1 TCP 4 - Manage natural hazards and technological accidents, Capability Gap Findings

1.1 WUI Gap No 1 [4.CGF.1] Inadequate Perception of Fire Risk and Lack of Risk Awareness in Wildland Urban Interface Areas

It was agreed that there is **Lack of security culture:** wildfire risk prevention is not integrated in the mindset and lifestyle of the citizens living in the WUI areas. Also, many citizens remain inactive even if they are informed about the fire risk, that is there is **no perception neither ownership of fire risk.** Both WUI residents and practitioners operating in WUI areas agreed that there are no adequate citizen awareness campaigns and there are no **Systematic** risk communications to residents. Lastly, **Tourists and visitors** to WUI fire-prone areas are **more** exposed to fire risk than locals since they have limited knowledge of the territory and the local risks. As a result, there is *Inadequate Perception of Fire Risk and Lack of Risk Awareness in Wildland Urban Interface Areas.*

The perception of risk depends on risk culture which differs per person. What one resident in a WUI area might consider as severe risk, a neighbour or a visitor might evaluate it differently. Although WUI fires are a frequent phenomenon during the last decades, there is no guidance provided to the public about safety practices. One of the reasons that might affect the perception of risk is the familiarity with the area (residents are more familiar with the area than visitors/tourists). The former group is aware of the available possible evacuation routes. Moreover, area visitors who do not speak the local language have an additional disadvantage of being informed and evacuate to a safe destination. More important is that the entire population in WUI areas do not receive any form of training on how to react in case of a WUI fire, while the complexity of the WUI environment and the WUI fire propagation patterns might turn some evacuation routes from safe to risky within minutes.

Table 1: 4.CGF.1 Technology Attributes

Technology Dimension Attributes
No **technology solutions to guide evacuees in case of a WUI fire** and **provide real time guidance** based on the WUI fire progress and the location of evacuees.
Lack of **multilanguage public announcement systems to inform foreigners** when an evacuation is scheduled.

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1.2 WUI Gap No 2 [4.CGF.2] Lack of a Standardized and Interdisciplinary Methodology for Developing Wildland Urban Interface Prevention Plans

First Responders, local and regional authorities, homeowners, residents developed prevention plans individually (if they develop any), without consultation and guidance from authorities, (which in many cases are not capable of issuing specific WUI prevention plans) often **following different methodologies**. As such, there is *Lack of a Standardized and Interdisciplinary Methodology for Developing Wildland Urban Interface Prevention Plans.*

Building regulations and standards that apply to urban environments are usually applied in residential areas located in Wildland-Urban environments. For WUI areas the spread of fire is different than urban environments. Therefore, different risk metric should apply, in wild-land-urban environment. There is lack of 'tools' that will produce WUI fire prevention plans at local and regional level.

Table 2: 4.CGF.2 Technology Attributes

Technology Dimension Attributes
Lack of tools that will take into consideration WUI risk metrics and predict the spread of fires in WUI residential areas, assess fire performance of structures and mitigate effects of fires on structures in WUI areas through science-based codes and standards for the construction of buildings and plans within these areas.

1.3 WUI Gap No 3 [4.CGF.3] Lack of Reliable and Real-Time Information on Crisis Communication

Usually the people **do not know where to get reliable information from** before a WUI fire occurs or during the fire event. Authorities are **not** adequately trained to **provide clear and straightforward information**. Consequently, the residents or the population at risk seldom follow recommendations. It was confirmed that there is *Lack of Reliable and Real-Time Information on Crisis Communication.*

In today's information-saturated society, there is no shortage of sources or ways to get information. Usually information is available electronically, from a number of communication channels, like Social Media channels (Facebook, Twitter, etc) and informative push notification messages sent by websites to their subscribers' smartphones. The range and diversity of information on the web nowadays is beyond staggering. It is common knowledge that you can find everything, for everyone and everything, authored by anyone. There are plenty of reliable sources, but there are also plenty of misinformation and untrusted material, and all sorts of

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things in between; some sources are reliable and thorough, some lack credibility, and some are utterly non trustworthy. Trying to determine the **quality** of the source (how accurate and reliable is the information?) as well as the **credibility** (how much can I trust the information? is it processed using accurate data and in a standardised manner?) of information during stressed times is an additional destruction. There are incidents where the official Social Media accounts of a practitioner's organisation urges the public to ignore all announcements and posts in social media and follow certain information sources from these media. Broadcasts of 112 messages is only for providing generic guidelines (stay at home or evacuate), are not broadcasted that frequent and do not sent personalised information. Moreover, it is not ensured that all population will receive, read and follow the guidelines.

It is therefore advisable that during a WUI fire, the population at risk to be informed about the official information channels that will convey information, recommendations, and guidelines to residents.

Table 3: 4.CGF.3 Technology Attributes

Technology Dimension Attributes
During **crisis communications** it is **recommended to eliminate/restrict/limit** all **information sources** that are **disseminating false data and transmit nonofficial guidelines**. Since most of the communication channels are electronically, technical means should be utilised for controlling the spreading of fake news and misinformation.
Capability to **precisely identify people to warn** (warning messages need to be accurately location based otherwise the population discard these alerts as unsolicited messages)

1.4 WUI Gap No 4 [4.CGF.4] Not All Stakeholders Share the Same Operational Picture. Lack of Interoperable Systems and Real-Time Situational Awareness in Firefighting

It is widely observed that there **is lack of communication, cooperation and information-sharing** between different authorities. Each practitioner organisation that is likely to be involved in a WUI fire incident has **no interoperable systems to exchange information**. Typically, if there are any **WUI fire response plans**, these **are not shared among agencies** neither a common platform is used. As a result, what is known as **Common Operational Picture** (COP) during the incident **is not shared** (most of the times) **between different practitioner organisations**. Therefore, *not All Stakeholders Share the Same Operational Picture. Lack of Interoperable Systems and Real-Time Situational Awareness in Firefighting.*

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Practitioners from various organisations and stakeholders responding in a WUI fire incident do not always have access to common or up to date information. Is it acknowledged that every organisation has different information needs and its members typically exchange intelligence within the boundaries of their organisation. For example, in case of a WUI fire, police in cooperation with fire fighters have to delimit a region by setting traffic management control points. These are temporary road closures set up during an emergency. They are used to protect the community and emergency services personnel when there is potential danger nearby. Police officers in consultation with various emergency service personnel and people who know the area decide on where to restrict access. There are different level of access varying from *No Entry - Emergency services only access*; Restricted Access - *Entry to Essential services* (public utilities, volunteers) based on risk assessment; Authorised Access where *residents, employees can enter* and finally Road Open – *No restrictions***.** Stakeholders who might not be part of this consultation might not be timely informed of the entry restrictions. This is a typical example where the parties that should operate in an area, they do not have access to the same information sources and consequently they do not share the same operational picture. Typically, volunteers are using their own means to conduct their operations and are not always included in the information exchange. The practitioners from various organisations are coordinated using points of contacts located in the incident command control center. Real time information might be available to a few practitioner organisations and might not be available to others.

Practitioner organisations are using their own systems for acquiring, processing, sharing and displaying information. Each organisation is interested in specific information fields more than others. As such, practitioner organisations, they have their own information systems, which are satisfying their operational needs, but these systems are not communicating /exchanging information with similar information systems used by other practitioners. As such there are non-interoperable information systems used by practitioners, which add complexity when practitioners should engage into joint operators with practitioners from other disciplines.

Instead of the different or customised information systems that are used by practitioners, it will be beneficial to have a common information system fed (updated) by all organisations responding to the same incident area and all relevant stakeholders. Using a centralised administration, each practitioner organisation will use the information, which is of interest to them, while actions performed will be recorded in the system so as other organisations can become aware. E.g., A road blockade performed by police in consultation with the fire department should be known to all stakeholders in the region, both public and volunteers. Fire propagation simulation data for a WUI area should be shared with all the organisations dispatched in the area. The placement of resources and their distribution in the area from all practitioners should be known to all first line responding organisations in case that means and resources should be shared or co-exploited.

Table 4: 4.CGF.4 Technology Attributes

Technology Dimension Attributes
Lack of interoperability between information systems used by all involved stakeholders responding to incidents and use of standardised interfaces between those systems.
Need of a common platform where all information is maintained and shared with all practitioners' organisations based on their involvement and expected response in a WUI fire. All practitioners should have a common operational picture and know the distribution and number of all resources of involved organisations / stakeholders.

1.5 WUI Gap No 5 [4.CGF.5] Lack of Evidence-Based Knowledge (Including Risk Assessment and Cascading Effects) On Fire Behaviour in Wildland Urban Interface Areas

It was agreed among practitioners that it is **difficult to accurately anticipate the fire development and the cascading effects in WUI areas**. There is **heterogeneity of the conditions inside WUI areas**, notably concerning fuel categories (buildings, gardens and natural vegetation) and their spatial distribution patterns. There is also **scattered presence of individuals and groups of people in an actively burning area**. Lastly, there are no risk assessment models adapted to the specific characteristics of fire behaviour and propagation in WUI areas. To summarise the above, there is *Lack of Evidence-Based Knowledge (Including Risk Assessment and Cascading Effects) On Fire Behaviour in Wildland Urban Interface Areas*.

Climate change, deforestation, increased urban development in former rural areas and fuel management policies have resulted to an increase in the frequency of occurrence of WUI fires with estimations that this trend will continue in the future years (Krawchuk et al., 2009). In this aspect, engineers and fire management agencies face new challenges in the design and protection of WUI communities necessitating the deployment of diverse set of resources and use of new firefighting plans to preserve property and life safety.

It is very common that, in large WUI fires many buildings burn several hours, after the main fire front passage through a settlement, due to spotfire ignitions. Firebrands as well as other smouldering debris slowly transition to flaming from innocuous sources, difficult to be identified, while the main fire front threatens new homes and settlement kilometres away. These debris and spots can be transferred several kilometres ahead of the fire front depending on local meteorological conditions, which consequently may affect a large area making firefighting extremely difficult and requiring large resources in terms of firefighters. Firefighting crews usually are not adequate to cover these needs (Koo et al., 2010). Thus, a different approach must be followed for firefighting and protection of structures in order to prevent future large-scale losses. Current strategies for exterior fire protection in WUI areas (e.g., homeowner checklists, mesh coverings for vents, etc.) are lacking compared to those developed for use inside buildings such as smoke detectors, or fire sprinklers, etc. A concept could be to protect the WUI areas by minimising the probable pathways of firebrands or other fire sources that can penetrate a property or community and destroy a structure, a problem recent reports (Gollner et al., 2015) tried to shed some light on.

It is important to understand how WUI fires spread and ignite structures in WUI areas, that is: (i) improved understanding of burned/unburned structure spatial distribution patterns; (ii) develop/define standardised data collection strategies; (iii) enhance the understanding of spotfire ignition mechanisms. In order to develop prediction tools, it is imperative to have metrics which means that quantification of WUI fire risks is required like:

- understanding wildfire risks in a community in conjunction with wildland fire behaviour research;
- quantification of exposure to fire spotting within the WUI area;
- improvement of the understanding of spotting fire mechanisms;
- translation of research results into mitigation strategies (e.g., develop representative standardised test methods indicative of the exposures, of new materials, designs, and technologies, of scientifically proven retrofitting strategies for existing communities); and
- incorporation of research results in codes and standards through better interchange between communities related to WUI standards and codes and fire safety science research.

Table 5: 4.CGF.5 Technology Attributes

Technology Dimension Attributes
Lack of prediction tools to accurately anticipate the fire behaviour and propagation and the cascading effects in WUI areas.
No solution to provide **intelligence about the presence of residents, people exposed at risk, vulnerable people in the WUI areas**.
Lack of risk assessment models adapted to WUI and new fire behaviour.

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1.6 WUI Gap No 6 [4.CGF.6] Inadequate Fire-Fighting Knowledge and Shortage of Fire-Suppression Resources and Operational Means for Operating in Wildland Urban Interface Areas

There is **no adequate knowledge concerning wildfire management in WUI areas**, a non-homogeneous environment with numerous particularities ((including human presence spatial and temporal patterns). Often, there is **missing geographic information about people and buildings in danger during a WUI fire**. There are **challenges in training of first responders in the WUI environment,** while there are no specific firefighting operational means, either terrestrial or aerial, suitable for intervention in the WUI area. Thus, there is *Inadequate Fire-Fighting Knowledge and Shortage of Fire-Suppression Resources and Operational Means for Operating in Wildland Urban Interface Areas.*

While the wildland–urban interface (WUI) is not a new concept, fires in WUI communities have rapidly expanded in frequency and severity over the past few decades. The number of structures and human loses lost per year has increased significantly, due in part to increased development in rural areas, fuel management policies, and climate change, all of which are projected to increase in the future.

Recent involvement of the fire science community in WUI fire research has led to some great advances in knowledge; however, much work is left to be done. While the general pathways for fire spread in the WUI (radiative, flame, and ember exposure) are known, the exposure conditions generated by surrounding wildland fuels, nearby structures or other system-wide factors, and the subsequent response of WUI structures and communities are not well known or well understood.

Structures exposed to wildland fire in the urban interface can and should be considered as another fuel type. The environment practitioners they should respond is often characterised by • narrow, one-way roads with difficult access; Risks related to underground utility networks (natural gas, water) and aboveground (power lines, propane tanks, and HazMat threats), structures on steep slopes• Extreme fire behaviour • Strong winds • Evacuation of public (panic) • Structural collapse zone when structures are exposed to fire • Smoke by-products often laced with chemical compounds not found in pure wildland fires. The above challenges require modern firefighting tools that will support firefighting operations.

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Table 6: 4.CGF.6 Technology Attributes
Technology Dimension Attributes
Firefighting organizations are often in shortage of modern operational means and fire-suppression tools that allow intervention in the sensitive wildland-urban environment.
Need for further distribution of technological tools with digitized information that could allow field teams to manage fire in a more controlled and educated manner.

1.7 WUI Gap No 7 [4.CGF.7] Difficulties in evacuating large number of people in a small amount of time while preventing that people get trapped while trying to escape

There are **no formal guidelines and evacuation plans for WUI settlements**, and the **evacuation instructions may be misused or disregarded** and eventually jeopardize population's safety. *Difficulties in evacuating large number of people in a small amount of time while preventing that people get trapped while trying to escape,* is one of the major issues in fire management.

Formal guidelines and evacuation plans do not exist for all WUI settlements, or at least the plans are not disclosed to all stakeholders (especially the residents who should perform the evacuation). Many WUI residential areas are preferred vacation destinations, as such their population in holiday seasons is multiple of the permanent population. As such it is challenging for authorities to practice emergency procedures (including evacuation) exercises.

It is important to test and drill the WUI Emergency Evacuation Plans several times a year, with the involvement of practitioners and volunteers although that does not necessarily mean a total evacuation for every test. Some tests may be limited to specific areas, populations, or extent. In between tests, it is important to check all the evacuations routes and alternate routes that are in the evacuation plan for each part of the WUI area.

There are no specific tools to account the complexity of mass evacuations. Nowadays, there are many evacuation modelling suites for public places and large indoor buildings and urban environment as well. These tools required many tens of thousands (10,000) of simulation runs in order to produce results and on average they need approximately more than one day per evacuee. WUI environment adds more complexity, while simulating the evacuation behaviour of non-permanent residents impose additional computational complexity. The said complexity is without taking into account fire simulation in WUI environments.

Table 7: 4.CGF.7 Technology Attributes

Technology Dimension Attributes
Lack of tools, in use at operational basis, that will take into consideration WUI risk metrics, fire propagation and population behaviour, for evacuation modelling.

1.8 WUI Gap No 8 [4.CGF.8] Limits in implementing in-place sheltering

There are **misconceptions concerning the use of houses as shelters** while **no specific guidelines exist for home-protection in WUI areas**. Moreover, there are **no building standards in** vulnerable **WUI environments and people do not feel safe in their houses when surrounded by fire.** As such, there are notable *Limits in implementing in-place sheltering.*
Shelter-in-place (SIP) is appropriate when conditions require that individuals seek protection in their homes, places of employment, or other locations when a hazard or threat is imminent or occurring. There are a number of **misconceptions** concerning the use of houses as shelters during a WUI fire incident. Sheltering-In-Place should be researched if it can be incorporated in current suppression/evacuation strategy. To be successful, SIP requires fire service commitment to education and comprehensive civilian preparedness[1]. Practitioners in US and Australia are using SIP for more than two decades. The Australian Fire Services have advocated this concept for the last decade and shown a marked decrease in both loss of life and property. Communities in California have been successfully developed around SIP principles and have demonstrated remarkable success. However, although WUI fires are occurring more often in M&BS countries, there are no specific guidelines for **home-protection** and **SIP** in WUI areas. Often buildings in WUI environments are erected without following construction and design building standards being in zones with no building permits.

The sheltering in place approach involved a minimal set of equipment (apart of practices) the WUI residents should use to protect their properties. Not all WUI residential areas they made of "ignition resistant homes" but **operating a sprinkler system before the fire front arrives** is a good practice. Other than that, the structures themselves can be mitigated through the development of a strategy that addresses the built environment, vegetation, and other combustible materials on the property. Use of non-combustible materials and ember-resistant design features are examples of strategies that reduce the vulnerability of homes to wildfire.

The use of coatings has been suggested as a strategy to provide enhanced protection against extended radiant heat and flame contact exposures for homes located in wildfire-prone areas, particularly when a combustible siding product is installed, and other homes are nearby.

[1] Kirby, A., Dietz, J. E., Matson, E., Pekny, J., & Wojtalewicz, C. (2014). Building Resilience in a Major City Evacuation Plan Using Simulation Modeling. pp. 114-120, 2014.

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Table 8: 4.CGF.8 Technology Attributes
Technology Dimension Attributes
Use of Gels as a mitigation measure for residential areas. Gels are water absorbent polymers that can be applied to a building exterior to provide temporary protection from radiant heat or flames.

1.9 WUI Gap No 9 [4.CGF.9] The current procedures inhibit deployment of innovative tools

There is **mismatch between established procedures and capabilities enabled by innovative solutions**. It is important thus, to underline that the *current procedures inhibit deployment of innovative tools*.

There are concerns about an "innovation emergency" across practitioner's organisations from EU MS, the causes of which is related to limited or restricted adoption of technological solution by them. The reasons that SOTA technology tools are not embraced by practitioners are: (1) The practitioners institution strategy is not aligned with technology roadmaps; (2) Practitioners organisations are not part of industry efforts to advance products and develop solutions; (3) Current practitioners needs and gap capabilities is not performed in a systematic and standardised manner; (4) No technology training is offered to practitioners; (5) Technology deployment plans require a change management approach (which is unpleasant by nature to practitioners); and last but not least an effective governance structure to advance the technology adoption by practitioners is associated with political will for transformation.

The practitioners have agreed that there is a mismatch between established procedures and capabilities enabled by innovative solutions. There are a number of research projects for WUI fires, however the research results are not yet considered by practitioner's organisations. For WUI associated risks findings about the fuels at homeowner and vulnerable elements in houses are nowadays part of SOTA simulation tools dealing with WUI problem at microscale, however these tools are not used by practitioners.

Table 9: 4.CGF.9 Technology Attributes
Technology Dimension Attributes

Adoption of innovative tools by firefighting organization, to be implemented as pilot tests, will enable integration of their capabilities into different activities during fire management.

1.10 Flash Flood Gap No 1 [4.CGF.10] Need for improved (spatially and temporally) weather forecasts and more accurate tracking of flooded areas

One of the main challenges for flash flood events during the prevention phase of the disaster management cycle is to have an as accurate as possible estimation of the **area** where the flash flood event is expected to occur, as well as the **time** when it is expected. Accurate weather forecasting can support efficient flood early warning systems and a more accurate tracking of the flooded areas, which will foster effective preparedness for a flash flood event and in turn robust event crisis management and resilience.

In areas with intense relief, as are the typical Mediterranean areas, the accuracy of large scale (*i.e.,* regional*)* weather forecasting may be affected, and local meteorological conditions prevail and may trigger flash floods. Hence, local weather systems strong enough to trigger floods may be underestimated. In addition, thunderstorms that typically trigger floods cannot be assigned with high accuracy to a particular area and this can result either in false alarms in local EWSs (in the area falsely identified to be affected) or in an unexpected flash flood (in the actual affected area). To this end, it is important to ensure increased accuracy in weather forecasting in terms of **spatial resolution** in order to track more efficiently the location of a resulting flood.

At the same time, for efficient flash flood preparedness, it is also critical to ensure increased accuracy in weather forecasting in terms of **temporal resolution**. More specifically, increased time lag between rainfall forecast and flood occurrence needs to be provided. This is particularly important for small basins in typical Mediterranean areas, which, due to intense relief and often dense hydrographic networks, have reduced concentration time and therefore frequent, though intense flash floods.

Overall, technological tools that may support the accuracy of weather forecasting need to be developed, while the existing ones need to be improved. During the TCP4 Flash Flood workshop, discussion focused on how to best exploit EFAS services for flash flood forecasting, especially for Mediterranean areas that have the characteristics mentioned above. It was eventually agreed between the invited experts that it would be very helpful to retrieve input from the EFAS system if it is improved in such a way so as to account for more extreme floods (*e.g.,* considering greater return periods).

Apart from the local meteorological conditions, the accuracy in flash flood forecasting depends strongly on other local conditions, such as the geomorphological features of a particular area, local land use and land cover characteristics, as well as other local particularities.

Table 10: 4.CGF.10 Technology Attributes
Technology Dimension Attributes
Inadequate knowledge of local conditions for local weather forecast. Need for improved spatial resolution of weather forecast at local level
Lack of optimal accuracy for weather forecasting Need for improved temporal resolution (increased time lag between rainfall forecast and flood occurrence) of weather forecast at local level. Improve the accuracy of rainfall forecast in terms of rainfall intensity, and rainfall volume.
Need to improve the EFAS system to account for more extreme floods (e.g. consider greater return periods).

1.11 Flash Flood Gap No 2 [4.CGF.11] Need for better dissemination of scientific/technical information related to flash flood event to the authorities.

The analysis of this gap revealed, the need to identify ways to better disseminate the outcomes weather forecasting and flood modelling to the authorities emerged. Considering the fact that that in both weather forecasting and flood modelling the probabilistic approach is typical, the dissemination of these outcomes, especially to those who are not familiar with this approach, needs to be performed in an appropriate way.

Moreover, stakeholders (practitioners, organisations from public and private sectors and local authorities) develop and implement prevention plans **individually** (if they deal with prevention measures). From this perspective, this TCP4 Capability Gap Finding (CGF) relates with the TCP4 2nd CGF (4.CGF.2: *Lack of a Standardized and Interdisciplinary Methodology for Developing Wildland Urban Interface Prevention Plans).*

Table 11: 4.CGF.11 Technology Attributes
Technology Dimension Attributes

Not identified

1.12 Flash Flood Gap No 3 [4.CGF.12] Need for full exploitation of aerial means and Earth Observation during the response phase of a flood event and their incorporation in real time situational awareness systems.

One of the characteristics of a flash flood is a very quick evolution, so a close follow up is needed to organise the rescue and the means repartition in the optimal places. Due to the nature of the event, during its occurrence, certain areas are inaccessible to ground rescue means and therefore aerial rescue means need to be fully exploited. In addition, aerial images, derived not only from drones, but also from satellites (Earth Observation) provide the practitioners and the other stakeholders with an adequate overview of the extent of the event, which would be impossible otherwise.

This TCP4 Capability Gap Finding (CGF) relates and complements the TCP4 9th CGF (4.CGF.9: *The current procedures inhibit deployment of innovative tools*).

During a flash flood event First Responders need to have access and be familiar with different sources of real time information, *i.e.,* information from both ground and aerial means. Ground information includes records from ground sensors and any other information (*e.g.* pictures, descriptions, reports) from the affected area that becomes available during the event. Aerial images can be provided from drones, helicopters, satellites *etc*. The identified gap has to do with the facilitation if the access to such information.

Table 12: 4.CGF.12 Technology Attributes

Technology Dimension Attributes
Need to facilitate the access to real time images and ground monitoring of the event

1.13 Flash Flood Gap No 4 [4.CGF.13] Need for an automatically real time situational awareness and decision support systems

Due to the quick evolution of a flash flood, as also discussed under 4.CGF.12, those who operate in the field (First Responders, volunteers and other representatives from the local authorities), as well as those who coordinate the crisis management, need to have real time situational awareness and provided the applied decision support systems with automatically updated information.

This TCP4 Capability Gap Finding (CGF) relates with 4.CGF.3: *Lack of Reliable and Real-Time Information on Crisis Communication*).

During the response phase of a flash flood event, it is very critical to properly merge event-related information from different sources on a real time basis. This information is updated throughout the event. Thus, a need for an efficient data fusion module that will collect and properly process information from several sources, also including information from Social Media, has been identified from the invited experts in the Flash Flood workshop. The real time merging of constantly updated information from these sources can significantly support response during a flash flood.

Focusing on information derived from the Social Media, special concern needs to be given to its efficient management, which constitutes another identified gap in this category. More specifically, efficient solutions need to be developed to properly filter information provided from the general public, both in terms of quantity (since it is expected to be increased) and quality (since it could sometimes be unreliable).

Table 13: 4.CGF.13 Technology Attributes

Technology Dimension Attributes
Need for an efficient data fusion module that will collect information from various sources and will process intelligence, including info from Social Media.
Need for efficient management of social media information and information from civilians.

1.14 Flash Flood Gap No 5 [4.CGF.14] Need for robust & resilient communications means in case of natural hazards

Another capability gap discussed during the Flash Flood workshop and then further analysed refers to the need for robust, as well as resilient communication means during the occurrence of a natural hazard (*i.e.,* flash flood in this case). An independent pan European such system needs to be developed, while the development of specific guidelines for the network will also be supportive. The different aspects of this gap that expand over all 4 identified categories in the THOR analysis, are presented in more detail in the following.

While operating during a flash flood event, First Responders and practitioners, as well as stakeholders engaged in the coordination of the responders and the allocation of the resources, need to use a robust, resilient, secure, critical broadband communication network. Such a network needs to be operable everywhere, including isolated and accessible with difficulty, if at all, areas, over which the event may have tremendous impacts. In addition, the applied network needs to allow its future evolution as technology advances, using preferably open standards interface (no vendor proprietary interfaces).

Table 14: 4.CGF.14 Technology Attributes
Technology Dimension Attributes
Need for robust, resilient, secure, critical broadband communication network, operable everywhere, allowing its future evolution as technology advances using open standards interface (no vendor proprietary interfaces).

1.15 Flash Flood Gap No 6 [4.CGF.15] Need for efficient and specific rescue means in case of flash flood

During the response phase of a flash flood event, a persisting gap seems to be the exploitation of appropriate rescue means. Efficient and specific means need to develop and widely applied for a robust response. Existing rescue systems (e.g., RescEU) may need to be expanded and also include other means, such as helicopters. Specific training for first responders and crisis management for flash flood and how to respond to small scale events needs to be foreseen as well.

From a technological perspective, efficiency in rescue means for flash floods is directly related with the development of advanced evacuation means, which remain operable and efficient under extreme weather conditions. This identified gap can be covered with solutions that expand from aerial to water and ground-based means.

Table 15: 4.CGF.15 Technology Attributes
Technology Dimension Attributes
Need for advanced evacuation means for flash flood (under extreme weather conditions).

1.16 Flash Flood Gap No 7 [4.CGF.16] Need for efficient and specific rescue plans in case of flash floods

During the prevention phase of the disaster management cycle for flash floods appropriate rescue plans need to be developed for every flash flood prone area and be in place so as to be exploited during the response phase. The rescue plans need to be generalized and at the same time detailed to a certain extent so as to be efficient. The preparation of guidelines and the

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development of a concrete methodology on how to create efficient rescue plans can also be particularly supportive.

Areas prone to floods are identified at Water District level in all EU countries, as foreseen in the EU Floods Directive 2007/60/EC. For these pre-identified areas and particularly for areas prone to flash floods (as derived from historical records and particular local features) rescue plans need to be developed. From a technological perspective, a gap that has been identified in this domain concerns the lack of simulation tools to update, validate and optimize such rescue plans.

Table 16: 4.CGF.2 Technology Attributes

Technology Dimension Attributes
Lack of simulation tools to update, validate and optimise rescue plans for flash flood risks.

1.17 Flash Flood Gap No 8 [4.CGF.17] Need for improving awareness of population toward natural hazards alerts

Apart from the need for an automated real time situational awareness, discussed under 4.CGF.13, and the need to disseminate scientific and technical flash flood information to the authorities, discussed under 4.CGF.11, it is also important to improve the general population awareness towards alerts for natural hazards. Attention needs to be paid on local population training on how to react responsibly when a natural hazard occurs. There is also a need for appropriate and reliable alerts on different means issued simultaneously. Flash flood alerts need to be region/local specific and include instructions on how to react. The filtering of information from the Social Media is also applicable in this CGF.

This TCP4 Capability Gap Finding (CGF) relates with the TCP4 1st CGF (4.CGF.1: *Inadequate Perception of Fire Risk and Lack of Risk Awareness in Wildland Urban Interface Areas)*.

Two types of solutions to improve population awareness towards natural hazard alerts were identified and discussed during the Flash Flood workshop. The first one concerns the need to develop efficient communication tools towards the general public in case of alerts for natural hazards. The application of reverse 112 emerges as a technological solution for this gap.

The second solution would cover the need for the transmission of reliable information via social media to the general public. Such information can reach this audience via authorised channels/sources. In this particular field, specific solutions need to be developed.

Table 17: 4.CGF.17 Technology Attributes

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Technology Dimension Attributes
Lack of efficient communication tools toward population in case of natural hazards, alert [reverse 112]
Need to send reliable information to population via social media via authorized channels/sources.

1.18 Flash Flood Gap No 9 [4.CGF.18] Need for solutions to efficiently archive past flood events (both for prevention and preparedness) in a standardized format and make them accessible to practitioners and relevant stakeholders.

In the aftermath of a flash flood, it is of vital importance to have a coherent picture of the event (conditions under which it took place, details on the event, impact assessment) and **keep track** on the correlation between rainfall and flooding (where, when and what happened), so as to properly process its characteristics and extract useful conclusions in order to support prevention and preparedness for another upcoming flash flood event. To this end, it is very critical to efficiently archive past events in a standardised format, so that they are ready for any appropriate analysis and become available to the practitioners, as well as other stakeholders involved. Hence, there is a need for a **dedicated entity** that would perform an automatic retrospective, which would provide **reliable post-event information** on the affected population and impacts on assets (industry, structures, CI, environment *etc.*).

In order to properly exploit lessons learnt from a past flash flood event, a solution that would keep track of the characteristics and the evolution of the event is needed. Such a solution could properly store and to a certain extent analyse all relevant recorded datasets (images, videos, technical characteristics of a flood, affected locations *etc*) so as to provide a complete overview of the progress of the event. Another particularly useful feature of such a solution, would be the correlation between rainfall and the associated flood impact.

[Note: technology is mature to fulfil this need]

Table 18: 4.CGF.18 Technology Attributes

Technology Dimension Attributes
Need for a solution to keep track of the data (images, flood data, locations…) during the event and assess the correlation between rainfall and flood impact.

1.19 Flash Flood Gap No 10 [4.CGF.19] Need for standardized information sharing among all stakeholders engaged in response to flash flood events.

Standardisation aspects that need to be considered in order to efficiently exploit lessons learnt from a past flash flood event, were also discussed during the Flash Flood workshop. It was agreed between the invited exerts that there is a need for standardised (in a structured, holistic and integrated manner) information sharing among all stakeholders who are engaged in prevention and preparedness (*i.e.,* civil protection authorities, hydrological specialists, multidisciplinary experts, urban engineers *etc*).

Table 19: 4.CGF.19 Technology Attributes

Technology Dimension Attributes
Nothing to report

1.20 Flash Flood Gap No 11 [4.CGF.20] Need for a solid approach to efficiently exploit lessons learnt from past floods

Another gap identified during the Flash Flood workshop is related with the overall lessons learnt process. More specifically, the need for the adoption of a solid approach to efficiently exploit lessons learnt form past floods was identified. Better knowledge of vulnerability/exposure of the territory (including definition and prioritization of flash flood prone areas), policy integrating risk prevention and actions to be taken and the identification of appropriate (case-specific) mixture of approaches for flood mitigation, can support the setting up of such a solid approach.

From a technological perspective, there is a need for combined approaches for flood mitigation that could be adopted in the aftermath of a past flash flood event so as to be better prepared against an upcoming event. For the selection of the approaches, the details of historic events need to be examined, so as to retrieve any useful experience from them and avoid their recurrence. To this end, proper (case-specific) combinations of structural and non-structural (mostly nature-based) solutions for flood mitigation need to be examined and eventually a justified optimum combination needs to be identified for application.

Table 20: 4.CGF.20 Technology Attributes

Technology Dimension Attributes
Need for combined approaches (identification of optimum combination between structural and non-structural solutions) for flood mitigation.

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