RECIPE

REINFORCING CIVIL PROTECTION CAPABILITIES INTO MULTI-HAZARD RISK ASSESSMENT UNDER CLIMATE CHANGE

Report on Civil Protection and emergency management requirements to face natural hazards

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1. Introduction

This report is part of the deliverables of the RECIPE project (**Reinforcing Civil Protection capabilities into multi-hazard risk assessment under climate change**) and corresponds to the deliverable 2.2 of task 2.2.

RECIPE is a two-year Prevention Project (January 2020 – November 2021) founded by the Civil Protection Mechanism of the European Commission (call identifier UCPM-2019-PP-AG), with the participation of 8 institutions from 5 EU countries:

- Forest Science and Technology Centre of Catalonia (CTFC), Spain (Project coordinator).
- Pau Costa Foundation (PCF), Spain.
- Civil Protection General Directorate of Catalonia (DGPC CAT), Spain.
- Forest Research Institute Baden-Wuerttemberg (FVA), Germany.
- CIMA Research Foundation (CIMA), Italy.
- Austrian Research Centre for Forest Natural Hazards and Landscape (BFW), Austria.
- Institute of Cartography and Geology of Catalonia (ICGC), Spain.
- Higher Institute of Agronomy (ISA), Portugal.

The RECIPE project seeks to develop operational recommendations and tools to reinforce Civil Protection capabilities into emergency management and risk planning of different natural hazards across Europe to address climate change impacts by using an integrated risk management approach and the exchange of lessons learned and best practices.

By means of putting together multi-hazards' expertise from science and practice of **wildfires, floods, storms, avalanches, rockfalls and landslides,** main impacts of climate change in risk management will be identified. The potential scenarios of unprecedented multi-risk events will be considered. The interactions between prevention-preparedness-response-recovery actions in projected climate change scenarios will be analysed with an active participation of practitioners and other users. Accordingly, Civil Protection requirements to face new risk management challenges about climate change impacts will be identified.

Based on the above, transferable guidelines will be edited to incorporate the projected multi-risk impacts of climate change into operational decision support systems (DSS) that are used for risk management. Complementary, specific operational tools will be developed at pilot site level for each natural hazard to reinforce Civil Protection capabilities. Participation of public agencies will be promoted from the beginning to achieve an end-user oriented focus. Results will be actively disseminated into Civil Protection systems.

Furthermore, the project's workshops will promote the knowledge exchange in the existing networks to reinforce European landscapes' resilience to natural hazards.

The project is divided in 5 work packages (WP) as follows:

- WP1 Management and coordination of the action.
- WP2 Framing Civil Protection requirements for integrated multi-hazard risk management.
- WP3 Impacts of climate change projections on multi-hazard risk management.
- WP4 Guidelines and decision support tools for integrate climate scenarios into risk assessment and planning.
- WP5 Publicity and project outcomes transference.

Task 2.2 is part of the work package 2. This WP is composed by two tasks. On the one hand, a common understanding of risks components of the different natural hazards to address multi-risk integrated and cost-efficient risk management is defined (task 2.1 and deliverable 2.1). In the second task (2.2), a gap analysis to identify how to best enhance response capabilities into risk assessment and planning process has been carried out and are explained in the present report.

Emergency management needs to face single and/or multi-hazards have been identified in this task 2.2 with the expertise contribution from partners on the different natural hazards. The integration of data and operational needs from the Civil Protection and the emergency management perspective into risk planning enhancing the coordination between prevention-preparedness-response-recovery actions should serve to reinforce the integrated and cost-efficient approaches of Disaster Risk Reduction (DRR) strategies. Face-to-face interviews with regional/national Civil Protection and other emergency management bodies have been carried out and finally summarized to extract the main needs and gaps. This task has only one deliverable which is the present report.

2. Objectives

Task 2.2 seeks to identify the main gaps and needs during all the stages involved (i.e. prevention, preparedness, response and recovery) in the risk management process, with the aim to enhance the Civil Protection capabilities in extreme or unprecedent single or multi-hazard natural events in the context of a climate change scenario. It is done over the basis of an integrated and cost-efficient approach focussing potential cascade effects between prevention-preparedness-response-recovery actions into risk management.

Therefore, the aim of this task is to find out possible important improvements of the emergency management regarding these scenarios (i.e. extreme events in the context of a climate change scenario) arisen from the main weakness points during all the risk management process (e.g., identifying operational needs to facilitate emergency management that should be introduced into the prevention stage through data collection during the risk assessment and planning process).

These improvements may arise from very different fields, from technology to organization, and will be used in the next work packages 3 and 4.

In the WP3, a state of the art of climate change impacts on each natural risk and potential multi-hazard cascade effects will be done, focusing on best practical knowledge and transferable guides available at the decision-making level. Data collection will be complemented with a qualitative gap analysis with practitioners, about the challenges for the effective integration of climate change scenarios into risk management strategies (task 3.1). Once the risk situations are defined, data requirements for Civil Protection identified in this report will be re-evaluated, to face the projected climate change impacts (task 3.2).

In the WP4, the present results will be used to develop transferable guidelines for decision support tools to include the climate change scenarios into the risk assessment and planning, integrating Civil Protection requirements to fill the main gaps and improve the main weaknesses and needs of the emergency management. Moreover, these requirements will be considered as well along the operational tools' development in each case study[1] planned in the project.

More information about the results of this sequential process can be find in the corresponding deliverables and in the project website. The final Book of Guidelines capitalises the results of the sequence developed through different WPs.

[1] CIMA, Italy: Guidelines for flood and fire civil protection planning with participatory approach with an operational tool for collecting citizens monitoring observations in emergency situations.
BFW, Austria: Decision support for sustainable multi-hazard risks management.
FVA, Germany: Guidelines for a participatory crisis management plan to manage wind throw along roads.
ICGC, DGPC CAT Spain: Visualizer tool for managing emergency situation in case of high avalanche risk.
CTFC, PCF, ISA, DGPC CAT, Spain-Portugal: Support tool and guidelines for integrated risk assessment and planning for landscape and wild-land urban interface fires.
CTFC, ICGC, BFW, Spain-Austria: Protocol for wildfire and avalanche risk management in mountain areas.

3. Methodology

The methodology proposed to obtain the required information is based on the conduction of a series of interviews to the different organisms involved in the Civil Protection and emergency management itself. All the interviews were carried out following the same questions and template (see annex I). Each partner was the responsible for the interviews in its region or country. Afterwards, each partner filled a questionnaire to review the main points of the interviews they performed as a tool to help in the preparation of this report (see Annex II).

Each partner has some preference risk of expertise (as can be seen in Table 1) so their contributions are benchmarked in each of these fields. However, as many reported questions are related to different risks and many answers from interviewees are referred to different risks also, here it is offered a more integrated view in coincidence of the response needed from the Civil Protection part. Moreover, some of the partners also have expertise in other risks and interviewed to actors of a wider field of knowledge. Nevertheless, in next project actions is planned a further work of individualizing some ideas which could be very risk specific, analysing the operational requirements per each natural hazards.

The questions in each interview where sorted in three different parts:

1. Most common single and/or multi natural hazard scenarios each interviewed used to face.
    - These scenarios.
    - The general procedure.
    - The operational tools used.
    - The most important needs in terms of operational tools, data quality and integration.
    - The most relevant procedures and or inter-agency or multi-actor cooperation.
    - The actions that should be conducted in the prevention and preparedness stages to enhance the response capacity.
    - The use of cost-efficiency criteria.
    - The use of post-event improvement protocol.
    - The level of involvement of the exposed population and stakeholders along the risk management process.
2. Extreme event experienced:
    - Biggest natural hazard experienced (situation, tools used, data, resources, etc.).
    - Main weakness points of the emergency management during this event.
    - Best practices used during this event.

It needs to be mentioned that these interviews where performed together with the interviews for the task 3.1 to avoid interviewing the same actors twice.

From all these questions each partner has summarized their interviews following the next questions from the sum-up review:

1. Gap analysis about the most common single and/or multi natural hazard scenarios.
    1.1 Description of the interviewed general profile.
    1.2 General description of the most common single and/or multi natural hazard extreme events (with special attention to cascade and trigger effects.

1.3 Description of the gaps and operational requirements during the risk assessment and planning process to enhance Civil Protection capabilities.

1.4 Description of the main needs related to the emergency management to face multi-hazards (integration of data, operational needs, DSS tools, etc., considering cascade effects between prevention-preparedness-response-recovery integrated approach under cost-efficient criteria).

2 Gap analysis about the extreme event experienced.

2.1. General description of the biggest single and/or multi natural hazard extreme events experienced.

2.2 Description of the main points of weakness that the emergency management system had in this event.

In order to reach the objectives of the current report, all this summarized information coming from each partner (so different countries, regions and natural hazards expertise) has been gathered together in the next chapter, sorted by issues (following the structure of the described sum-up review) and highlighting the most relevant assertions. All sum-ups are available in Annex II.

It needs to be clarified that it has been observed some discrepancies around the place where the different parts of the information from each sum-up review need to be embedded in this report. So different partners have considered to put the same kind of comments in different places. It may be reasonable since many issues are related and sometimes is difficult to separate each part of the emergency management process.

Consequently, within Conclusions (chapter 5), all needs, gaps and improvements has been mixed in an effort to organize all the interesting ideas found in the interviews in a synthetic manner. Results have been organised through cross-sectoral components or risk management within DRR strategies considered in the methodological frame of RECIPE as follow:

- **Risk governance and policy**: The corresponding regulations and a public-private multi-actor governance framework for regional/national DRR strategies.
- **Risk assessment, mapping, and planning tools**: Comprises the assessment of risk level (e.g. through modelling, mapping or qualitative surveys); identification of underlying causes of the driving hazard, exposure and vulnerability; and risk planning tools.
- **Emergency management and response capacity**: Considers all actions related to the protection of people, goods and environmental services, and the organisation of the emergency services during the event.
- **Technical measures**: The corresponding mitigation measures at technical level.
- **Risk culture and communication**: Refers to actions promoting risk awareness and participation of exposed population in mitigating risk under the general framework of risk culture.
- **Recovery**: Recovery and post-disaster management initiatives (e.g. from assessment of lessons learned to recovery plans).

4. Summary of interviews

In this chapter there is a summary of the main ideas arisen in the interviews.

4.1 Overview of the interviewed profiles

In this point there is a general description of the interviewees as a base to support the comprehension of the next chapters.

The overall number of interviewed experts is 43 as can be seen in the next table.

Country	Partner/s	Risk analysis developed within RECIPE	Nº of interviews
Germany	FVA	Storms	6
Austria	BWF	Landslides and rockfalls	11
Italy	CIMA	Forest fires and floods	17
Spain	PCF, DGPC CAT, ICGC, CTFC	Forest fires and avalanches	8
Portugal	ISA	Forest fires	(Postponed)

Table 1 – Number of interviews per each institution

FVA conducted 4 interviews at different administrative and geographic levels, covering different stakeholder groups and levels of management (from Section President to Technical Advisor). The institutions are the following:

- The **DKKV** is the national platform for disaster prevention in Germany. It is an intermediary to international organisations and initiatives active in the field of disaster prevention and serves as competence centre for all questions of national and international disaster risk management.
- The **BBK** is the Federal Agency for Civil Protection and disaster risk reduction. As a subsidiary of the Federal Ministry of House Affairs it has a central organisational element working to ensure the safety of the population, combining and providing all relevant tasks and information in a single place.
- The **Regional council Freiburg** constitutes the higher emergency authority. It oversees the work of emergency authorities at district level and coordinates and advices during cross-district extreme events. It has operational competences for nuclear safety only.
- The **City and Rural District Karlsruhe** are two typical districts within the Federal State of Baden-Württemberg, Germany. The **District Fire Service** oversees and coordinates the operational Civil Protection of the firefighting service in the municipalities.

Consequently, there is a high degree of geographical representativeness and a wide range of responsibility.

BFW conducted 11 interviews to relevant actors in natural hazards and disaster management with regard to the processes of landslides and rockfall, the issue in which BFW has its expertise. They cover different levels of the managing process, from representative of fire brigades and Civil Protection to political decisions-makes. In Austria planning and executive activities are managed together. This indicates unclear distributions of competences for the assessment of damage disposition and the provision of preventive planning bases. The stakeholders interviewed were most frequently involved in flood events. Anyhow, rockfall and landslides also play a major role in their area of responsibility. In addition, large slope movements, surface water runoff, high winds, fire, snow load and ice smoothness are also mentioned as areas of application.

CIMA conducted 17 interviews at different administrative and geographic levels, covering different stakeholder groups and levels of management (some mayors but mainly technicians). They include Civil Protection technicians from the National Department of Civil Protection with expertise in floods and fire (respectively), municipal mayors and technicians of local Civil Protection, Civil Protection technicians from the (Liguria) Regional Sector of Civil Protection with expertise in floods and forest fires, experts from the regional department of agriculture, tourism, training and work policies in the internal areas, forest fire fighting, foresting, parks and biodiversity. The majority are involved in planning, prevention and preparedness duties rather in the operational emergency management.

It has to be mentioned that in Italy, each region has a high degree of autonomy in this issue. They regulate the organization of Civil Protection systems, ensuring the implementation of the procedures for the preparation and implementation of activities aimed at forecasting and preventing risks, managing the regional operating room (also aimed at information exchange with the Department of Civil Protection, Prefectures and Municipalities), managing the regional mobile deployment resources including also the volunteer organizations, organizing training activities in the field of forecasting, prevention and management of emergency situations and in general aimed at raising awareness on Civil Protection matters.

The degree of representativeness in these series of interviews is very high because the amount and the coverage of all geographic levels.

In the case of Spain, local partners coordinated to conduct the interviews, tackling main emergency bodies in the target region of analysis of Catalonia.

PCF conducted 2 interviews from the Catalan Fire and Rescue Service (CFRS), so with expertise in wildfires. They hold different levels of responsibility but with a high degree of technical expertise. One mainly deals with the management of the command and control central room and communication and use of technological tools to communicate and monitor operations in the field. The other interviewed is more wildfire oriented, being a wildfire analysis and assessment specialist.

CTFC conducted 1 interview from the Catalan Civil Protection (DGPC CAT) body. The representative works, with a mid-level responsibility, coordinating the global strategy from a local perspective, giving support to the territorial coordination of the different operational corps and local stakeholders, programming the operative resources and their dimension for the Civil Protection actions and coordinating the logistic actions in case of emergency.

Finally, **DGPC CAT** conducted 5 interviews, all within the Catalan Civil Protection body and all with mid-level or high responsibilities. Their role is related to planning, operational emergency management, development of technology and communication, so they cover a wide range of fields.

In relation to the interviews performed by the Spanish partners, it has to be highlighted that all are from Catalonia and covers different bodies related to the Civil Protection and emergency services from the regional government. It needs to be mentioned that in Spain each region has a high degree of autonomy in relation to the emergency management, although there is a basic regulation at the country level that all regions must follow. In the particular case of Catalonia, it has its own emergency management bodies for fire and rescue services, police, health emergency service, forest officers, Civil Protection and institutions for risk management in some natural risk (hydrology, meteorology and geology).

On the other hand, municipalities play a very important role although only Barcelona holds its own fire department, many of them holds local police and all have a high degree of autonomy in emergency planning. However, regarding natural emergencies, the management is performed at a regional level because the Catalan administration holds the resources and only in case of an emergency affecting other autonomic regions or in case of non-manageable dimensions there would a coordination from the Spanish administration.

As a conclusion, the number of interviews seems quite high and seems enough to draw a picture of the current needs, improvements and weaknesses in relation to Civil Protection and the emergency management. Obviously, it has to be pointed out that each country has different organizational schemes implying different degrees of autonomy for the regions and municipalities.

Finally, a question needs clarification. Due to internal and external organisational matters, the important contribution of the ISA (forest fires) and ICGC (avalanche risk) to this task will be considered along the next project steps and included within the WP3 and 4 analysis as well.

4.2 Gap analysis about the most common natural hazard scenarios

In this point, there are three parts:

- A description of the most common natural hazards scenarios (single or multi-hazard).
- The improvements identified for the risk assessment and the planning process in these events.
- The improvements identified in the overall emergency management process in single or multi-hazard events.

4.2.1 General description of the most common single and/or multi natural hazard extreme events

FVA differentiates between winter and summer conditions. The most common natural hazard events during the winter are storms, flooding and torrential rain events.

Multi-hazard events occur mostly as a combination of the latter, when there are abrupt changes in weather and temperatures, leading to increased and sudden snowmelt in combination with heavy precipitation. These trigger flooding and soaked grounds, which can lead to landslides in steep terrain. Moreover, in combination with a storm event, blown trees can block streams, increasing the risk of flooding and limit access to affected areas.

On the other hand, during summer months, the most frequent events are local storm cells that can cause extreme wind speeds and heavy rainfall leading to flash floods. This is the most common emergency scenario caused by natural hazard event. Drought and heatwaves lead to drier conditions in forests and an increasing forest fire danger. In case of forest fires, it is mostly air pollution that causes problems for the general public.

BFW reports many different cascade effects related to landslides, floods and storms:

- The impact of landslide masses into the receiving water (blocking rivers with the danger of dam breakage scenarios).
- The blocking of channels as a result of rockfall events.
- The developing of mud/debris flows from landslides masses.
- The blockings caused by wild wood fallen after high winds.
- The increase of landslides, rockfalls and avalanches caused by high winds or forest fires.
- The increase of soil erosion due to insect pest weakening forests (loss of forest cover and soil protection).
- The increased surface runoff after long periods of dryness.

CIMA reports that the most common natural hazard events are floods (river floods and flash floods) and forest fires (but in recent years much less), sliding landslides and storms. At national level forest fires are characteristic of the summer and spring and at regional level they are characteristic of the summer and winter. They also include WUI (Wildland-Urban Interface) fires. Nevertheless, at regional level (Liguria region), Civil Protection technicians from Regional Sector of Civil Protection mark the hydrogeological risk as the most frequent.

In some circumstances, multi-risk events with cascading effects occurred (e.g. seismic landslides, forest fires favoured by drought conditions, or landslides and floods favoured by the effect of forest fires). The interviewed highlighted that the consequences of a forest fire can in fact exacerbate a hydrogeological risk scenario; however, there are few studies at regional level and does not represent a real emergency management issue.

PCF reports that flooding and forest fires are the most common natural hazards that the Fire Service deal with. In regard to wildfires, Pyrenees host fires during winter and early spring thanks to low relative humidity, while the rest of the territory has summer as the worst fire season because of the high temperatures. Wildfires have a large impact in Catalonia, however, in terms of human fatalities, flooding and wildfires have a similar impact.

As is reported by other partners, the most common trigger effect pattern are wildfire events followed by flooding. When vegetation burns, the terrain losses a part of its capacity to absorb the water from the rain, thus, rain has the potential to cause flash flooding because of the water run-off. A common trigger effect pattern is a wildfire threatening properties, large chemical industries, communications, etc. It is very important to know that when the CFRS faces a large emergency, it absorbs a lot of resources for other small emergencies and can facilitate that a small emergency become a large emergency.

CTFC develops the effects of intense river flood and snowfall events affecting large areas with thousands of citizens and critical infrastructures involved, which seems to be more frequent in recent years. Among others, along the interview is discussed the cascade effects of such a large events and the multi-emergency situations created. Also forest fires events are considered, and how extreme events are forcing more and more to the confinement/evacuations of the population.

DGPC CAT summarizes that the most common natural hazard extreme events faced by Civil Protection are floods, flash-floods and wildfires. Floods and flash-floods cause the main of the personal damages, whereas forest fires cause the main damage to the environment. It seems that large wildfires are less frequent in the last years than in the past and, besides, heavy winds are more intense and frequent. It is also mentioned snow falls and heat weaves. All these phenomena are, apparently, related to climate change.

Regarding the trigger effect pattern, wildfires and heavy winds increase the severity of floods due to the loss of forest cover protection. Besides, natural hazards may threaten chemical factories (it is known as NATECH, technological accidents triggered by a natural hazard or disaster which result in consequences involving hazardous substances).

4.2.2 Description of the gaps and operational requirements during the risk assessment and planning process to enhance Civil Protection capabilities

FVA reports that the structure of Civil Protection and emergency management services in Germany are much localized, so municipalities are responsible for the main duties. Only when the extension or the intensity of an events exceeds the local capacities the next level is activated (next level represents district, region and state). Although this system works well there is room for improvement in relation to the management of the equipment (e.g. building a more comprehensive and user-friendly database for all the shared items). They also explain that self-help and general resilience of households should be promoted.

Finally, they identified a needed improvement which is the monitoring (forced by law) of the results of the risk analyses performed annually in order to identify gaps.

BFW explains that there is no risk planning in Austria although it would be necessary. In addition, the only available tool is a hazard mapping which is only available in a rather large-scale for landslides and rockfalls (so it should be more useful in a more local and precise scale). It is also mentioned the necessity of frictionless flow of information and the crucial contribution of the weather forecast in a small-scale. In addition, the next improvements are highlighted:

- Monitoring (only possible for already well-known landslide slopes).
- Early warning systems (although not yet matured and associated with the risk of false alarms).
- More transparent distribution of tasks between the various levels of deployment (local - state - federal).
- Better interaction between blue-light organisations, experts of risk assessment and damage prevention (emergency technical measures).
- Development of best practice examples.
- Improvement of alarm plans.
- Creation of reserved areas (e.g. for deposition of bed load material).
- Strengthening risk awareness (among the emergency services, authorities and population).
- Communication of the residual risk.
- Rising awareness of the administrative units and operational staff.
- Increasing the political support (financial resources).

From the side of **CIMA**, in relation to the local administration, it is observed the low level of involvement of stakeholders during the planning process. It could be useful to generalized the use of debriefings.

Regarding the national level, the following improvements are identified:

- Strengthening the Civil Protection planning.
- Improvement of the risk scenario and events knowledge.
- Increase the information given to the population.
- Improvement of the exchange of information between the various stakeholders involved in risk management for better coordinating all activities, also taking into account the private stakeholders as essential service providers for Civil Protection actions.
- Increase the use of the new technologies, useful for mapping the different stakeholder/bodies/ agencies that operate simultaneously for risk managing.

In addition, they assess that the involvement of the population at local scale should be improved also, with systematic participation during the planning and risk assessment process. They highlighted the importance to inform the population of the risks they are exposed to and the self-protection actions they should take. Moreover, the involvement of the population during the response stage should be organized in a systematic way.

The analysis of a post event at national level - in the case of particularly intense and significant hydro-pluviometric event – consists of a report ("event report") drawn up by the Service, concerning the meteorological forcing of the event, its hydro-pluviometric features, the impact on the territory and the ”residual risk scenarios” and eventually in a field technical investigations aimed at ascertaining the effective

impact on the territory, assessing residual risk scenarios and verifying the existence of the conditions for the declaration of state of emergency.

At a regional level, no post-event lesson learned protocol are established in a systematic manner. Even at this level, the involvement of the population and stakeholders during the planning process is identified as a needed improvement, as well as the communication with citizens.

PCF marks that the Catalan Fire and Rescue Service do not currently has enough capacity to carry out all the wildfires prevention actions needed and the percentage of actions done compared to the actions that should be done is very small due to the lack of resources. It seems there is a room for the development of new decision criteria based on global cost-benefit balances although they have already developed a unit for strategic management (GRAF) which is driving in this direction. Regarding the involvement of population, they explain that educational and training programs for society (Firewise, Safer together, Preparedness Day, etc.) can enhance community preparedness. They asses that successful cases should be more disseminated and replicated in other areas. Additionally, they assert that it is also important to have tools able to plan actions with enough time, especially cartographic tools allowing the visualization or modelling the consequences of certain actions in advance.

In the interview conducted by **CTFC** remarks the importance of having high quality data about the available logistic resources present in the territory.

Normally this data is collected in the "Catalogue of Municipality Resources" (by law) which is updated every 4 years. Nevertheless, not always is exhaustive enough. Moreover, it could be useful to have a visualizer tool that collects all data of municipal resources and thus all the information in one DSS.

Regarding the involvement of the population it is mentioned again the importance of the communication with citizens to rise their awareness and increase their self-protection capacity, and the necessity to change their mind about the capacity of the administration in solving problems and the need to collaborate. It is stated that de Civil Protection is still under development and that much support in prevention and preparedness is needed.

From the **DGPC CAT** side, it is reported some gaps and operational requirements during the risk assessment and planning process listed below, some are coincident with other partners:

- Raise public awareness (about the risk they are exposed to, the planning tools they may access, etc.) through local leaders will help to implement some measures, especially in prevention and self-protection.
- Stronger Civil Protection measures in urban planning during the prevention stage will avoid dangerous situations.
- Improve forest management for fire prevention (fuel management, prescribed fires, etc.).
- Improve the risk analysis, especially regarding the local characteristics and effects, specific scenarios and, most importantly, the location of the most vulnerable and problematic spots in a data base fed by municipalities.
- Start a continuous training system for all the operative groups (fire fighters, police, emergency health, etc.) to improve the interaction (coordination) and reliability. It should bring an improvement of the coordination, knowledge between operative groups in order to avoid duplication of tasks and clarify responsibilities.
- Implement warning systems for the general population.

- Develop and implement more standards and protocols in relations to the improvement and quality assurance in the planning and operational process.
- Increase the involvement of the population and stakeholders creating new work forums (though a daily base and active mechanism) which allow to detect needs in each field, getting their concerns, how they may be affected and offering them the opportunity to participate in the emergency management to create synergies.
- Local information should be transferred to the regional level to be integrated in the regional plans, because it is very difficult to know the local characteristics of each risk and municipalities are may hold this knowledge. It is important that municipalities to detect possible situations difficult to be managed (especially the vulnerable elements in their territory) and be transferred to the regional level for further analysis and planning. At the same time, plans should be more truly accessible for the general population.
- Use of indexes to assess the performance and assess whether the taskforce and resources are enough.
- More support to small municipalities from other superior administrations (e.g. a compulsory position of a technician specialized in Civil Protection for each group of municipalities, the so called "comarca" or county), during the planning and implementation processes.
- Increase practical training to better know what to do in case of an emergency.
- More investment in planning and prevention and less in urgent and immediate needs will save money, especially with long-term spending schemes and investments.

4.2.3 Description of the main needs related to the emergency management to face multi-hazards

FVA reports that the main needs are communication and improvement of data availability and applicability. Digitalization and data availability are emerging issues which needs more support, especially to overcome legal and financial obstacles. Although it does not seem a need to be solved it has to be highlighted that there is a lack of cost-efficiency criteria for emergency decisions. Some specific needs are the next:

- Data base with overview of available equipment within state.
- Standardization of data formats for emergency classification across Germany: There is no standard or uniform data format which would allow generating a nationwide overview (e.g. on climate change related emergency cases), nor is there a central focal point that collects and assesses this data.
- GPS equipment in emergency vehicles.
- Education and training faces challenges related to knowledge transfer and experience sharing and development. It should include new types of disasters. This needs practical training as it is not enough with written and generic instructions and guidelines.

From the side of the **BFW**, they mention staff as the most important operational tool. Also weather forecast, severe weather warning systems, IT-supported systems (simulation programs, GIS, elevation and terrain models, precipitation radar data and laser scans, alarm plans, communication) and heavy machinery. They do not have any cost-efficiency criteria in decision-making in some vital questions, although there are some already in use for other issues (less urgently needed for protecting of lives and restoring protective

structures, i.e. a monetary consideration of human life is not included). Additionally, fire brigades have precise requirement profiles and guidelines for purchases.

CIMA highlights the crucial importance of Civil Protection plans, radios and other devices, monitoring systems (e.g. cameras, hydrological and meteorological measurements), radios with positioning systems, alarm systems for population, memorandum of understanding on the management of trails, forest fires forecast and alert bulletins, Standard Operational Procedures of the regional control room integrated in an application to gather, know and visualize municipal Civil Protection plans. Finally, they found the following needs:

- Greater coordination and collaboration between neighbouring municipalities (also in terms of actions to be implemented), also for the management of tourist flows, and also between different administrations.
- Improvement of monitoring systems and more in general the coping capacity[1].
- Improvement of the technological infrastructure of communication systems e.g. radio transceivers.
- Improvement of the coordination with volunteers.
- Integration of meteo-hydrogeological data with other information, including news (also non-instrumental) from the territory in real time, to fully have an overview of the event and risk scenarios.
- Improvement of the analysis of the cascade effects of forest fires and hydrogeological risk.
- Improvement of the integration between territorial planning and risk planning.
- Improvement of the internal organization and procedures, even by certificating their quality, including internal communication flow and objective criteria for the activation of resources.
- More effective communication flow and a support tool to collect and effectively organize information, obtaining then an overview of the emergency situations in real-time.
- More collaboration between institutions at different levels.

They report not a structured evaluation system in terms of costs-efficiency in daily routines.

PCF finds a lack of updates in Information Technology (IT) tools (including the current DSS), especially in relation to geolocalization in real time.

Instant information flow is needed, as well as the integration of data from other services at Fire Service tools (i.e. integration of weather variables into simulators). Data and information flow pace may be slow, complicating this essential feeding process.

Cost-efficient criteria are not considered currently and it would be a good improvement.

[1] According to the UNDRR the **capacity** is "The combination of all the strengths, attributes and resources available within an organization, community or society to manage and reduce disaster risks and strengthen resilience".
Annotation: Capacity may include infrastructure, institutions, human knowledge and skills, and collective attributes such as social relationships, leadership and management.
Coping capacity is the ability of people, organizations and systems, using available skills and resources, to manage adverse conditions, risk or disasters. The capacity to cope requires continuing awareness, resources and good management, both in normal times as well as during disasters or adverse conditions. Coping capacities contribute to the reduction of disaster risks.

CTFC remarks the importance of well-developed forecast tools.

A potential improvement could be to gather the information (resources) in some digital format or DSS platform to be shared with all operational bodies. Now all the local information is located separately.

It should be useful to have a common radio communication frequency (with positioning system) shared by all operational bodies, although it would need a common protocol to standardize the technical language between emergency bodies beforehand.

They assert that the communication during an emergency is a key issue that should be more developed. In some cases, it has been seen that some non-official channels (e.g. Whatsapp and Telegram) are used and are very useful during an emergency. Nevertheless, at the same time, their use has some dangers since there is no record about the existence of the communication and legal implications can appear. To solve this, an official channel could be generated, but spontaneity may be lost. These citizens-based communication tools work better and therefore, there is a need to organize and manage this potential.

In addition, Territorial Coordination Centres should be properly embedded into the emergency planning and norms to guarantee the corresponding coordination, transparency and legal coverage.

Finally, it is identified as a need the promotion of cartography and information sharing between emergency and management bodies during an emergency, with common protocols and language.

DGPC CAT summarizes the next needs:

- Improvement of the emergency management software with more transparency regarding the decisions taken, make use of the amount of information in the system, sharing the information, use of more explicit cost-efficiency criteria based on well-defined indexes. It might integrate forecast and monitoring tools. This digital platform, currently used in the central emergency room for emergency management, needs more involvement from the risk management agencies (specialized in each risk i.e. hydrology, meteorology and geology). It also needs communication system tools with citizens and operational bodies. It needs to be assimilated all the current process done by hand which may turn into optimization. It must also cover the recovery stage (post-emergency) also, to be able to keep track from the beginning of the emergency and cover all the steps (now when we manage the emergency, it is closed when the phenomenon is extinguished). The tool should also include the management of resources based on agreements and contracts with existing companies. Finally, it should include the emergency management plans.
- Improvement in monitoring the different perspectives of the emergency, to better understand what is happening, take advantage of in situ data, which could be digested, summarized and organized in a fast way (may be some artificial intelligence). It needs pre-agreed protocols (and reusable data formats) in the information sharing process between different agencies and bodies, clear communication channels between them. It would help better monitoring tools, like sensors, drones, satellite imagery, etc. It may help to improve the forecast and to increase the time in advance of this forecast to initiate prevention and preparedness measures.
- Improvement of the accuracy (in time and space at local level) of the meteorological predictions and the time in advance which the forecast can foresee a potential event. It will help to give warning advice in time with precision and reliability to the councils and vulnerable elements. Meteorological simulations need to be linked to damage simulators and other related phenomena (e.g. hydrology).

- Databases of information are needed to be crossed with scenarios and their consequences: social information of the population, the economic scope, vulnerable elements, etc. It needs more transparency from different agencies and a better feeding process of the local information.
- Some information flows could be improved very easily in order to drive as fast as possible all the information and decisions to the central emergency room as a hub of information from where it can be safely disseminated. In relation to the decision-making process promote remote meetings to reach a greater agility would help to speed-up the process.
- Improvement of the information flow to the citizens, may be with warning systems, especially to decrease the time between the detection and the warning time to the population.
- New apps for municipalities, very easy to use, to get warnings in order to help them to know whether they are affected and what to do in each case. It may help to increase local involvement and decentralise the decision-making process.

4.3 Gap analysis about the extreme event experienced

In this point there is a description of the biggest natural extreme hazard events experienced by each interviewee and the description of the main points of weakness that the emergency management system had in this event.

4.3.1 Description of the biggest single and/or multi natural hazard extreme events experienced

FVA states that, there was general agreement among all interviewees, that the number of extreme weather events will increase. It is mostly the occurrence of small-scale, high-intensity events that may overwhelm local emergency bodies and cause punctual devastations. Additionally, large-scale natural hazards (e.g. flooding, winter-storm) will continue to happen on an irregular basis. Despite all preparation efforts and experience gained during past events, full preparation is impossible. Nevertheless, preparation needs to be continuously reinforced and enhanced.

During the interviews, one recent extreme weather event in the Black Forest (St. Blasien January 2018) was discussed to illustrate a potentially more frequent multi-hazard situation: in conjunction with a predicted winter storm event, rapid temperature rose and heavy precipitation in high altitudes led to sudden snow melt. Soaked ground and inundated river banks led to landslides and mud avalanches during night-time. Toppled trees in river beds and roads impeded the emergency services and overwhelmed local authorities. A neighbourhood of the village had to be evacuated and several buildings were damaged. The Regional Fire Chief was sent to support local forces and take stock of the situation, as the initial situation looked more dramatic.

BFW, focusing on landslides and rockfalls, explains that the extreme events experienced are either combined processes that occur in typical large-scale weather situations of heavy precipitation events (e.g. floods with landslides) in several places (with a focus in Tyrol), causing large losses and long-term evacuations.

Meteorological factors (long-lasting precipitation events, short intensive heavy rainfall, and snowmelt in some cases) were named as the main triggers of almost all major damage events. For many of the observed damage processes, a **very short process duration was characteristic** (especially for rockfalls). For the types of landslides considered by BFW, it is characteristic that a very high number of individual landslide processes always occur during major events.

Although there was a fundamentally established, regional disposition for landslides and rockfalls everywhere, it was not possible to predict where and to what extent the damage events would occur. Often, due to the small area, hardly any advance notice of the damage events could be perceived or their extent was very surprising.

Direct main damages of the mentioned events were destroyed or damaged residential buildings and industrial areas, road sections, protection forest and existing protection structures. Very often the indirect damages (road block evacuations) caused the actual costs. In any case, it is remarkable that no human lives were lost in any of the extreme events described.

From the **CIMA** side, at local level they describe an event of flash-floods and landslides in Vernazza and Monterosso on the 25th October 2011, with return periods between 100 and 350 years and cumulated precipitation until 539mm in 24h.

At national level focusing on floods, they describe an event in Messina on the 1st October 2009. This event can be considered paradigmatic of the dynamics and effects of climate change and, at the same time, it can be considered (even if partially) multi-risk, as the impacts of the event were accentuated by the fires which occurred two years earlier in the territory. In particular, the Ionian coast of Messina was affected by a very intense rainfall event (250mm in 6h) with an estimated return time of 300-500 years. Numerous mud and debris flows, landslides and floods led to the loss of 37 human lives and enormous damage to buildings, settlements and infrastructures. The predictability of the event was very low, in relation to the limited area and the very small spatial scale: the weather models had not reported anything significant.

At national level focusing on wildfires, two situations were discussed in detail: the forest fire of 2007 and the forest fires of 2017.

In 2007, all the regions of central and southern Italy were busy dealing with a large number of events, the forecasting tools were able to predict the particularity of the conditions, but the situation was so widespread and contemporary events were so numerous that the resources available were unable to cover them all at the same time.

2017 was characterized by the simultaneous presence of climatic weather factors particularly favourable to the triggering and propagation of forest fires, and by organizational factors. It was also favoured by the persistence of events even for several days.

At a regional level, focusing on wildfires, it was discussed the same event as mentioned at a national level (from the 25th September to the 14th October 2017). An important constraint mentioned was the operational capacity due to the change of the entity that would have faced the fire event as a responder. In 2017, there was a change of competence between the fire department and the forest rangers who previously dealt with the suppression and reconnaissance of fire damage. This made the system work slower and hinder the organization of Civil Protection.

Finally, at regional level focusing on Civil Protection, they discuss the floods event of October / November 2019 in Liguria. Those that recorded the greatest effects on the ground were 14-15th October, 19-22th October and 2-3 November, in a disturbed context characterized by further episodes that - although less impactful - contributed to increasing the hydrogeological stress of the area. The events affected the whole region and in particular the territory of the metropolitan city of Genoa and the provinces of Savona and La Spezia, causing floods, landslides, roads subsidence and disruption, tree crashes, etc.

PCF, focusing in wildfires, describes main events (Solsonès 1998, Horta de Sant Joan 2009 and Sant Llorenç Savall 2003, Torre de l'Espanyol 2019), although they assess that flooding cause same or more deaths.

In Sant Llorenç Savall 2003 affected a part of a natural park that people thought should be protected whereas its regulations did not allow forest management. The strategy was mainly to protect citizens and limit as much as possible the propagation of the front using several combined manoeuvres. 5 civilians were killed because the fire caught them in the middle of a road, trying to escape from their homes. However, their homes were a save place and did not burn. It was an early August fire; Catalonia experienced a very difficult week under a heat wave and simultaneity of wildfires. Almost 4.600 hectares burned for 9 days. Despite the strong blaze was only during the first days.

Another severe wildfire was Torre de l'Espanyol 2019. It burned 5.000 hectares between 26th and 27th June 2019. Fire service suggested to activate the maximum alert for these days. It burned a very abrupt terrain. The fire had the capacity to generate massive spotting at the front. Despite there was a low load of fuel, the fire had the capacity to burn in a very fast propagation rate. Weather was very complex, under a heat-wave situation. The suppression capacity was overcome by the fire.

From the part of **CTFC**, two natural hazard events were mentioned with low detail: The Gloria storm (January 2020) with an important flood event associated, and a severe snowfall event (March 2010), with high impact in road, communication and electric networks with thousands of citizens affected in a huge territory.

DGPC CAT shortly describes different events of flooding with some casualties, forest fires affecting urbanized areas with thousands of people evacuated, exceptional snowfalls affecting big cities and forest fires with some casualties. Flooding on the 23th October 2019 with 6 deaths, a return period around 500 years, high intense rainfall especially in the south of Catalonia, some extreme abrupt change in the river flow and damages valued around 5.8 million € on the overall Catalonia.

4.3.2 Description of the main points of weakness that the emergency management system had in the described event

FVA reports the next main points of weakness:

- More resolution for flood alarm maps to cover small creeks.
- Permanently established measuring network of flow and water level.
- A forecast system that could combine several hazards and make predictions and warnings based on the actual situation.

- Dynamic and updated situation overviews in large-scale disaster situations. An efficient information flow and data transfer is necessary.
- The challenge with predictions and the issue of extreme weather warnings is to quickly fall into disrepute in general public in case there is no severe event (e.g. closing air traffic as a precautionary measure). The involvement of and continuous communication with the population is needed.

On behalf of **BFW**, despite a high personal engagement (with a very strong system partly based on very well competent voluntary fire brigade and a great reliability and knowledge between all actors), not all measures always run in the same direction and therefore it reveals the following weaknesses:

- Lack of routines for major damage events.
- Problems with the occurrence of subsequent events.
- Some difficulties in achieving consensus between different stakeholders.
- Overworking of the emergency services due to lack of breaks.
- Lack of cooperation in the exchange of materials (shovels, picks, etc.) between different operational organisations.
- Lack of experience in responding to political pressure (e.g. for early lifting of roadblocks).
- Too small extension of some tools (weather data and warnings, geographical information, geological surveys, webcams, heavy machinery).
- Heterogeneities of the communications between organizations.
- A partially unclear distribution of competencies, especially for landslides and rockfalls, causes that many risk management processes are not standardized. This already starts with the regulation of deputies in the event of failure to reach the persons actually responsible.

CIMA describes the most important weak points as follows:

In relation to the local administration:

- Poor coordination for actions implemented by the different municipalities.
- Poor coordination with other national or local agencies.
- Low level of infrastructure for communication systems (microwave radio collapse, power supply interruptions).
- Neglecting the risks related to the tourism crowding and its management in the emergency planning.

In relation to the national administration, at local level they noted these weaknesses:

- Difficulty in understanding and evaluating risk scenario and its evolution in real time, due to the remarkable speed of the event and the rapid evolution of scenarios.
- Weakness of Civil Protection planning.
- Lack of operational procedures (especially concerning the organization of territorial monitoring teams).
- Lack of a structured information activities for the population.
- Inadequate knowledge of the event and risk scenarios.

- Failure to prepare non-structural measures.
- Low success in transmitting to the population the risk they are exposed to and the self-protection actions associated.
- Low coordination between actors involved in risk management.

In relation to the regional administration:

- Lack of protocols.
- Low knowledge of risk scenarios.
- Low coordination between actors involved in risk management.
- Difficulty in checking, validating and organizing (in a structured and effective way) the incoming information. Also difficulty in keeping track of updates and having immediate information and feedback by the operational staff in the territory.

From the side of **PCF** these are the most relevant questions:

- Needed improvement in the coordination and the internal communication between units and command posts.
- Lack of technology. Signal is a key point to assure communication between deployed teams and command posts.
- More community awareness is needed before, during and after the emergency to make people understand decisions.
- Need to split Fire Service in specialized units, like the GRAF unit which is focused in forest fires (analysis, operations, etc.) allowing more potential to train the staff only in this issue to ensure a more qualified response system.

After the interviews conducted by **CTFC** next ideas arises:

It is highlighted the crucial role that the communication and the electric networks plays nowadays. Several collateral problems appeared without these basic networks working properly. Therefore, it is very important to make these systems stronger and seek alternatives. For instance, asking private operators to have enough electricity transformers spread in the territory in case of emergency and including this requirement in contracts. It is suggested to work on new management approaches/protocols to face the emergency if the basic supply network falls.

In order to reinforce Civil Protection capabilities to face extreme events in a climate change context, some suggestions were mentioned:

- Enhancement of the involvement of citizens in a proactive way in the emergency management (with the corresponding tools and resources), since public service will not be able to cover all needs. This is especially relevant in events affecting a large group of population, when self-protection and the use of their own capabilities to manage the situations are essential. A reformulated risk awareness and communication strategy would be useful.
- Improvement of forecasting tools with a better integration of climate change scenarios, the severity and the recurrence of unprecedented events.
- Promotion of digital platforms to gather all the operational information about the resources in the territory that can be used in case of an emergency. Additionally, it is necessary the integration of

all these digital platforms in a unique and accessible platform (open for and fed by all the emergency agents), together with reinforced collaborative and communication protocols, to face the expected increasing complexity of the emergency management.

DGPC CAT unveil the next weak points:

- Sometimes operative bodies only concentrate in specific parts of the emergency, leaving others uncovered, may be due to a lack of resources or a weak organization.
- Local authorities usually have a low knowledge of protocols (owns and else's) and at the same time regional operational bodies are reluctant to the inclusion of local administration in the decision-making process. It is due partly to a weak relationship and a low reliability and coordination between municipalities and regional administration. It has to be improved before the emergency, together with training and awareness.
- Lack of information (e.g. reliable database) for decision-making during the event. Visual tools to spot the incidents in real time will help to take action earlier.
- Lack of technological tools to quickly inform the population during the emergency, especially in fast phenomena.
- Weak preparedness of local emergency management and planning.
- Lack of agility in the information flow. The information does not flow properly to the emergency room where some important decisions are taken (some others are taken in the coordination advanced centre on the ground).
- Too political intervention on the technical field.
- Lack of specific training for Civil Protection (there are no specific high education programs).
- Lack of technology support.
- Excess of bureaucracy.
- Lack of reusable data formats in the sharing of information process. It should use an easy predefined protocol or an exchange information system, predefined, easy to use, fast, accessible by any agency, etc.
- Lack of knowledge in Civil Protection and risk planning from authorities. They also need dashboards with summarized information.

5. Conclusions

We have conducted a series of 43 interviews, from different countries, regions and from the perspective of different natural risks, with the aim to identify gaps and operational requirements to be considered during the risk assessment and planning process to enhance Civil Protection and emergency management capabilities to face single and multi-hazard events.

Thereupon, it has done an attempt to extract and organize the most relevant ideas expressed above in a clear way.

Firstly, we have identified different sets of improvements listed as follows. We have gathered the different related gaps and needs in these groups, although it has to be highlighted that some can be part of different groups too. These groups are deeply related to cross-sectoral components of risk management (adapted from Plana et al. 2019[1]) used in the RECIPE methodological frame for risks analysis (see chapter 3).

- Risk governance and policy.
- Risk assessment, mapping, and planning tools.
- Emergency management and response capacity.
- Technical measures.
- Risk culture and communication.
- Recovery.

First group, and at the base for the rest is **Risk governance and policy**. From these series of interviews, it can be understood that **risk assessment and planning need to be strengthened**, even with more resources and staff, and obviously with an increase in political support and financial resources in the long-term as a key point and a crucial part to reduce future damages and carry out long-term investments (beyond political cycles). In the same direction, some has alerted about political intervention and excess of bureaucracy.

Different interviewers placed emphasis on the need for a **better integration between spatial and urban planning and risk analysis**. It has to be highlighted that urban planning during the prevention stage is crucial to avoid future damages with the reduction of the exposure and vulnerability.

The importance of involving **private actors into DRR strategies** was also mentioned. Some find that management of **tourist flows** should be included in the risk management.

It has been also pointed the relevance of integrated approaches **connecting actions and policies within the risk management cycle** (from prevention to recovery stages) of all different actors involved. And how integrated approaches are more and more necessary to face the expected increase of impacts and severity of natural hazards in a climate change context and the increased complexity of potential multi-emergencies situations over large surfaces.

[1] Plana, E., Font, M., Serra, M., Hörl, J., Hengst-Ehrhart, Y., Hartebrodt, C., Held, A., Clemenceau, A., Giroud, F., Tola, F., Capula, T., Cinus, S., Visani, C., Soi, F., Manca, G., Prat, N., Borràs, M., Vendrell, J., Ballart, H. and Vilalta, O. 2018. Forest risks in a climate change context: trends and risk management challenges of wildfires, floods, storms, avalanches and their interactions in EU landscapes. Networking for the European Forest Risk Facility Initiative (NET RISK WORK ECHO/SUB/2016/740171/PREV10 Project). CTFC Editions.

Deeply related with this issue it is found the **Risk assessment, mapping, and planning tools.** Here there is a wide consensus that **planning and the deep understanding of the risk phenomena**, are a key point and a crucial part to reduce future damages, so it needs to be strengthened, even with more resources and staff, and obviously with an increase in political support and financial resources in the long term. It needs special support at the local scale and needs to take into account climate change scenarios and subsequent events. Regarding these plans, some suggest the development of best practice examples. Finally, it is clear that planning has to be properly and fully implemented, but also that it needs assessment and monitoring, where the use of indexes is suggested (even to assess whether the resources are enough).

Also **prevention** is crucial to avoid excess outlays in the response stage. A good example is that a properly managed forest (fuel reduction) is more effective to avoid large wildfire than investing exclusively in suppression.

Linked with these ideas, it appears the need for the **improvement of risk analysis** (and the knowledge of extreme events), especially regarding the local characteristics and specific scenarios. It means also **to increase spatial resolution for the risk related maps** (e.g. flood alarm maps) used for forecast, alarm, prevention, etc. It is also related to a technological improvement, but also to a better knowledge of the risk scenarios, more information and research. At the seam time, it will help to reduce the inaccuracies in the decision-making process during the preparedness stage. Finally, it should include the monitoring of the results of the risk analysis in order to identify future improvements.

As it is clearly affirmed, the **forecast**, which is an important part of the risk assessment, is one of the most important tools in the emergency management and there is room for improvement, especially of the accuracy, resolution, the time in advance which the forecast can foresee a potential event, reliability, etc. It is needed more accuracy in the local scale. It is suggested the promotion of early warning systems.

May be the more developed prediction systems is the **weather forecast**. There is the need to include climate change scenarios, extreme events and cascade effects. Moreover, it should be able to nest or feed other hazard simulations (like hydrology and the river's behaviour) in order to give more damage-related results.

Another important component is the **Emergency management and response capacity**. Here a great improvement is suggested in **organization**, **coordination and cooperation** between and within all actors (including between municipalities) involved in the emergency is a major key factor. As extreme disasters demand more resources, it brings to the necessary optimization of the overall emergency management system. In the same directions, the speed of some extreme events are increasing and it will be necessary to speed up also the response of the emergency management and the efficiency of the overall system. Therefore, it means: a **clearer distribution of tasks** between the various levels of actors, a **better use of resources** (avoiding useless duplicity and saving funds in sharing equipment), an **increase in efficiency** and a better flow of information.

The German model seems to work quite well in the definition of responsibilities and scenarios, together with shared resources, especially between municipalities and regarding the role of regional administration in the allocation of rarely used resources. It works together with a regular synchronization between different actors. It may be useful for other countries and regions to take this model as a reference as it should bring some important improvements.

Generally, although it seems there are many differences between partners and agencies in different countries, it is found the need for more **standard procedures** (especially operational), especially for large-scale events. Some go further and suggest more standards and protocols during the planning and the operational processes, even with standardized quality assurance certified systems. Anyway, it needs training and awareness (some local authorities need more knowledge about Civil Protection procedures), resulting also in more coordination at different scales (e.g. regional and local actors need to rely on each other) and more efficient internal organization too.

There is consensus in the need for the inclusion of **cost-efficiency criteria** for emergency decisions, based on global cost-benefit balances (e.g. burn forest to avoid the burning of houses) and strategic thinking rather than in short-term and local results (it obviously does not mean a monetary consideration of human life).

Another factor which will contribute to a better organization is practical training and formation. There is a wide consensus in highlighting the usefulness of **drills gathering all actors**, especially from different administration levels and bodies. It seems important the concept already implemented in Germany and known as "**know your heads during crises**". Although it is implemented everywhere in some degree, it should be emphasized, trained and promoted. In addition, some mentioned that there is the need for **practical training** (specific for Civil Protection and in addition to the use of written documents) to transfer knowledge and experience, including new types of disasters.

The management of the **information** is another pillar for the emergency management, especially for the decision making. Especially in the context of multi-hazard and large-scale events, there is coincidence in the need to have a **global and detailed knowledge about what is happening in the territory**. It is needed a global view based on a thorough knowledge of what is happening in detail (spots where incidents are being detected, information about the evolution of the event, information from actors in the field, …), where the resources are and the possible problematic spots (e.g. vulnerable elements). It is a bottom-up process which needs to be settled in an **integrated platform**.

It means also to get effective communication systems and an **effective transmission of information** which allows the decrease of response times and facilitates the decision making.

In deep relation, it needs previous **access to trustable positioned data bases** (i.e. resources, vulnerable elements, dangerous spots, etc.) with the right coverage of the overall territory. In order to guarantee a proper functioning, it needs reusable data formats and predefined protocols for all parts. Therefore, it needs cooperation between agencies which should share all the available information. Finally, the positioning of all emergency vehicles is suggested as important.

This question is also linked with another agreed need, which is the **standardization of data formats and classifications (and language)**, with pre-agreed protocols and clear transmission channels, to enhance the process of information sharing process between the different actors and the integration process of information. It will also help to improve the forecast and to increase the time in advance of this forecast to initiate prevention and preparedness measures earlier.

In relation to the need to improve information, it is considered very important to highlight the next contribution that arose from the last extreme events in Catalonia (reported by the Catalan Fire and Rescue Service and PCF) as an **example** of how they work. They describe that in recent events the Fire Service used

all the available tools (GPS, radio, phones, cameras, real time chats, satellite data, GIS, etc.) to collect, share and display in real time as much information as possible. This is the necessary direction to follow in order to get an overview, from the general to the detail, enough to keep the picture of the scenario continuously updated and take the right decisions that can save lives and goods as fast as possible.

Finally, some has shown concern about the **overload of the emergency services**, with a lack of breaks and the impossibility to cover some issues, and some suggested the need for specialized units in some services.

Technical measures are also observed as another important component to reinforce Civil Protection capabilities, so investment in updating the already in use tools and in developing new ones turns into crucial (some excess of bureaucracy is detected as an important obstacle).

The convenient and fitted technology must be deployed to empower an **integrated platform** which has to supply the global view mentioned above. This platform should be able to process a huge amount of data, as has been mentioned before. It needs to include forecasts tools, monitoring tools and communication system tools. It could also assimilate all manual processes for better optimization of the organization. It is suggested to include the recovery stage management in this platform. This platform should be as **visual** as possible, with as much positioned information as possible. All these improvements obviously need cooperation from other agencies. It seems that many actors already have some kind of integrated platform, but some partners report the need for the **improvement of the emergency management platforms in the central emergency rooms.**

Obviously, an integrated platform should imply to deal with **huge amounts of information** from different sources (also non-instrumental), some dynamic in real time and some static. This in turn also means an increase in monitoring, of both, the available resources and the evolution of the event (e.g. river's flow). It is need more data form the field. Here the use of **digestion, summarizing and organizing tools** (e.g. artificial intelligence, use of dashboards and indexes) arises as a future contribution, together with **new monitoring tools** (new sensors, drones, satellite imagery, etc.).

It is very important to assure **effective communication systems** (fast and reliable) which assure the transmission of information. Communication systems are quite based on **power supply** (e.g. for antenna), so both needs to be robust (may be redundant systems). Here arises the need for the study of the use and possible substitution of citizens-based communication tools like WhatsApp or telegram for emergency communications.

Although **DSS** (Decision Support Systems) are identified as an important tool and partners describe the tools already in use, this issue will be fully developed in future reports as it is tackled in further tasks.

Finally, it as to be pointed that some needs may part of this group or part of the emergency management and response capacity.

Other needs related to technology has been already explained before (e.g. reliable communication and power supply systems, deployment of monitoring systems to improve real time diagnosis…)

The last group, **Risk culture and communication**, is related with **social issues**. It means the interaction with population.

A remarkable topic which needs a further discussion and some improvement is related with failures in forecast, the decision-making process and the degree of confidence of the population in the emergency management system. With the aim to take the best actions with time enough for preparedness and avoid larger damages it is needed to advance as much as possible the predictions of extreme events. However, these predictions have inaccuracies and sometimes fail (the intensity, the place or the time). It easily brings to **discredit** of the Civil Protection system from the point of view of the general population, especially when it triggers some precautionary measures that have economic impacts. Consequently, it needs some changes in the communication with the public, which in turn will provide other benefits.

Other ideas around the involvement of the population arises:

- A **systematic participation mechanism** for citizens and stakeholders during the planning and risk assessment process is needed.
- It is important to **communicate to the population the risks they are exposed to and the self-protection actions** they should take. It is also important to rise their awareness to change their mind about the capacity of the administration in solving problems and the need for collaboration based on self-responsibility, especially in large-scale emergencies, when **self-responsibility and resilience** are essential because emergency services might need to focus in the biggest issues and are not able to solve all possible problems. There are some successful examples. Educational and training programs for society can be the way. Local leader's involvement is suggested.
- It is important to develop **tools for communication with the population and local authorities during these emergencies**, like warning systems for the general population.
- The role of the population during the response stage is controversial. They might not help. In any case it needs organization and planning.

As an additional and very interesting idea it has been noted that beyond the population, also **companies** are more and more interested in risk management. The last vast and severe events have made them aware of the idea that it is not only an issue of personal safety but also of making economic activity more resilient. On that sense, this is opening new "windows of opportunity" to engage them in being more proactive in risk management (also linked to Risk governance and policy).

About the **Recovery** stage, in the special case of **lessons learned protocols** during the after-event stage, it is absolutely clear that it needs more promotion and standardization, adding suggested gaps, unconformities and improvements, apart from the normally incorporated event description and the informal review of the emergency management.

All these ideas are outlined in the following table.

Type of issue	Improvements to enhance Civil Protection capabilities
Risk governance and policy	• More political and financial support to the risk management. • Deploy long-term investments in Disaster Risk Reduction strategies. • Enhance the influence of Civil Protection in spatial and urban planning. • Management of tourist flows. • Promote integrated risk management approaches. • Involve private actors into DRR and mitigation actions.

Risk assessment, mapping, and planning tools	• More resources and staff. • More support to the local scale. • Include the effect of climate change. • Include assessment and monitoring. • More resolution of maps and analysis (including forecast): more technology and more knowledge. • Monitoring the results. • Weather forecast: include or feed other models (hazards and damage). • Develop and promote early warning systems. • Include cascade effects and extreme events.
Emergency management and response capacity	• Faster response of the emergency management. • Extend the use of standard procedures: within and between actors. • Introduce cost-efficiency criteria. • Improve coordination and cooperation between and within all actors involved in the emergency (including between municipalities). • Clearer responsibilities within the emergency management. • Improve the resources management through sharing strategies. • Increase efficiency (especially in the decision-making process and more objective and transparent decisions). • Increase practical training. • Extend the use of drills: “know your heads during crises”. • Provide tools to get a global knowledge of the event evolution based on field detailed real-time information. • Access to trustable positioned data bases, especially the precise knowledge of where the available resources, the vulnerable elements, the problematic spots and the reported incidents are. • Improve efficiency in communication processes (better information flow and pre-agreed protocols). • Improve the data exchange process with reusable formats and standardization of formats, classifications and language. • Study the overload of the emergency services.
Technical measures	• Increase of data management and visualization tools. • Develop and empower integrated platforms: real time information from field, positioned static information (risk analysis), summarized data, recovery stage, reduce manual process for optimization. • Addition of information discrimination and summarizing tools. • Deploy new monitoring tools to diagnose the evolution of the event. • Develop new tools and support the current ones. • Develop and promote DSS (Decision Support Systems). • Improve reliability of communication and power supply systems. • Evaluate the use of different real time communication tools between different actor’s units.
Risk culture and communication	• Tackle possible discredit mechanisms: improve communication. • Deploy mechanisms to enhance the participation of population in planning. • Improve communication with the population about their exposition and self-protection. • Promote self-responsibility and resilience.

	• Develop efficient communication tools with (and from) population during the emergency. • Make use of synergies with the private partners.
Recovery	• Introduce written lessons learned protocols during the after-event stage.

Table 2 Gaps and operational requirements to reinforce Civil Protection capabilities extracted from the interviews

With these points it is expected to get a considerable improvement in the risk assessment, the planning process and the management of single and multi-hazards. Although it is a general view which takes into account different countries and regions (i.e. different systems and slightly different necessities) and needs a closer look to adjust exactly how it is translated to each emergency management system in each natural hazard, it contains many shared improvement requirements. Overall, all systems need in some degree an improvement in each of these ideas.

Next actions in the project will consider these operational requirements per each natural hazard (and/or multi-risk situations identified) along the climate change impact assessment, DSS operability guides and the Civil Protection tools develop at case study level.

Annex I: Interview template

This interview is focused on natural hazards (including forest fires) so we must exclude manmade hazards (technological hazards like accidents in chemical factories or during transportation involving dangerous goods).

DATA OF THE INTERVIEW	**Num**		**Date**		**Partner**	
Name			Email			
Position						
Organization/Service						
Main duties						

MOST COMMON SINGLE AND/OR MULTI NATURAL HAZARD SCENARIOS
1. What are the **most common single and/or multi-hazard natural scenarios** that you have to deal with? In the case of multi-hazard, could you identify a trigger effect pattern (the effects of one hazard triggers another hazard) in these situations?
2. How do you **proceed** (in general, globally)? Which kind of **tasks** you have to do? What are your **responsibilities**? (specify for single/multi-hazard situations)
3. What are the most important **operational tools** (decision-making, **data integration**, etc.) you have/use in these situations? What are the most important **needs** in these scenarios in terms of **operational tools, data quality and integration, procedures and/or inter-agency or multi-actor cooperation**? (specify for single/multi-hazard situations)
4. What kind of actions developed in **prevention** and **preparedness** are essential for you in the **response** stage? What actions do you think could be developed in prevention and preparedness stage to **enhance** the **response capacity**? (specify for single/multi-hazard situations)
5. Do you (team, institution or procedures) currently take into account **cost-efficiency criteria** in decision-making? In which way (e.g. through an indicators system, Standard Operating Procedures, empirical knowledge or pre-defined values)? (specify for single/multi-hazard situations)
6. Do you have any post-event **lessons learned** protocol? How does it work? (e.g., internal and/or including the exposed population)

7. What is the level of involvement of the **exposed population/stakeholders** along the risk assessment planning and response where you are involved? How could it be improved?

EXTREME EVENT EXPERIENCED
1. What is the **biggest single and/or multi natural hazard situation you have ever experienced** in your professional career as a part of the emergency response system? (e.g. e.g. Gloria storm in Catalonia).
*2. Regarding **the event**, please describe shortly this event in terms of:* • Site and date • Hazards / multi-hazard involved and potential interactions and cascade effects • Predictability (and level of uncertainty) and return period of the event • Causes of the event (meteo, seismic,…)" • Spatial and temporal scale • Dynamics (physical evolution) of the event
*3. Describe the main points of the **emergency management and its post emergency management** of this extreme event in terms of:* • Data and tools used (for monitoring-forecasting / communication / coordination / rescue and assistance / data collecting and updating / risk scenarios knowledge and static data) • Territorial levels and authorities activated and typology of actions • Means and resources used • Main direct and indirect damages • Risks in the aftermath
4. Taking a back analysis: What are the **main points of weakness** that the emergency management system had? (in general: communication within institutions, communication/coordination between institutions, communication with population, data and information availability, decision-making process, information discrimination schemes, resources management, Standard Operating Procedures, Civil Protection plan,..)
5. What are the **best practices** that the Civil Protection system used during this event?

Annex II: Sum-up reviews

GAP ANALYSIS ABOUT CIVIL PROTECTION AND EMERGENCY MANAGEMENT REQUIREMENTS TO FACE MULTI-HAZARDS

FVA, Germany (Windstorms)

1.- Gap analysis sum up report about MOST COMMON SINGLE AND/OR MULTI NATURAL HAZARD SCENARIOS for Civil Protection & emergency management stakeholders

1.1.- Responders general profile

Four interviews were conducted at different administrative and geographic levels: national (DKKV e.V., BBK), regional (Regierungspräsidium Freiburg) and local (Stadt- und Landkreis Karlsruhe). Simultaneously the interviews covered different stakeholder groups:

- German Committee for Disaster Reduction (Deutsches Komitee Katastrophenvorsorge e.V., DKKV).
- Department II Risk management and International Affairs – Federal Office of Civil Protection and Disaster Assistance (BBK).
- Police, Fire Service, Civil protection, Emergency Service – Regional council Freiburg (higher emergency authority).
- Fire Service – Regional council Freiburg (higher emergency authority).
- Fire Service of City and Rural District Karlsruhe.

The DKKV is the national platform for disaster prevention in Germany. It is an intermediary to international organisations and initiatives active in the field of disaster prevention and serves as competence centre for all questions of national and international disaster risk management.

The BBK is the Federal Agency for civil protection and disaster risk reduction. As a subsidiary of the Federal Ministry of the Interior it has a central organisational element working to ensure the safety of the population, combining and providing all relevant tasks and information in a single place.

The Regional council Freiburg constitutes the higher emergency authority. It oversees the work of emergency authorities at district level and coordinates and advices during cross-district extreme events. Only for nuclear safety, it has operational competences.

The City and Rural District Karlsruhe are two typical districts within the Federal State of Baden-Württemberg, Germany. The District Fire Service oversees and coordinates the operational civil protection of the firefighting service in the municipalities.

1.2.- General description of the most common single and/or multi natural hazard extreme events (with special attention to cascade and trigger effects) (Question 1)

The most common natural hazard events are winter storms, flooding and torrential rain events. Multi-hazard events occur mostly as a combination of the latter. During winter months, storm periods bring abrupt changes in weather and temperatures, which can lead to increased and sudden snowmelt in combination with heavy precipitation. These trigger flooding and soaked grounds, which can lead to landslides in steep terrain. In combination with a storm event, blown trees can block streams, increasing the risk of flooding and limit access to affected areas. Flooding of large river basins can affect urban centres for several days.

In summer months, it is mostly local storm cells that can cause extreme wind speeds and heavy rainfall leading to flash floods. This is the most common emergency scenario caused by natural hazard event. Drought and heatwaves lead to drier conditions in forests and an increasing forest fire danger. In case of forest fires, it is mostly air pollution that causes problems for the general public.

1.3.- Describe the gaps and operational requirements during the risk assessment and planning process to enhance civil protection capabilities (Question 4, 6, 7)

The interviews showed that the structure of civil protection and emergency management services is much localized in Germany. Usually natural disasters are addressed at a municipal level. Due to the status of federal states, every state developed their particular and historical structure for civil protection services. It is also the state administration and its subsidiary bodies that have primary responsibility for disaster risk reduction. Operative civil protection is predominantly executed by the municipal fire service (voluntary and professionals), which over the years continuously professionalized and standardized its education system. Today it forms the most suitable emergency organization amongst various other emergency organizations, to sufficiently cover this field.

Oftentimes the extent and severity of a natural disaster determines the responsibility and regulates the command roles. As soon as a disaster exceeds the boundaries or capacities of the initially responsible authority, the next higher body is engaged.

To ensure a smooth functioning of operations during crises, regular synchronization with different responsible authorities on emergency plans, as well as common drills, was identified very beneficial. Ensuring efficient and precise communication across different administrative levels from ground level to state level is a continuous task (e.g. municipality → district → region (bundling function) → state (ministry of interior if several districts are affected).

A common saying in disaster risk management is the so-called '3 K-principle' – "in der Krise Köpfe Kennen" – literally translated: "know your heads during crises", which points out the importance of personal contacts and the professional network to capitalize during a crisis.

Ensure and maintain equipment of emergency services; government bodies subsidize investment in up-to-date specialty equipment (e.g. forest fire vehicles), yet one municipality needs to still invest a lot in expensive equipment that is not used very often. Thus new concepts of resource sharing were said to be beneficial. The allocation of necessary resources and equipment in times of crises is done by the regional authority, which has the overview on the overall available material. Yet, there is room for improvement by e.g. building a more comprehensive and user-friendly database.

Successfully implemented was the concept for inter-district support, where regional units are deployed at inter-regional scale and resource and equipment exchange is coordinated by regional administration.

The involvement of the general public was regarded differentially: all interview partners agree that in the planning and preparation stage it is better to limit the public involvement due to the complexity and necessary specialist knowledge, whereas during an emergency situation, clear and pre-defined communication helps to limit the damage. Generally, help for self-help and general resilience of households should be promoted. Yet, this is more and more difficult, as people expect to get help from officials at any time and seem rather unprepared for situations where the emergency system is overwhelmed (i.e. fully comprehensive insurance society).

Risk analyses are conducted at a federal level on a yearly basis for a fictive scenario by the interdisciplinary working group "risk analysis". The results are officially reported to the German Bundestag (parliament). The problem is that there is no follow-up required by law and the identified gaps are oftentimes not treated or addressed appropriately. For example, in 2012 a risk analysis was conducted and reported to the parliament for the scenario of a global Corona Virus pandemic. It identified some of the shortcomings that actually appeared during the real crisis of 2020.

1.4.- Describe the main needs related to the emergency management to face multi-hazards (Integration of data, operational needs, DSS, tools ... considering cascade effects between prevention-preparedness-response, integrated approach, cost-efficient criteria. Question 3, 5)

Related to the gaps and operational requirements, the main needs are communication and improvement of data availability and applicability.

It is crucial to ensure and maintain the functioning of the technical communication during natural disasters, as storms or flooding can lead to local disruption in the electricity and communications network. Similarly, the availability of critical data must be secured permanently. Being able to successfully alarming the crisis management unit (Verwaltungsstab) needs to be ensured as well (e.g. by providing priority line mobile phones).

There is no standard or uniform data format which would allow generating a nationwide overview (e.g. on climate change related emergency cases), nor is there a central focal point that collects and assesses this data.

Education and training faces challenges related to knowledge transfer and experience sharing and development. There is a generation shift of executive personnel in upcoming years. Practical trainings remain and become even more important with increasing lack in experience. Education should encourage and promote flexible and adaptive approaches to address situation-specific requirement as well as new types of disasters. These cannot be addressed just by following written and generic instructions from guidelines.

Digitalization and data availability are emerging topics. While the implementation is technically feasible, it is mostly legal obstacles (i.e. licenses) that need to be overcome. Pilot project in some districts have demonstrated the benefits, but need financial support (i.e. subsidies) from the state, so that municipalities can purchase these systems. E.g. so far only the Fire Chief and its deputy have access to GPS System and digital maps (2 licenses), while the ground crew still relies on paper maps.

They would like to get:

- Data base with overview of available equipment within state.
- Standardization of data formats for emergency classification across Germany.
- GPS equipment in emergency vehicles.

Cost-efficiency criteria for emergency decisions are usually not much considered, but resource-friendly actions are taken. Generally the subject is underdeveloped and no valid data exists. From policy, there is no real interest in order to avoid public discussions on an unpopular topic, i.e. how such decisions would be taken. In emergency situation, the individual case will determine how money and resources can be made available.

2. Gap analysis sum up report about EXTREME EVENT EXPERIENCED for civil protection & emergency management stakeholders

2.1.- General description of the biggest single and/or multi natural hazard extreme events (with special attention to cascade and trigger effects) experienced (Question 1 and 2)

Among the interviewees, there was agreement that the number of extreme weather events will increase. It is mostly the occurrence of small-scale, high-intensity events that may overwhelm local emergency bodies and cause punctual devastations. Additionally, large-scale natural hazards (e.g. flooding, winter-storm) will continue to happen on an irregular basis. Despite all preparation efforts and experience gained during past events, full preparation is impossible. Nevertheless, preparation needs to be continuously reinforced and enhanced.

During the interviews, one recent extreme weather event in the Black Forest (St. Blasien January 2018) was discussed to illustrate a potentially more frequent multi-hazard situation: in conjunction with a predicted winter storm event, rapid temperature raise and heavy precipitation in high altitudes led to sudden snow melt. Soaked ground and inundated river banks led to landslides and mud avalanches during night-time. Toppled trees in river beds and roads impeded the emergency services and overwhelmed local authorities. A neighbourhood of the village had to be evacuated and several buildings were damaged. The Regional Fire Chief was sent to support local forces and take stock of the situation, as the initial situation looked more dramatic.

2.2.- Describe the main points of weakness that the emergency management system had (with special attention to communication/coordination between institutions, communication with population, data and information availability, decision-making process, information discrimination schemes, resources management, Standard Operating Procedures, civil protection plan,...) (question 3 to 5)

The German Weather Service (DWD) predicted the storm event, with increasing resolution the closer the event came. Flood alarm maps provided comprehensive forecasts as well. However, small and inconspicuous creeks are not covered by these maps. Also there is no permanently established measuring network. Lacking was a forecast system that could combine several hazards and make predictions and warnings based on the actual situation.

A challenge with large-scale disaster situations is that there are no dynamic and updated situation overviews available. An efficient information flow and data transfer is necessary. For this, technical improvements are under development, yet not readily available.

The challenge with predictions and the issue of extreme weather warnings for an organisation like the DWD is to quickly fall into disrepute in general public in case there is no severe event (e.g. closing air traffic as a precautionary measure). The involvement of and continuous communication with the population is needed. In general, the notification system is constantly improving (e.g. official warn app “NINA”).

GAP ANALYSIS ABOUT CIVIL PROTECTION AND EMERGENCY MANAGEMENT REQUIREMENTS TO FACE MULTI-HAZARDS

BFW, Austria (Landslides, Rockfalls)

1.- Gap analysis sum up report about MOST COMMON SINGLE AND/OR MULTI NATURAL HAZARD SCENARIOS for civil protection & emergency management stakeholders

1.1.- Responders general profile

Within the framework of these interviews, 11 different, relevant actors in natural hazards and disaster management were interviewed with regard to the processes of landslides and rock fall. Political decision-makers as well as representatives of public authorities, support organizations of the federal states and representatives of the fire brigades and civil protection and disaster management were interviewed. An overview of the interview partners is provided in the table: Interview Partners - BFW.xlsx.

A separation between groups of persons who are involved in planning in the field of natural hazard risk management and those who are actually involved in executive activities is rarely made in Austria. Therefore, no distinction was made in the interviews.

Especially in the field of landslides and rockfall, however, many actors who are normally strongly involved in prevention and spatial planning are mainly executing (immediate measures in case of an event, set up protective structures). This indicates unclear distributions of competences in Austria for the assessment of damage disposition and the provision of preventive planning bases.

The stakeholders interviewed are most frequently concerned with flood events. Anyhow, rockfall and landslides also play a major role in the interviewees' area of responsibility. In addition, large slope movements, surface water runoff, windthrow, fire, snow load and ice smoothness are also mentioned as areas of application.

1.2.- General description of the most common single and/or multi natural hazard extreme events (with special attention to cascade and trigger effects) (Question 1)

The vast majority of the actors was able to identify cascade effects, and many interviewees also identified these as multidisciplinary challenges. The following cascade effects were mentioned:

- Impact of landslide masses into the receiving water - bed load loading up to blocking rivers with the danger of dam breakage scenarios.
- Blocking of channels as a result of rockfall events.
- Landslide masses, which develop to mud/debris flows.
- Windthrows, which lead to a very high proportion of wild wood and can cause blockings.
- Windthrows or forest fire areas which are very difficult to reforest and in the meantime represent areas with increased danger of landslides, rockfall and avalanches.
- Calamities with insect pests (bark beetles) and resulting weakened forest stands with an increase in soil erosion.
- Long periods of dryness with increased surface runoff on dried-out soil.

1.3.- Describe the gaps and operational requirements during the risk assessment and planning process to enhance civil protection capabilities (Question 4, 6, 7)

In Austria there is (still) no risk planning in the course of natural hazards as in Switzerland, for example. Instead, there is the well-proven instrument of hazard mapping, which has been generally accepted, implemented and used after decades of effort. However, in the case of landslides and rockfalls, these are usually only available on a regional, rather large-scale. Despite this, or perhaps precisely because of this, many actors are rather reluctant to jeopardise this status by introducing "new instruments" (as risk planning would be).

Much more important are in the case of damage events, rapidly available emergency forces (e.g. fire brigade!), professional alerting, and, if necessary, the establishment of disaster rescue camps. The flow of information between emergency management and the emergency services should function frictionless in order to be able to implement roadblocks, evacuations and bypasses as frequently necessary measures. Weather forecasts, which provide information about the next relevant (small-scale) precipitation events, are considered to be an extremely important basis for planning. The following preventive measures, which could be improved, were identified:

- Monitoring (but only possible for already well known landslide slopes).

- Early warning systems (although not yet matured and associated with the risk of false alarms).
- More transparent distribution of tasks between the various levels of deployment (local - state - federal).
- Better interaction between blue-light organisations, experts of risk assessment and damage prevention (emergency technical measures).
- Development of best practice examples.
- Improved alarm plans.
- Creation of reserved areas (e.g. for deposition of bed load material).
- Strengthening risk awareness (among the emergency services, authorities and population).
- Communication of the residual risk.
- Enhanced awareness of the administrative units and operational staff.
- Increased political support (financial resources).

All actors and institutions draw up operation protocols. This is done in the form of inspection reports, findings, expert opinions or in the form of standardised procedures (e.g. at the Florian station/central fire station). The documentation can also be important for claims settlements (insurance claims).

The torrent and avalanche control uses its own event register (WLK = digital torrent and avalanche register) where damage events can be entered according to certain levels of detail. In some cases, however, (smaller) damage events are also recorded by unsystematised file notes and event logs. In the case of major events, usually more detailed analyses are carried out, often with the help of external teams of experts (universities). The "ESIS+" tool is of great importance at the level of district authorities. This is a web-based application that serves as a uniform documentation tool for the operational organization.

In almost all organisations, "lessons learned protocols" are derived, which are incorporated into future work plans. In the context of torrent and avalanche control this is frequently not executed in a systematic way, but is incorporated into thought processes, which mostly relate to the concrete measures, but not the organisational structure as such.

Basically, the derivation of "lessons learned protocols" is done internally or with the involvement of the participating actors. Statements by external persons (eyewitnesses, experts from other disciplines) are also included. Processes are reviewed in the context of informal exchanges and non- or little standardised debriefings directly after the assignment. From this, cornerstones for further training, for example, are derived. In the case of the fire brigades, feedback is sent to the mayor.

In principle, the population is only involved if it is affected directly by the incident or if the damage dimension of the event requires this. For example, if a house need to be evacuated due to a ban by the authority. However, the basic tenor of the interviewees' statements leaves the impression that involving the population in the acute phase of the damaging event is sometimes rather counterproductive.

Hazard zone plans are expert opinions of the torrent and avalanche control division which have gained spatially relevant legal significance through their incorporation in the land use plans of the municipalities. Additional experts (state geologists, etc.) are consulted during the preparation of the plans and perceptions and statements from neighbouring residents, forest wardens and blue-light organisations are integrated. These hazard zone plans are drawn up in the respective municipalities prior to approval and every citizen has the right to comment. In addition, information days are held for the affected population.

Overall, the need for civic participation has increased significantly in recent years and is a useful addition in several areas. Especially when it comes to the acceptance of measures, there is no way around a targeted presentation of information and findings. Participation of the population is also implemented in the sense of obtaining information (e.g. for more complete damage event chronicles).

However, this also revealed a discrepancy between, on the one hand, an increased need for information and possibilities (document upload and download, workshops, etc.) and, on the other hand, the tendency that "others should take care of the whole thing anyway" and the individual does not want to know anything about it.

However, sometimes complete laymen express themselves loudly. Hence, ensuring that the appropriate awareness is raised is often associated with a great deal of (time) effort. A cooperation with competent actors is often perceived as much more "pleasant".

1.4.- Describe the main needs related to the emergency management to face multi-hazards (Integration of data, operational needs, DSS, tools ... considering cascade effects between prevention-preparedness-response, integrated approach, cost-efficient criteria. Question 3, 5)

The availability of competent personnel (as "instruments" in the figurative sense) was mentioned as the most important operational tools. The focus was on both, the company's own staff and external experts or persons from other operational organizations (mountain rescue, ambulance, police, armed forces).

Weather forecasts and severe weather warnings as well as IT-supported systems (software or hardware in the form of simulation programs, GIS, elevation and terrain models, precipitation radar data and laser scans) were mentioned as further important instruments.

Alarm plans, mobile phone and on-board-communication, barrier materials, tools (including heavy equipment such as trucks, excavators, caterpillars and helicopters) also by private construction companies were mentioned as absolutely essential.

For emergency measures in the case of imminent danger, where the direct protection of people is the most import challenge, and the function of protective structures need to be restored as quickly as possible, the answers are uniformly "NO". For almost all other measures (e.g. new protective structures, biological measures), the criterion of cost-effectiveness is very important. However, the political components of this issue must always be taken into account.

In the event of imminent danger, all possible financial resources are usually mobilized. For the State Geological Survey and the torrent and avalanche control structures, weighing up the cost-benefit ratio is a central task and is sometimes even mandatory. Cost-benefit analyses mean that the prevented damage must be greater than the costs of the implemented measures. However, a monetary consideration of human life is not included.

Fire brigades do not carry out cost-benefit analyses to cover the basic requirements of their operational capability. However, there are precise requirement profiles and guidelines for purchases beyond this. For example, if municipalities are located in regions with a high risk of flooding, large capacity pumps are more likely to be financed than elsewhere.

2.- Gap analysis sum up report about EXTREME EVENT EXPERIENCED for civil protection & emergency management stakeholders

2.1.- General description of the biggest single and/or multi natural hazard extreme events (with special attention to cascade and trigger effects) experienced (Question 1 and 2)

The interviewees described damaging events from the entire Austrian territory (with a focus on Tyrol). The extreme events experienced are either combined processes that occur in typical large-scale weather situations or heavy precipitation events in several places (e.g. floods with landslides).

The main reasons to cite these events were the large losses caused, some of which required long-term evacuation measures. Such major events were also analysed in further proceedings, mostly by a supra-regional group of people.

Meteorological factors (long-lasting precipitation events, short intensive heavy rainfall or in some cases snowmelt) were named as the main triggers of almost all major damage events. For many of the observed damage processes, a very short process duration was characteristic (especially for rockfalls). For the types of landslides considered by us, it is characteristic that a very high number of individual landslide processes always occur during major events.

For all the major events mentioned, the prediction possibilities were classified as absolutely limited. Although there was a fundamentally established, regional disposition for landslides and rockfalls everywhere, it was not possible to predict where and to what extent the damage events would occur. Often, due to the small area, hardly any advance notice of the damage events could be perceived or their extent was very surprising.

Direct main damages of the mentioned events were destroyed or damaged residential buildings and industrial areas, road sections, protection forest and existing protection structures. Very often the indirect damages (road block evacuations) caused the actual costs. In any case, it is remarkable that no human lives were lost in any of the extreme events described.

2.2.- Describe the main points of weakness that the emergency management system had (with special attention to communication/coordination between institutions, communication with population, data and information availability, decision-making process, information discrimination schemes, resources management, Standard Operating Procedures, civil protection plan,...) (question 3 to 5).

Various data and tools are used, but they are not available to the same extent in all cases:

- Weather data and severe weather warnings.
- Maps, country information systems.
- Aerial photographs and data from drone flights.
- Digital elevation models and data from laser scans.
- Geological surveys.
- High resolution webcams.
- Communication facilities (Attention: different radio frequencies of the different emergency organisations).
- Own machines (excavator, helicopter,...).

Depending on the size of the damage events, different organizational units are responsible: municipalities (mayor) - district captain - central crisis management of the federal states - assistance missions of the armed forces. Experts (torrent and avalanche control, state geologists, blue-light organisations, etc.) are consulted at all levels. The question of resources used was answered as follows:

- Existing assessments from previous events.
- Fire brigades (including disaster trains with pumps and other tools and equipment).
- Torrent and avalanche control division.
- Geologists (state geologists but also private geologists.)
- Community worker.
- Federal armed forces (assistance mission).
- Private earthmoving companies (excavators, trucks).
- Civil engineering offices.
- Helicopters, drones.

In the case of immediate measures during the event, but also during the rehabilitation work directly following it, the risk of further rockfalls or landslides of similar dimensions in the vicinity is sometimes high when precipitation starts to fall again. The reasons for this are similar geological conditions, soils already saturated with water or eroded trench slopes. In such cases, severe damage is also to be expected to the emergency measures already under construction.

The experts interviewed described the following as the best measures and procedures:

- Coordinated action of the heads of operations and inter-organisational cooperation.
- Exact coordination of operational sections.
- Preselection/prioritisation of measures.
- Prepared evacuation measures based on hazard zone plans.
- Rapid roadblocks and sentries.
- Timely implementation of immediate measures (e.g. evacuation, installation of monitoring systems).
- Rapid repair of affected objects.

The fact that many actors know each other from previous damage events has enabled arranging partly spontaneous, flexible cooperation within the framework of emergency management. A great advantage is that in Austria the system of the voluntary fire brigade is traditionally very well-developed. With a total population of just over 8 million, almost 600,000 people are members of this organisation. This ensures very good personnel resources - the emergency services also usually have excellent local knowledge. Therefore, it is essential to maintain and expand this volunteer system by creating appropriate political framework conditions (e.g. free time off work for employees in case of damage). By involving such a large number of people, good conditions are also created for the mediation/(further) development of a corresponding awareness of natural hazards risks. The following features are seen as the greatest strengths of emergency management:

- Conflict-free communication between all levels and partly clear responsibilities.
- Speed in setting up and organising the necessary structures, emergency forces and local and regional crisis teams.
- Appreciative cooperation between experienced, competent planners and actors or internal bodies.
- Rapid deployment regarding closures and evacuations.

Especially for landslides and rockfalls, a partially unclear distribution of competencies causes that many risk management processes are not standardized. This already starts with the regulation of deputies in the event of failure to reach the persons actually responsible.
Despite mostly high personal engagement, not all measures always run in the same direction and therefore reveal the following weaknesses:

- Routines for major damage events are lacking.
- Problems with the occurrence of subsequent events.
- Consensus between different stakeholders is not always easy to achieve.
- Overworking of the emergency services due to lack of breaks.
- Lack of cooperation in the exchange of materials (shovels, picks, etc.) between different operational organisations.
- Lack of experience in responding to political pressure (e.g. for early lifting of roadblocks).

GAP ANALYSIS ABOUT CIVIL PROTECTION AND EMERGENCY MANAGEMENT REQUIREMENTS TO FACE MULTI-HAZARDS

CIMA, Italy (Floods and Forest Fires)

1.- Gap analysis sum up report *about MOST COMMON SINGLE AND/OR MULTI NATURAL HAZARD SCENARIOS* for civil protection & emergency management stakeholders

1.1.- Responders general profile

LOCAL: 3 Municipal Mayors and 3 local technicians have been interviewed, from the municipalities of Monterosso, Vernazza and Riomaggiore. The first ones are local authority of civil protection and the others are in charge of managing the preparedness and the prevention phases and of territorial planning.

NATIONAL-CP-Flood: 1 technical officer from the National Department of Civil Protection (DPC) was interviewed. He works in the Service of hydraulic, hydrogeological, water and coastal risks and he is involved mainly in the assessment of hydraulic, hydrogeological and water risks.

NATIONAL-CP-Fire: 1 expert has been interviewed, from the National Department of Civil Protection. He is involved at national level in monitoring activities of vegetation and weather conditions, in operational forecasting of the susceptibility conditions to the triggering and propagation of forest fire, in coordinating the fire suppression volunteers and the shutdown managers during an emergency.

REGIONAL- Fire: 1 experts has been interviewed, from the regional department of agriculture, tourism, training and work policies in the internal areas, forest fire fighting, foresting, parks and biodiversity. He is involved in risk planning , in coordinating the fire suppression volunteers and the shutdown managers during an emergency.

REGIONAL-CP: 8 experts from the regional sector of civil protection have been interviewed, included the public officer. They are involved in both civil protection planning related to different risks and in the regional control room activities.

[In Italy, the Regions - while exercising their respective legislative and administrative power - regulate the organization of civil protection systems in the framework of their respective territories, ensuring the implementation of the procedures for the preparation and implementation of activities aimed at forecasting and preventing risks; the orientation for the preparation of civil protection plans at municipal and provincial levels; the modalities to ensure the collaboration of the respective civil protection regional systems and national scale activities; the management of the regional operating room, also aimed at information exchange with the Department of Civil Protection, Prefectures and Municipalities; the organization and order of its structure as well as its offices in order to ensure their operational and response readiness; the methods of coordination of the implementation of urgent interventions and the performance of emergency services in case of emergencies, ensuring its integration with the interventions implemented by the Municipalities, on the basis of the related civil protection plan; the preparation , management and activation of the regional mobile deployment resources including also the volunteer organizations; the procedures to organize the necessary activities to remove obstacles for the recovery of normal living conditions in areas affected by disasters; the modalities to enhance training activities in the field of forecasting, prevention and management of emergency situations and in general aimed at raising awareness on civil protection matters with particular reference to local administrators and operators and the bodies and institutions of regional civil protection systems.]

1.2.- General description of the most common single and/or multi natural hazard extreme events (with special attention to cascade and trigger effects) (Question 1)

LOCAL: The most common natural hazard events flash floods and Forest fires (but in recent years much less), Sliding landslides, Storm surges.

There is another important local risk: people crowding.

NATIONAL-CP-Flood: The most frequent risk scenario at national level are hydrogeological and / or hydraulic phenomena (landslides and / or floods), with different spatio-temporal evolution and in geographical areas characterized by different levels of anthropization.

In some circumstances, multi-risk events with cascading effects occurred (e.g. seismic landslides, forest fires favoured by drought conditions, or landslides and floods favoured by the effect of forest fires).

NATIONAL-CP-Fire: The most common natural hazard events are summer and spring forest fires and WUI Fires, due to drought conditions.

REGIONAL-Fire: The most common natural hazard events are summer and winter forest fires and WUI Fires.

Talking about the possible interaction of fire and hydrogeological risk, and so the possible trigger effect of the fire for the hydrogeological risk, the interviewed highlighted that the consequences of a fire can in fact exacerbate a hydrogeological risk scenario; however, there aren't any data or studies that can confirm this effect.

REGIONAL-CP: The most frequent risk scenario in the past 20 years is the hydrogeological risk.

Moreover, some examples of multi-risk scenario have been reported, such as the Covid-19 that must be considered in the management of all the risks that civil protection ordinarily deal with.

One example of cascade effect has been reported for fire + hydrogeological risk scenario: the consequences of a fire can in fact exacerbate a hydrogeological risk scenario; however, this has been highlighted more as a planning aspect rather than a real emergency management issue.

1.3.- Describe the gaps and operational requirements during the risk assessment and planning process to enhance civil protection capabilities (Question 4, 6, 7)

LOCAL: The interviewed highlighted the importance of prevention, especially regarding the communication of the alerts given to the population and the tourist sector.

They also dressed the importance of the coordination between themselves, with other neighbouring Municipalities and with the National Park of 5 Terre, in order to improve managing the tourist flow. And finally the training of technicians and administrators.

Only some municipalities carry out debriefings after the events .

The level of involvement of the population during the risk assessment and emergency planning, in general, is low although its importance is unknown. There has been an attempt to involve commercial activities, but the response has not been entirely favourable. Only one municipality have involved a specific stakeholder (schools sector) during the information and consultation phase on the civil protection planning.

NATIONAL-CP-Flood: The interviewed highlighted some actions that are essential in the response phase and that must be strengthened - especially in relation to the scenarios of risk that occur in limited areas and in limited time range – such as:

- activities for strengthening the civil protection planning,
- activities for improving the risk scenario and events knowledge,
- information to the population.

The analysis of a post event at national level - in the case of particularly intense and significant hydro-pluviometric event – consists of a report ("event report") drawn up by the Service, concerning the meteorological forcing of the event, its hydro-pluviometric features, the impact on the territory and the" residual risk scenarios". Moreover, if the Region affected requested the declaration of the national state of emergency, a technical investigation is carried out by the DPC (according to the Dir. PCM 26.10.2012) through technical inspections aimed at ascertaining the effective impact on the territory, assessing residual risk scenarios and verifying the existence of the conditions for the declaration.

Regarding the level of involvement of the population in the activities of civil protection, at local scale, the interviewed reported that it can be improved both as regards awareness on civil protection issues and as regards participation in planning and risk assessment activities. For example, he highlighted that the participation of the population in the drafting of civil protection plans and in the risk assessment phase is low: the participated civil protection plans are still very few today. However, he reported that there are certainly signs of improvement in these terms, but these activities must be strengthened and systematized. In this context, the campaigns of communication for the population regarding the different types of risk and the necessary self-protection actions (e.g. the communication campaign "I do not take risk") can be particularly useful. In the response phase, the level of involvement of the population needs to be reorganized in a more systematic way.

NATIONAL-CP-Fire: The interviewed highlighted the importance of prevention, especially regarding the exchange of information between the various stakeholders involved in risk management for better coordinating all activities, also taking into account the private stakeholders as essential service providers for civil protection actions, and the information of population.

Other important issues are the technical expertise of the operators and the mutual knowledge of the different bodies involved in the activities (to be realised also using common training and exercise moments) and the use of the new technologies, useful for mapping the different stakeholder/bodies/ agencies that operate simultaneously for risk managing.

The analysis of a post event at national level is mainly based on the comparison between the forecasted scenarios and those that occurred, also considering the resources used and any critical issues encountered in their use.

Usually the analysis is carried out based on the physical data available at national level and on results of questionnaires administered to the regional administrations (responsible for the AIB activities) which allow to highlight any critical issues or possible implementations of the system.

The level of involvement of the population must certainly be increased in the drafting Civil Protection plans, including risk assessment and in the communicating the risk.

In order to encourage these processes, the DPC, in addition to stimulating various communication and training campaigns (a national campaign called "I do not take risk" and some school camps), conducts some specific activities:

- ✓ Drafting a document containing indications on how to inform the population about the conditions of daily danger and actions to be implemented to avoid the occurrence of the phenomena;
- ✓ Ongoing document for drafting municipal plans for fire risk containing, with particular attention on information for the population and their participation in the drafting.

REGIONAL-Fire: The interviewed highlighted the importance of prevention, especially regarding the active monitoring of the forest - when forest fire risk increases - and the regional plan for Prevention, Forecast and Active Fight, au useful tool for planning the prevention actions at regional level and defining the regional and municipal procedures.

- ✓ They don't have any official post-event protocol. They map the burned areas with the help of the Fire Fighters
- ✓ The level of involvement of the population is low. The only group of population highly involved are the volunteers. But It could be improved with awareness campaigns and pilot projects to keep alive the memory about past events.

REGIONAL-CP: The interviewed highlighted the importance of preparedness, especially related to the internal organizational structure, for example through the knowledge of the capacity level of civil protection in the regional territory and then through the mapping of good practices. Good practices that emerge from civil protection plans (at municipal level) could in fact be systematically mapped and possibly replicated and applied to other territories, on the one hand giving feedback to the Municipalities and on the other hand adopting them as an element of internal growth and of the civil protection sector.

- ✓ There is no established post-event debriefing practice. However, brainstorming activities are activated to evaluate the experiences and to improve planning and programming documents. Moreover, the regional control room has a well-established practice of brief every Wednesday to increase the level of knowledge and skills of the operators and to guarantee an effective interchangeability.
- ✓ Regarding the level of involvement of the population in the activities of civil protection, there is ample margins for growth. There is certainly the need and the will to better communicate to the population the activities they do in a useful and understandable way. As regards civil protection planning and the definition of the regional programmatic level, they highlighted the need to identify the stakeholders to be involved. There are already numerous representatives of widespread interests in the area that may be involved. This has already been done with the referents of the voluntary service - who can also be seen as representatives of the population - and with the mayors (representatives of the population as well) when they approve new documents.

1.4.- Describe the main needs related to the emergency management to face multi-hazards (Integration of data, operational needs, DSS, tools ... considering cascade effects between prevention-preparedness-response, integrated approach, cost-efficient criteria. Question 3, 5)

LOCAL: The interviewed use some Operational tools for managing the emergency:

Civil Protection Plan, Radio, civil protection devices, monitoring system also through monitors and cameras, monitoring system of water canals through cameras to detect water height in some cases with warning procedure, positioning system of volunteer radios, Sirens that can also be activated by the COC, memorandum of understanding on the management of trails

They would like to get:

- greater need for coordination between neighbouring municipalities (also in terms of actions to be implemented), also for the management of tourist flows,

- improvement of monitoring system and capacity,
- improving the technological infrastructure of communication system like as radios,
- better coordination with volunteers.

NATIONAL-CP-Flood: They use some operational tools for in real-time monitoring activities, such as IT tools for viewing and consulting hydro-rain and meteorological data.

Regarding these IT tools, they would like to get:

- the integration of the aforementioned data with information and news (also non-instrumental) from the territory in real time, to fully have an overview of the event and risk scenarios.

In relation to the activities carried out, there is not a structured evaluation system in terms of costs / efficiency in daily routines. So, the empirical knowledge based on the individual and collective experience of the Office are central.

NATIONAL-CP-Fire: National forest fires forecast bulletin. The bulletin is daily based and provides a 365-day forecast, it is shared with the various actors of the system, some of whom use it for their related activities. The bulletin is based on the use of numerical forecasting models capable of simulating the conditions predisposing to the trigger and spread of fires both in a timely manner and through specific indices.

During the summer AIB campaign, a specific working group is activated to support the use of the state fire-fighting air fleet, in which the various sectors of the DPC that deal with forest fire-fighting participate. The working group meets daily and forecast information is exchanged on the conditions of susceptibility to triggering and the propagation of forest fire, both on weather conditions and on the situation of fires in progress.

It would be useful to have more information in real time on the events taking place in the area.

REGIONAL- Fire: They use Regional Fire forecast bulletin (SPIRL bulletin) - through which the areas at risk of forest fires are identified

They would like to get:

- Better procedures for integrating the firefighting actions among the bodies involved in the shutdown (Region, Firefighting, Volunteers).
- Better analysis of the cascade effects of forest fire and hydrogeological risk.
- Better integration between territorial planning and risk planning.

There are not cost-efficient criteria but the decisions relating to the interventions are adopted on the basis of SPIRL bulletins, risk assessment, based on previous territorial knowledge and the availability of volunteer teams

REGIONAL-CP: They use many tools such as Standard Operational Procedures for the regional control room of civil protection to be implemented for each operational phase and for all the risks, built in a collaborative manner and computerized. They have also an application to gather, know and visualize municipal civil protection plans. Moreover, they are preparing the regional civil protection plan and other technical documents on the dams and on the territorial civil protection monitoring teams on the ground. Regarding fire risk they have consolidated a protocol / agreement with the national fire brigade.

They would like to get

- Continue improving the internal organization and the procedures, even by certificating their quality.
- More collaboration with the Municipalities.
- More effective communication flow and a support tool to collect and effectively organize information, obtaining then an overview of the emergency situation in real-time.
- Better internal communication flow.
- Improve the criteria coding for the activation of resources.

Cost efficiency criteria are applied as regards the activation of volunteers and resources management, even if this is done in an empirical and spontaneous way. Moreover, if the Municipality does not have sufficient resources to cope the event, the prefecture is consulted by the regional level to optimize the available resources to support the territory taking into account cost-effectiveness criteria (subsidiarity principle).

2.- Gap analysis sum up report about EXTREME EVENT EXPERIENCED f*or civil protection & emergency management stakeholders*

2.1.- General description of the biggest single and/or multi natural hazard extreme events (with special attention to cascade and trigger effects) experienced (Question 1 and 2)

LOCAL: Vernazza and Monterosso, 25 October 2011

Flash floods and landslides The return times of the maximum values recorded vary, depending on the cumulative period, between 100 and 350 years.

The storm structure, persistent and highly organized, produced very intense rainfall (153 mm / ha Brugnato, 129 mm / ha Calice al Cornoviglio, 111mm / ha Levanto) with cumulated, for the overall duration of the event, very high (539 mm / 24h in Brugnato, 454 mm / 24h in Calice al Cornoviglio, 382 mm / 24h in Monterosso).

NATIONAL-CP-Flood: 1 situation was discussed: the event of Messina on the 1st of October 2009. This event can be considered paradigmatic of the dynamics and effects of climate change and, at the same time, it can be - even if partially - considered multi-risk, as the impacts of the event were accentuated by the fires which occurred two years earlier in the territory.

In particular, in the early hours of the afternoon of October 1, 2009, the Ionian coast of Messina was affected by a very intense rainfall event (250 mm / 6 h) with an estimated return time of 300-500 years in a territory of around 50 km^2. Specifically, the Municipalities of Messina and the neighbouring Municipalities of Scaletta Zanclea and Itala were particularly affected. Numerous mud and debris flows, landslides and floods led to the loss of 37 human lives and enormous damage to buildings, settlements and infrastructures.

The predictability of the event was very low, in relation to the limited area and the very small spatial scale: the weather models had not reported anything significant.

Moreover, the 2009 Messina event can be considered as multi-risk: in fact, on the basis of the terrain inspections, it has been ascertained that the interface fires that occurred in 2007 had at least a contributing role in the triggering of mud and debris flows.

NATIONAL-CP-Fire: Two situations were discussed: the forest fire of the 2007 and the forest fires of 2017.

The main causes of these events were:

- ✓ Scarce water availability in the periods before the summer season.
- ✓ Persistence of favourable conditions for triggering and propagating forest fires.
- ✓ High number of contemporary events with persistence even for several days.

The events of 2007 were mainly the consequence of conditions particularly favourable to the ignition and spread of fires with regional AIB response systems not calibrated for those particular conditions. All the regions of central and southern Italy were busy dealing with a large number of events, the forecasting tools were able to predict the particularity of the conditions, but the situation was so widespread and the contemporary events were so numerous that the resources available were unable to cover them all at the same time. The situation was complicated by the fact that some events used resources continuously over several days.

2017 was characterized by the simultaneous presence of climatic weather factors particularly favourable to the triggering and propagation of forest fires, and by organizational factors as it was the first summer campaign conducted in the absence of State Forestry Corps (CFS) suppressed due to the reform introduced by Legislative Decree 167/2016. Following the reform, the CFS staff was merged partly within the Carabinieri Corps and partly into the National Fire Brigade, this caused a dispersion of know-how and the need to create new balances in many of the regional AIB systems that boasted ten-year collaborations with the CFS. The weather and climatic conditions, although not comparable to those of 2007, were in any case particularly favourable and favoured the ignition and spread of fires with problems related to the massive use of resources and the persistence of events even for several days.

REGIONAL- Fire: A situation was discussed: a forest fire and WUI occurred between 25 September and 14 October 2017 in the territory of two provinces of the Ligurian Region (Imperia and Savona). During this event 125 hectares were burned. The main cause was the high drought of forest biomass.

An important constraint mentioned was the operational capacity due to the change of the entity that would have faced the fire event as a responder. In 2017, there was a change of competence between the fire department and the forest rangers who previously dealt with the extinguishing and reconnaissance of fire damage. This made the system work slower and hinder the organization of civil protection.

REGIONAL-CP: 1 situation was discussed: the floods event of October / November 2019 in Liguria. During the period considered, a series of weather-hydrogeological events took place. Those that recorded the greatest effects on the ground were 14-15 October,

19-22 October and 2-3 November, in a disturbed context characterized by further episodes that - although less impactful - contributed to increasing the hydrogeological stress of the area. The events affected the whole region and in particular the territory of the metropolitan city of Genoa and the provinces of Savona and La Spezia, causing floods, landslides, roads subsidence and disruption, tree crashes, etc.

2.2.- Describe the main points of weakness that the emergency management system had (with special attention to communication/coordination between institutions, communication with population, data and information availability, decision-making process, information discrimination schemes, resources management, Standard Operating Procedures, civil protection plan,...) (question 3 to 5)

LOCAL: Main point of weakness that the emergency management has in these situations can be summarized in:

- Poor coordination for actions implemented by the different municipalities;
- Poor coordination with other national or local agencies that were involved in emergency management;
- Low level of infrastructure of communication system (during the event, Microwave radio crashing, no electricity);
- The Civil Protection plan doesn't take into account the risk related to the tourism crowding and its management.

NATIONAL-CP-Flood: In such event, all the territorial levels were involved (central, regional, provincial and municipal). The operational tools used were the standard ones, like tools for consulting hydro-rainfall data, e-mail, fax, spreadsheets, etc. Moreover, the means and resources activated were both land, air and even naval vehicles. The main direct damages were related to buildings, settlements and infrastructures; indirectly, the whole economy of the area, based on the service sector, agriculture and tourism, was affected.

Regarding residual risk in the post-event, it was the subject of numerous inspections aimed at identifying and delimiting the areas that could have been affected by any further events and in which to adopt measures to safeguard the population, including the evacuation of a few thousand people.

Main point of weaknesses that the emergency management had in this situation can be summarized in:

- difficulty in understanding and evaluating the event and risk scenario in real time, due to the remarkable speed of the event and the rapid evolution of the scenarios,
- the weakness of civil protection planning,
- lack of operational procedures (especially concerning the organization of territorial monitoring teams),
- lack of a structured information activity for the population,
- inadequate knowledge of the event and risk scenarios,
- failure to prepare non-structural measures.

However, the interviewed reported that some good practices have been implemented after the event, such as:

- the assessment of post-event residual risk scenarios, carried out by numerous inspections in the area,
- the organization of a system of territorial monitoring teams in the area.

NATIONAL-CP-Fire: It is necessary to:

- ✓ have the ability to quickly evaluate the scenario and its evolution so that it can quickly undertake the most effective actions both for extinguishing and for civil protection,
- ✓ focus on the participation of the population in understanding the risk and in self-protection,
- ✓ improve coordination between subjects involved in risk management,
- ✓ increase communication activities for the population.

REGIONAL- Fire: Main point of weakness that the emergency management has in these situations can be summarized in:

- Too few protocols.
- Low risk knowledge.
- Low coordination between different agencies, also between operational bodies.

REGIONAL-CP: In such event, all the territorial levels have been activated: municipal, provincial, regional and even national level, since the national state of emergency has been declared. There were huge damages: the post-event intervention plan provided for the financing of approximately 3'3500'000 euros.

Main point of weaknesses that the emergency management had in this situation - given the complexity and duration of the event, during which several operators followed one another - can be summarized in:

- Difficulty in organizing information collected from the territory in a structured and effective way;
- Difficulty in checking and validating incoming information and to keep track of updates and to have immediate information and feedback by the operational staff in the territory.

GAP ANALYSIS ABOUT CIVIL PROTECTION AND EMERGENCY MANAGEMENT REQUIREMENTS TO FACE MULTI-HAZARDS

PCF, Spain (Forest Fires)

1.- Gap analysis sum up report *about MOST COMMON SINGLE AND/OR MULTI NATURAL HAZARD SCENARIOS* for civil protection & emergency management stakeholders

1.1.- Responders general profile

Two experts have been interviewed. They are representatives of the Catalan Fire Service. The first one mainly dealing with the management of the command and control central room and communication and use of technological tools to communicate and monitor operations in the field. The second one is more wildfire oriented, being a wildfire analysis and assessment specialist.

1.2.- General description of the most common single and/or multi natural hazard extreme events (with special attention to cascade and trigger effects) (Question 1)

Flooding and forest fires are the most common natural hazards that the fire service deal with. In regard to wildfires, Pyrenees host fires during Winter and early Spring thanks to low relative humidity, while the rest of the territory has Summer as the worst fire season because of the high temperatures. Wildfires have a large impact in Catalonia, however, in terms of human fatalities, flooding and wildfires have a similar impact more or less.

The most common interaction or trigger effect pattern between hazards are wildfire events followed by flooding. When vegetation burns, the soil losses a part of its capacity to absorb the water from the rain, thus, rain has the potential to cause flash flooding because of the water run-off. A common trigger effect pattern is a wildfire threatening property, large chemical industries, communications. It is very important to know that when the service faces a large emergency, it absorbs a lot of resources for other small emergencies and can facilitate that a small emergency become a large emergency.

1.3.- Describe the gaps and operational requirements during the risk assessment and planning process to enhance civil protection capabilities (Question 4, 6, 7)

Concerning forest fires, the key of prevention and preparedness is forest management. Investments in this field can strongly help reducing the risk. However, the Catalan Fire Service do not currently has enough capacity to carry out all the prevention actions needed. Actually, the percentage of actions done compared to the actions that should be done is very small due to the lack of resources. Therefore, the fire service focuses prevention efforts mainly in strategic areas identified to change fire behaviour. These areas are identified by forest fire specialist, and its management is very useful to ensure operations, access and changes in fire behaviour and limit propagation.

The working scale in different emergencies is variate. Some years ago, GRAF units developed strategic management areas, but currently, we know that these infrastructures may be overwhelmed. We have to think in the cost-opportunity and the possibility to loss for instance 100 hundred houses unless 100 hectares are managed. It is important to be aware of the trad-off between short-long impact and what I want and its consequences.

Society may play a key role, too. A society aware of forest fire risk can better understand decisions taken during the emergency and make wiser self-protection actions. Thus, society response can facilitate or difficult fire service response. Therefore, educational and training programs for society (Firewise, Safer together, Preparedness Day, etc) can enhance community preparedness. Currently, society involvement is not enough. But there are some successful experiences related to the involvement of society in pre-emergency decision making processes. Successful cases should be more disseminated and replicated in other areas.

It is also important to have tools able to plan actions with enough time. Cartographic tools allowing the visualization or modelling of the consequences of certain actions in advance.

With the aim to better train firefighters, Catalan Fire Service is currently implementing 2 kinds of performance assessment actions: In-situ debriefing with the units (At single emergency level) and Lessons learned meetings (At seasonal level). There is not a protocol, but there are some practices that the service usually make: briefing every day during an emergency, fire data collection and reports, experiences return, lessons learnt, training modules, reports, video, etc.

1.4.- Describe the main needs related to the emergency management to face multi-hazards (Integration of data, operational needs, DSS, tools ... considering cascade effects between prevention-preparedness-response, integrated approach, cost-efficient criteria. Question 3, 5)

There is an obsolescence problem in terms of DSS. The current program was implemented more than 20 years (despite some updates and improvements have been done). Technical tools must be improved and updated to the current needs. The current GIS DSS shows the location of the units in the area, but nothing else. The improvement of the tool could extremely help to give a more rapid and effective operational response. Data and information flows at a slow pace, therefore, instant information flow is needed, as well as the integration of data from other services at fire service tools (i.e. integration of weather variables into simulators). FS have GIS tools that give spatial information that facilitate the obtaining of fire and units position. A key tool is the framework that allow us to take decisions and share these decisions. ArcGis is very useful to share information with decision-makers.

Cost efficient criteria is not considered currently. The fire service only follows operative criteria to successfully solve the emergency. But economic criteria should be considered in the future to be more efficient and to explain to society the cost of the actions. Cost-efficiency is considered as possibilities (manage- no management, location of a strategic area, let 1000 thousand hectares burn to safe 2000 thousand hectares…). It is not quantified, but cost-efficiency is considered somehow.

2.- Gap analysis sum up report about EXTREME EVENT EXPERIENCED f*or civil protection & emergency management stakeholders*

2.1.- General description of the biggest single and/or multi natural hazard extreme events (with special attention to cascade and trigger effects) experienced (Question 1 and 2)

About wildfires, the most important ones have been Solsonès 1998, Horta de Sant Joan 2009 and Sant Llorenç Savall 2003. However, flooding cause the same or more deaths than wildfires in Catalonia.

Sant Llorenç Savall 2003 fire affected a portion of a natural parc. Since it was a natural parc, people thought that it should be preserved, but park regulation didn't allow forest management. Therefore, the fire got an extreme behaviour.

The fire propagated through massive spotting, not in a linear front. The strategy was mainly to protect citizens and limit as much as possible the propagation of the front using several combined manoeuvres.

5 civilians were killed because the fire caught them in the middle of a road, trying to escape from their homes. However, their homes were a save place and didn't burn.

It was an early August fire; Catalonia experienced a very difficult week under a heat wave and simultaneity of wildfires. Almost 5000 hectares burned for 9 days. Despite the strong blaze was only during the first days.

Another severe wildfire was Torre de l'Espanyol 2019. It burned 5000 hectares between 26th and 27 June 2019. Fire service suggested to activate the maximum alert for these days.

It burned a very abrupt terrain. The fire had the capacity to generate massive spotting at the front. Despite there was a low load of fuel, the fire had the capacity to burn in a very fast propagation rate. Weather was very complex, under a heat-wave situation. The suppression capacity was overcome by the fire.

2.2.- Describe the main points of weakness that the emergency management system had (with special attention to communication/coordination between institutions, communication with population, data and information availability, decision-making process, information discrimination schemes, resources management, Standard Operating Procedures, civil protection plan,...) (question 3 to 5)

Both fires crossed municipality and county limits, therefore, it was a provincial emergency. Plenty of authorities attended the event (county, mayors, head of the interior department and province authorities).

At operational level, the fire mobilized resources from all parts of Catalonia, GRAF teams and aircrafts and helicopters. Nowadays, the deployment of units would have been almost the same. Maybe EPAF units would have played a role in using manual tools. Coordination between units and command posts would have been better, thus, the improvement potential is in the coordination and internal communication part rather than human resources and operations.

In the case of Torre de l'Espanyol, FS used all the tools available like GPS, radio, phones, cameras to collect information, etc. We used ArcGis, so every time someone saw a hotspot or anyone was making a manoeuvre it was documented and accessible for everybody.

There was satellite data, multiple information from different weather stations. Also fire service chat to share fire updates. Regional authorities and mayors of the area were present in the command post.

The fire burned farms and affected some houses. Of course, that has a socioeconomic impact on the area. There were road brakes, evacuations and some people in the area needed a rescue. Fortunately, any civilian or firefighter was killed. There was a nuclear plant near the area. The main concern was to protect electric power lines in order to avoid possible negative consequences on the nuclear plant. The fire had a lot of reignitions. Actually, it was not fully extinguished after 1 month.

Weaknesses were at technological level. Signal is key to assure communication between deployed teams and command posts. If the communication is lost, the efforts of the units may be useless. More community awareness is needed before, during and after the emergency to make people understand decisions.

Training is a very important part to improve the response. However, Catalan firefighters are deployed in many different emergencies such as forest fires, urban fires, flooding, traffic accidents, mountain rescue, oil spills, industry explosions, buildings collapsing, etc. That makes training very difficult and highlights the need to have specialized teams inside the service. That is the example of GRAF units, that specialized their activities in forest fires (analysis, operations, etc). GRAF units have more potential to train the staff only in forest fires to ensure a more qualified response system.

GAP ANALYSIS ABOUT CIVIL PROTECTION AND EMERGENCY MANAGEMENT REQUIREMENTS TO FACE MULTI-HAZARDS

CTFC, Spain (Forest Fires and Avalanches)

1.- Gap analysis sum up report *about MOST COMMON SINGLE AND/OR MULTI NATURAL HAZARD SCENARIOS* for civil protection & emergency management stakeholders

1.1.- Responders general profile

From CTFC, complementary to those interviewed by other Catalan partners, one expert from the Catalan Civil Protection (CCP) body (from Logistic Service and Territorial Operability, Sub-General Directorate of Emergency Coordination and Management) has been interviewed. CPP representative is involved in designing and implementing the logistic support in the territory of the CCP system. The representative works coordinating the global strategy from a local perspective, giving support to the territorial coordination of the different operational corps and local stakeholders, programming the operative resources and their dimension for the civil protection actions and coordinating the logistic actions in case of emergency.

1.2.- General description of the most common single and/or multi natural hazard extreme events (with special attention to cascade and trigger effects) (Question 1)

Within their competences, they face all kind of emergencies, from natural hazards to traffic or industrial accidents. Regarding natural hazard, they cover all type of episodes.

1.3.- Describe the gaps and operational requirements during the risk assessment and planning process to enhance civil protection capabilities (Question 4, 6, 7)

It is mentioned the importance of having high quality data about the available logistic resources present in the territory. This will facilitate emergency management and will increase civil protection capabilities. Normally this data is collected in the "Catalogue of Municipality Resources" (by law) which is updated every 4 years. Nevertheless, not always is exhaustive enough. Moreover, could be useful to have a visualizer tool that collects all data on municipal resources and thus all the information in one DSS (see next point).

On a practical level, a personal contact and knowing the responsible person in the territory makes the emergency management easier, taking into account that normally the "proximity" gives several advantages and helps the collaboration. These pre-contacts should be done through prevention and preparedness actions, for instance, carrying out drills in the area. It is very useful, on a practical level, to know each other. Thus, there is a constant need to consolidate and maintain this relationship.

As a collateral effect to improve the response, it is highlighted how communication campaigns to exposed population are fundamental to reach the citizens and increase their own risk awareness and self-protection capacity. Normally, people have a "short memory" of past events, they forgot it. Even closer events not necessarily make a difference. Thus, a special emphasis was posed in risk awareness and communication to reinforce the prevention and preparedness and to improve the efficiency during the response. In that sense, awareness campaigns could be reformulated, looking for an increased impact. Focusing on the limits that public services have, and the necessary proactive collaboration of citizens and related stakeholders during the emergency, increasing public authorities' credibility and trust at the same time.

Regarding the development of the Civil Protection system in the territory, currently situations in the municipalities are very diverse which do not allow to conceive the human capital for the response in the same way, and this suppose a challenge to manage. The CP system is under development. Therefore, as much reinforced the system is, a more consistent role in the prevention (participating in the risk assessment and planning) and preparedness (undertaking drill, having personal contact with key people) they will have.

The emergency management post-analysis procedure is consolidated, and gives an opportunity to extract lessons and to be translated into risk assessment and planning process. Therefore, the lessons learned approach should be extended beyond those who participate in the emergency, including those stakeholders involved in prevention and preparedness stages.

1.4.- Describe the main needs related to the emergency management to face multi-hazards (Integration of data, operational needs, DSS, tools ... considering cascade effects between prevention-preparedness-response, integrated approach, cost-efficient criteria. Question 3, 5)

Related to the above mentioned highlighted needs, it is important to have a good knowledge about what is happening in the territory and which resources are available. A potential improvement could be to put the information in some digital format or DSS platform to be shared with all operational corps. Currently, the data about resources is available per each municipality, and it is necessary to look at it one by one. This is time consuming in any emergency situation, where time is very valuable.

On the other hand, in natural hazard's emergencies, it is essential to have well developed forecast tools (since natural hazards are normally linked to meteorological events).

With regards the communication among operational corps, a radio communication net was created (TETRA) where each service has their own channel. It has been tested the option of having one inter-agencies channel. Nevertheless, it should be necessary to develop a common protocol to standardize the technical language between emergency bodies beforehand.

Communication during an emergency is a key issue that should be further developed. In some cases, it has been seen that some non-official channels (e.g. WhatsApp and Telegram) are used and are very useful during an emergency. Nevertheless, at the same time, their use has some dangers since there is no record about the existence of the communication and legal implications can appear. To solve this, an official channel could be generated, but spontaneity may be lost. These citizens-based communication tools work better and therefore, there is a need to organize and manage this potential.

Other advantage in the emergency management is the development of Territorial Coordination Centres, which appear spontaneously at some stage, since local stakeholders want to be informed and participate in the decision-making. Nevertheless, this "proximity" CP tools should be properly embedded into the emergency planning and norms to guarantee the corresponding coordination, transparency and legal coverage.

About multi-actor cooperation, it was mentioned the possibility to promote cartography and information sharing between emergency and management bodies during an emergency. Nevertheless, the increasing complexity of the emergencies, makes fully necessary to move towards shared data platforms for all operational bodies. Also, the common protocol above mentioned could be interpreted as a multi-actor cooperation since the main objective of the protocol would be to stablish a common language to manage the emergency.

Regarding the cost-efficient criteria, the Civil Protection system at municipality level shows that it has been decided to have all the territory covered with contact persons – regardless their profile – rather than very prepared profiles only in some parts of the territory. An alternative could be to develop expert profiles and insert them into fire stations which are distributed in the territory in a planned way. Nevertheless, the "proximity" contact with the municipalities could be lost this way.

2.- Gap analysis sum up report about EXTREME EVENT EXPERIENCED for civil protection & emergency management stakeholders

2.1.- General description of the biggest single and/or multi natural hazard extreme events (with special attention to cascade and trigger effects) experienced (Question 1 and 2)

Two natural hazard events were mentioned: The Gloria storm (January 2020) with an important flood event associated, and a severe snowfall event (March 2010), with high impact in road, communication and electric networks with thousands of citizens affected in a huge territory.

2.2.- Describe the main points of weakness that the emergency management system had (with special attention to communication/coordination between institutions, communication with population, data and information availability, decision-making process, information discrimination schemes, resources management, Standard Operating Procedures, civil protection plan,...) (question 3 to 5)

One very practical lesson learned from wet snowstorm event was the crucial role that the communication and electric network nowadays plays. Without this basic network working, several collateral problems appeared. Society is basically technological, without electricity mobiles communication is not going to work and most people do not have any alternative to be informed or have a communication with their family, emergency services, etc. Without the basic supply network functioning, it is not possible to properly manage the emergency ("blind work") since, among other, there is no available information to take decisions.

Therefore, to face properly the vast and more severe events expected, ensure the functioning of the basic supply network is crucial. For instance, asking private operators to have enough electricity transformers spread in the territory in case of emergency, including this requirement in the terms of the contracts.

On the other hand, work on new management approaches/protocols to face the emergency if the basic supply network falls.

Based on what was mentioned in point 1, other questions, related to reinforce civil protection capabilities to face extreme events in a CC context, were mentioned:

- To enhance the involvement of citizens in a proactive way in the emergency management (with the corresponding tools and resources), since public service will not be able to cover all needs. This is especially relevant in large affectations, when self-protection and own capabilities to manage the situations will make the CP system more resilient. A reformulated risk awareness and communication strategy asking for the participation of citizens was discussed.
- To improve forecasting tools and the need of a better integration of CC scenarios and the severity and recurrence of "unprecedented" expected events.
- To move towards digital platforms compiling all the operational information about the resources in the territory that can be used in case of emergency. And to integrate it in existing or new platforms, in a shared way among all emergency corps, together with reinforced collaborative and communication protocols, to face the expected increasing complexity of the emergency management.

As an additional information, it has been noted that beyond the population, also companies and private sector are more and more approaching to the civil protection. The last vast and severe events make them aware that it is not only an issue of personal safety but also of making economic activity more resilient. On that sense, this is opening new "windows of opportunity" to engage them in being more proactive managing risks.

GAP ANALYSIS ABOUT CIVIL PROTECTION AND EMERGENCY MANAGEMENT REQUIREMENTS TO FACE MULTI-HAZARDS

DGPC CAT, Spain (Multi-risk)

1.- Gap analysis sum up report about MOST COMMON SINGLE AND/OR MULTI NATURAL HAZARD SCENARIOS for civil protection & emergency management stakeholders

1.1.- Responders general profile

We have conducted 5 interviews, all within the Catalan Civil Protection body and all with mid-level or high responsibilities. Their role is related to planning, operational emergency management, development of technology and communication.

In Spain, each region has a high degree of autonomy in relation to emergency management, although there is a basic regulation at the country level that all regions have to follow. Besides, the Spanish administration is in charge of the nuclear safety and emergency management.

In the particular case of Catalonia, it has its own emergency management bodies for fire extinguishing services, police, health emergency service, forest officers, civil protection and institutions for risk management in each natural risk (hydrology, meteorology and geology).

On the other hand, municipalities play a very important role although only Barcelona holds its own fire department, many of them holds local police and all have a high degree of autonomy in emergency planning. However, regarding natural emergencies, the management is performed at a regional level because the Catalan administration holds the resources and only in case of an emergency affecting other autonomic regions or in case of non-manageable dimensions there would a coordination from the Spanish administration.

1.2.- General description of the most common single and/or multi natural hazard extreme events (with special attention to cascade and trigger effects) (Question 1)

Floods, flash-floods, snowfalls and wild fires. Floods and flash-floods cause the main of the personal damages, whereas fires cause the main damage to the environment. It is mentioned also heavy winds and heat weaves. It seems that fires are less frequent in the last years than in the past and, besides, heavy winds are more intense and frequent. All these phenomena are related to climate change.

Regarding the trigger effect pattern, wild fires and heavy winds increase the severity of floods. Besides, wild fires may threaten chemical factories, which is known as NATECH (technological accidents triggered by a natural hazard or disaster which result in consequences involving hazardous substances).

1.3.- Describe the gaps and operational requirements during the risk assessment and planning process to enhance civil protection capabilities (Question 4, 6, 7)

Raise public awareness will help to implement some measures, especially in prevention, like the prohibition to establish camping areas in flooding areas, but also in relation to self-protection.

Stronger civil protection measures in urban planning during the prevention stage will avoid dangerous situations.

Improve forest maintenance for fire prevention (cleaning up, prevention fires…).

Improve the risk analysis (local characteristics and effects, specific scenarios, locate the most vulnerable and problematic spots).

Start a continuous training system for all the operative groups (fire fighters, police, emergency health….) to improve the interaction (coordination). It should bring an improvement of the coordination, knowledge between operative groups, in order to avoid duplication of tasks and clarify responsibilities.

Develop and implement more standards and protocols in relations to the improvement and quality assurance in the planning and operational process.

Increase the involvement of the population and stakeholders creating new work forums (though a daily base and active mechanism) which allow to detect needs in each filed, getting their concerns, how they may be affected and offering them the opportunity to participate in the emergency management to create synergies.

It is recommended to rise awareness within the general population about the risk they are exposed to, the planning tools they may access…

Municipalities should also give more information regarding the risk in their areas and give real public access to their plans.

Local information should be transferred to the regional level to be integrated in the regional plans, because it's very difficult to know the local characteristics of each risk and municipalities are may hold this knowledge. It's important that municipalities to detect possible situations difficult to be managed and to be transferred to the regional level for further analysis and planning.

Start a georeferenced data base fed by local administrations, especially with the vulnerable spots, in order to better protect them in an emergency.

We need to develop indexes to assess our performance and whether our taskforce and resources are enough.

We need to implement standards for organizing and managing, especially for the operative service.

We need local leaders to raise awareness.

The obligation to hold a position of technician specialized in civil protection for each group of municipalities (the so called "comarca" which gathers different municipalities under the regional scale) which may give support to small municipalities.

Improve the implementation of local plans.

Support the interaction between local and regional actors to increase reliability in each other.

Increase practical training to better know what to do in case of an emergency.

1.4.- Describe the main needs related to the emergency management to face multi-hazards (Integration of data, operational needs, DSS, tools ... considering cascade effects between prevention-preparedness-response, integrated approach, cost-efficient criteria. Question 3, 5)

New apps for municipalities, very easy to use, to get warnings in order to help them to know whether they are affected and what to do in each case.

More explicit cost-efficiency criteria based on well-defined indexes.

More accurate (in time and space at local level) and reliable meteorological predictions will help to give warning advice in time with precision and reliability, to the councils and vulnerable elements.

Databases of information are needed to cross with scenarios and their consequences: social information of the population, the economic scope, etc.

Long-term spending schemes and investments.

More investment in planning and prevention and less in urgent and immediate needs will save money.

Improvement of the emergency management software with more transparency regarding the decisions taken, make use of the amount of information in system, sharing the information…

Improvement of the forecast tools to foresee the emergency with time enough to take measures.

Improvement in monitoring the different aspects of the emergency, to better understand what is happening, take advantage of in situ data. Digest, summarize and organize all the available data in a fast way, to better understand what is happening (may be some artificial intelligence). It needs standards in the information sharing process. Better monitoring tools, like sensors, drones, satellite imagery… may help to improve the forecast and increase the time in advance to initiate prevention and preparedness measures.

Some information flows could be improved in order to drive as fast as possible all the information and decisions to the emergency room as a hub of information from where can be safely disseminated. In some cases, each body reports to its head or room directly, so no direct information is reported to the coordination room. Improvement of the information flow to the citizens. Increase communication avoiding in situ meetings and promoting remote connections to reach a greater agility in the decision-making.

We need a nowcasting in hydrology at a local scale, especially in urbanized areas. We have a weather nowcasting and forecasting system, but we lack the conversion to hydrology which means flooding forecast.

We need to forecast the speed of the phenomena.

Increase local involvement to decentralise the decision-making process.

Establish clear communication channels.

Reusable data formats in the sharing of information process.

Clear and pre-agreed protocols from all risk management agencies (specialized in each risk i.e. hydrology, meteorology and geology) for the sharing of information process.

Decrease the time between the detection and the warning time to the population and decision-makers.

Implement warning systems for the general population.

We can distinguish two types of information:

- Information which allows to foresee a potential dangerous situation (comes from the different risk specialized agencies i.e. hydrology, meteorology and geology)
- Information generated during the emergency.

2.- Gap analysis sum up report about EXTREME EVENT EXPERIENCED for civil protection & emergency management stakeholders

2.1.- General description of the biggest single and/or multi natural hazard extreme events (with special attention to cascade and trigger effects) experienced (Question 1 and 2)

Floods with some casualties, forest fires affecting urbanized areas with thousands of people evacuated, exceptional snowfalls affecting big cities, forest fires with some casualties.

2.2.- Describe the main points of weakness that the emergency management system had (with special attention to communication/coordination between institutions, communication with population, data and information availability, decision-making process, information discrimination schemes, resources management, Standard Operating Procedures, civil protection plan,...) (question 3 to 5)

Sometimes operative bodies only concentrate in specific parts of the emergency, leaving others uncovered, may be due to a lack of resources and or a weak organization.

A visual app to spot the incidents in real time.

Mayors usually have a low knowledge of protocols (their own and from other bodies).

Weak relationship, reliability and coordination between municipalities and regional administration. It has to be improved before the emergency, together with training and awareness.

Regional operational bodies must be more open to the inclusion of local administration in the decision making process.

Lack of information (e.g. reliable database) for decision making during the event.

Lack of fast information to the population during the emergency, especially in fast phenomena. May be specific for each risk. We need a tool.

Weak preparedness of local emergency management and planning.

Improve the knowledge about what is happening to take action before it will become a damage.

The information flow is not agile enough. The information does not flow properly to the emergency room where some important decisions are taken (some others are taken in the coordination advanced centre on the ground). The flow of information between both should be improved may be with better technology.

Lack of knowledge in Civil Protection and risk planning from political decision makers.

Lack of dashboards with summarized information, especially for decision making positions.

Too political intervention in the technical field.

Lack of specific training for Civil Protection (there are specific high education programs).

Excess of bureaucracy.

Lack of technology support.

In the emergency management technological tools in the emergency room it is needed more involvement from the risk management agencies (specialized in each risk i.e. hydrology, meteorology and geology). It needs communication system tools with citizens and operational bodies. May be integrate other tools currently manually done. It needs to be very powerful. It must also cover the recovery stage (post-emergency) also, to be able to keep track from the beginning of the emergency and cover all the steps (now when we manage the emergency, it is closed when the phenomenon is extinguished). The tool should also include the management of resources based on agreements and contracts with existing companies.

Lack of integration between operation management technologic tools and emergency management plans.

Lack of reusable data formats in the sharing of information process. It should be an easy predefined protocol or an exchange information system, predefined, easy to use, fast, accessible by any agency.