prepare the experts who were to attend the workshop.

This list is next:

- Resiliency of society and emergency systems should be an integral part of any policies (economic, social ecology, technology...). Policies boosting society as a part of the solution.

- Prepare for the short window of opportunity to build robustness.

- Shift from reactive to proactive strategic decision-making (DM) in the emergency system; focusing on reducing uncertainty at a prize.

- Resilient command structures: adapted to complexity, focused on strategic centralized guidance, boosting tactical autonomy, knowledge- based.

- Empower emergency experts that capitalize knowledge in making decision and spreading successful innovations.

- Promote adaptative management by fostering 'emergency labs' (first responders, science society).

- Focus on maintaining and rising trust and credibility in uncertain collapse scenarios.

Two different scenarios were approached:

- ❖ **Scenario A:** Scenario like the actual context with a gradual change towards a worsening service. Unreal expectation of safety in front of complex, infrequent emergencies, where responders are liable. Decision-making in emergencies is slowly shifting, but new innovations are slower than the pace of emergencies. Different stressors (demography, climate change, new technologies...) increase the vulnerability in front of emergencies. In the end, in your area or region the accumulated number of people affected by emergencies increases 50% gradually up to 2040 mortality, affected people, infrastructure damage, economic loss, disempowerment... What are the drivers and resistors to prepare emergency management systems and society for these scenarios, how do you restore normality?

- ❖ **Scenario B**: A collapse due to major emergencies. In your area or region, a major disaster will collapse your emergency system, with high impact in deaths, infrastructure damage, secondary emergencies, socio-economic structure, ... You don´t know which type of emergency nor where and when... How do challenges, drivers and resistors change? The scenarios and challenges for this workshop are based on 3rd cycle webinars and WP1 deliverables.

The day of the WS, the methodology used is explained next:

1. **General introduction**: The WS, the objectives, the methodology to be used and the final list of participants were introduced. The introduction included the next points:

   a. The **path followed in FIRE-IN** to reach the WS. This included the process followed to identify the Common Capability Challenges, the need to focus on decision-making and the challenges that drive innovation (sustain operative effort in time, low frequency high impact scenarios, multi-leadership, high uncertainty).

   b. The approach to the **objective** to be addressed: 'Advise EU on a strategic agenda to focus efforts in front of novel **emerging threats and an uncertain future'.**

   c. **Key concepts:** How the unknown is approached, and some examples were given:

   - ✓ '**Unknown, knowns'** (See Section *Reflexions and Highlights*)

- ✓ **'Unknown, unknowns'** (See Section *Reflexions and Highlights*)
- ✓ **Asymmetries between 'authority, knowledge, impact'** .
- ✓ The **common capability challenges matrix** and the challenges from it to bear in mind for the WS discussion, send to experts previously to the WS by email (see some paragraphs above '**preliminary list of challenges'**).

2. **Scenario A:** Scenario A was presented to all participants using the same ZOOM room (main room).

3. **Discussion about Scenario A**: Next, participants were split into the two groups (two different ZOOM rooms) and a series of questions were posed about this scenario to discuss about them using 40 minutes. The final 15 minutes of these 40 minutes were to be used, based on the discussion held, to address what European policies should look like to fit in with what was discussed. The experts contributed with their opinions and discussion.

4. **Scenario B**: All participants were gathered again (ZOOM main room) and Scenario B was explained (5 min). Next, participants were split again un the same two groups.

5. **Discussion about Scenario B**: Participants were split again into the two same groups (two different ZOOM rooms) and a series of questions were posed about this scenario to discuss about them using 30 minutes. This time was shorter assuming that participants had had time to understand the procedure and practice it. The final 15 minutes of these 40 minutes were to be used with the same aim explained in point (2). The experts contributed with their opinions and discussion.

6. **Final discussion for EU policies recommendations**: All participants were gathered again in the main room to share and discuss focusing directly on recommendations for European policies.

Each group counted with 1 'moderator', 1 'observer' and the different experts, including TWG leaders. The role of the '**observer**' of each group was to lead the discussion, adjust it to the content of the questions and facilitate discussion. The role of the **'helper'** was to control technical aspects, keep time on schedule and support the group (connections, problems with ZOOM, etc.).

A shared document, separate for each of the two groups, was opened so that participants could contribute their written contributions within each group. This was to make it easier for experts to write down their ideas without them being distorted by the listener's interpretation.

The initial proposal was to create 3 separate groups, but although some experts confirmed their attendance, they did not show up on the day of the session. This meant that one group had to be eliminated.
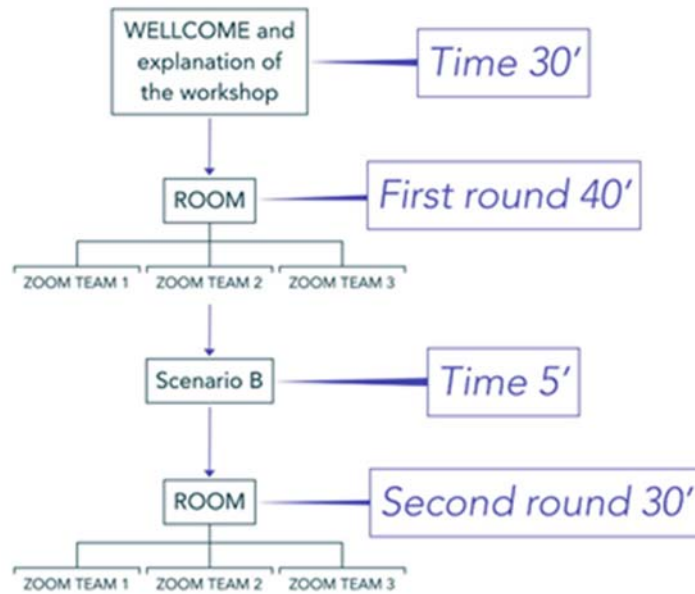
After the WS, the inputs were checked against the points detected in previous deliverables.