TEMA

TRUSTED EXTREMELY PRECISE MAPPING AND PREDICTION FOR EMERGENCY MANAGEMENT

Deliverable D2.1: Report on TEMA requirements

Funded by the European Union

TEMA
TRUSTED
EXTREMELY PRECISE
MAPPING AND PREDICTION
FOR EMERGENCY
MANAGEMENT

Project Information

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D2.1 – Report on TEMA requirements			
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Disclaimer

The TEMA consortium consists of the following partners:

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3	ENGINEERING - INGEGNERIA INFORMATICA SPA	ENG	IT
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Acronyms

CPA	Civil Protection Agencies
CFD	Decentralised Functional Center
EC	European Commission
EU	European Union
FR	First Responders
LEAs	Law Enforcement Agencies
NDM	Natural Disaster Management
ND	Natural Disaster

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PPDR	Public Protection Disaster Relief
UC	Use Case
UAV	Unmanned Aerial Vehicle
WP	Work Package

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Executive Summary

The aim of the project is to improve Natural Disaster Management (NDM, e.g., for wildfires, floods) by automating precise semantic 3D mapping and disaster evolution prediction to achieve NDM goals in near-real-time. It will analyse and fuse many heterogeneous extreme data sources: smart drone and in-situ sensors, remote sensing data, topographical data, meteorological data/predictions, and geosocial media data (text, image, and videos).

This deliverable will present the requirements of end users for Natural Disaster Management.

A methodological approach was followed for the development of end user requirements. It starts with identification of the gaps before, during or after an event of Natural Disaster. The gaps pointed from the literature review, the Grant Agreement, and the storytelling of the end users of the consortium. The stories were about a natural disaster event in the area where the pilots use cases will take place. In this framework, a detailed questionnaire was also drafted, asking first responders the technical solutions that they would like to have in their operations. Finally, the use cases of the pilots were identified, extracted from the above information.

This document presents the needs and requirements that have been identified through the aforementioned actions, in order to ensure that a common understanding is obtained on the operations. In this context, end users of the consortium seek to achieve a consensus on the most important operations of Natural Disaster Management.

This deliverable will act as the axis which enables the link with the following project tasks, a sort of guidelines, which will be combined with the related functionalities, performance requirements and the respective indicators to measure them. All these findings will provide the initial and concrete input for the next WPs, guiding the technical partners on the design and development of each one of the components.

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1 Introduction

1.1 Purpose of the document

The purpose of this document is to present the end-user requirements, as emerging from the four pilots of the project. That needs to be addressed by the tools and services that will be provided by the TEMA platform. In order to ensure consistency and comprehensiveness, this activity involved the identification of gaps via literature analysis, storytelling from end users and analysis of a questionnaire dedicated to consortium end-user needs and CPAs. Furthermore, a close collaboration with end users was achieved, by organizing meetings and exchange experience with the first responders from different countries.

1.2 Relation to other project work

This deliverable will provide input in the many tasks of the project because it defines the user requirements and the technologies that will be used in TEMA. The findings of this deliverable must fulfil the needs of the end users and give input to the upcoming pilots. Specifically, the deliverable 2.1 provides input to the following other TEMA tasks:

Table 1: Relation to other Deliverables

Task. #	Deliverable title	How the two deliverables are related
T2.2	HW/SW Specifications and Design	Taking into account inputs coming from T2.1., T2.2 will elicit the technical requirements
T2.3	Regulations, Ethics, and Technology Review/Monitoring	The collected data would be compliant with european and international regulations
T4.1	Precise phenomenon prediction	This task will develop precise and fast modelling engines for evolving phenomena relevant to the TEMA use cases.
T6.3	TEMA trials specifications	The trial use cases that were defined in this deliverable will give input to trial specifications

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1.3 Definitions

For the purpose of this document, the following definitions are presented to establish a clear and shared understanding. The two concepts presented earlier are defined first: gaps analysis and user requirements.

Gaps: According to the Trial Guidance Methodology [1], a capability gap is the difference between a current capability and the capability necessary for an adequate performance of different tasks. Accordingly, the first step in planning a trial is to identify crisis management gaps practitioners are experiencing in their daily operations.

This needs to be done in close relation to the practitioners who experience one or more gaps. Every gap depends on a role, its responsibilities, and the surroundings. This is not only the case in terms of location but even more in terms of culture, systems, procedures, etc. So even if two different practitioners had the same gap, for example – a lack of situational awareness – they would experience it very differently depending on their context.

Gaps can be of different natures: technical (e.g., the ability to link different systems, to integrate data from different sources, to gain a common operational picture, etc.) or non-technical, i.e., organizational, political, legal (e.g., integrating different organizational processes, or overcoming legal incompatibilities) or a combination of several dimensions.

User requirements: The user requirements express how a facility, equipment or process should perform in terms of the platform, required production, and conditions in which tool should be made. User requirements provide information that serves as the basis for further specification, design, and verification of a system [2].

Requirements should have certain characteristics in order to be effective. Writing the requirements well is as important as determining the right ones. Requirements should be:

Solution independent. This means that requirements should not specify a solution to the problem; they should specify what needs to be done but not how to do it.

Complete. Requirements must cover all areas of the platform, including all phases of the product life cycle.

Clear. Requirements should be clear with no further questions required.

Concise. Unnecessary requirements should be omitted, and the wording of requirements should be concise.

Traceable. It should be possible to trace a requirement back to the rationale from which it was derived and forward to its implementation in the design [3].

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1.4 Methodology

This section describes the methodology used for the development of project TEMA user requirements.

The methodology is described in *Figure 1*. In this diagram, the techniques that were used for the development of user requirements are represented.

Each step has its own use and purpose and complements the needed elicitation process in its own characteristic way, while their combination ensures the effective collection process. The approach on defining the user requirements and their added value for the implementation of TEMA is presented in the below figure.

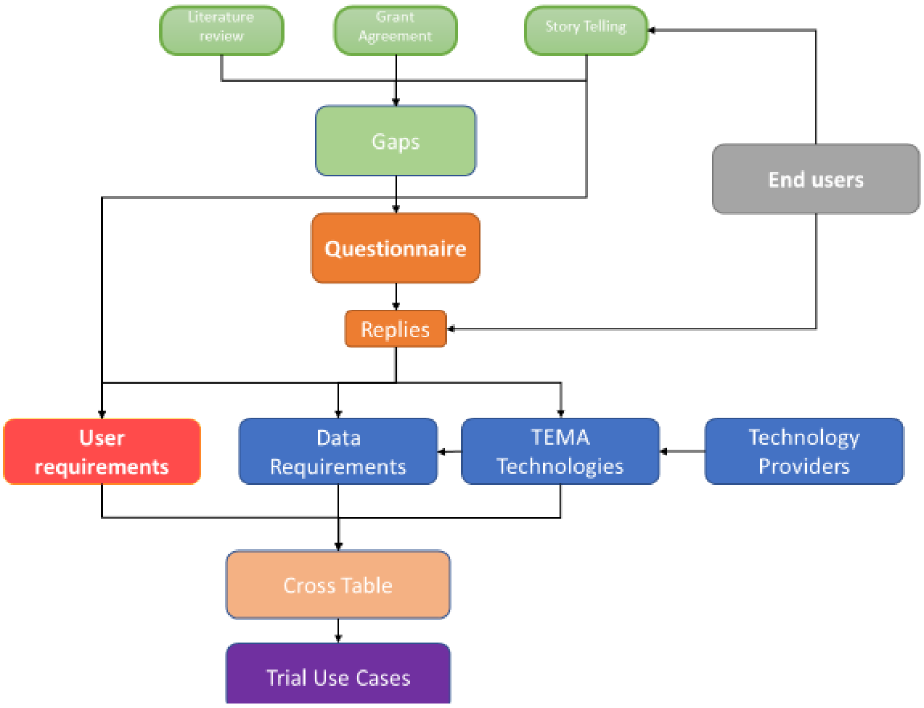

Figure 1: Methodology of User Requirements

Under the scope of the TEMA project, the specific steps were used for gathering and analyzing data related to the definition of the user requirements, namely:

- *Gaps Analysis:* Identification of gaps were defined through:

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  - *Literature review*: Having defined the scope of the literature review, the deliverable focused on searching and collecting relevant literature. The literature analysis was the base of identifying the end user requirements.
  - *Grant Agreement*: Analysis of the gaps on natural disaster management according to the Grant Agreement of TEMA
  - *Story telling*: The four end users' partners narrated a natural disaster event and how their organization reacted.
- **Questionnaire**: The questionnaire was created and distributed to TEMA partners for their review, and then, the final text was shared with project's End-users who circulated it within their organization as well as to relevant stakeholders outside the consortium (ANNEX I), in order to extract the user requirements for TEMA solution.
- **Collaboration with end users**: Close collaboration with TEMA End-users through physical and online meetings in order to collect their know-how and experience among different countries and organizations.

As a result, the user requirements were extracted from the above data collection.

Therefore, the data requirements and TEMA technologies with the technical providers contribution, are conducive to a cross table that presents the requirements in accordance with the technologies.

Based on the above information a short description for each one of the four trial use cases referred to in the DoA was generated and is presented in section 5.

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2. Gap Analysis

2.1. Literature review

Having defined the scope of the literature review, the deliverable focused on searching and collecting relevant literature. The literature analysis was the base of identifying the end user requirements.

The gaps that identified from literature review were:

- Lack of communication among the first responders and command control

The lack of communication among the first responders and the command control has been identified and mentioned in various research papers because effective communication leads to a common operating picture when there is a fire, flood, or any natural disaster. Effective communication also leads to collective action and reduces the overall risk of potential disaster [4].

- The ability to collect and share crucial information.

With the advent of technology and IT systems, traditional NDM fields can improve by integrating the latest technological means and innovations with the focus in collecting and sharing crucial information before, during-after a natural disaster phenomenon. Digital transformation can assist first responders and command control in optimizing critical information, especially the phases of Prepare – respond – recovery in a natural disaster [5].

- Non-existent coordination management centers for natural disasters

In disaster management, it is very important for different agencies and organizations to sync and coordinate in order to successfully manage a natural disaster, thus many challenges need to be taken into consideration (communication, environmental, political, information, etc.). Differences in the culture and inherent mechanisms inside these different organizations make it difficult to create a unified coordination management center for natural disasters. Maybe the organizations or agencies can act on their own, individually to face a natural disaster, but the only way to succeed is the collaborative manner and multi-agency collaboration through coordination management centers for natural disasters [6].

- The absence of comprehensive maps or data sources is an issue (e.g topographic maps, geologic maps, hydrological data, etc.)

Mapping is crucial in the risk assessment of natural hazards like floods or fires therefore comprehensive maps and data sources play a pivotal role. Geospatial data accuracy is very important for flood modelling. As has been noted, sometimes the elevation of the ground in areas

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of dense vegetation brings absence of detailed information thus necessary data to evaluate the situation when a flood occurs. This can be overcome with the assistance of UAVs, satellite imagery, and other open-source data [7].

- Lack of an enhanced sharing information tool

Literature research also poses the challenge and the lack of enhanced information sharing tools in the management of natural hazards and disasters. Current information sharing systems need to be evaluated for their quality and if they can be understood by the end users as there are interdependencies that may deter stakeholders from using information sharing optimally. Another important aspect of information sharing tools is if the information is static (location maps) or dynamic, formal (command structure) or informal (cell phones) [8].

Taken as a whole, the identification of gaps when facing natural disasters like fire, flood, and relative to the purpose of TEMA, should take into consideration the gaps from the literature as well as the gaps stemming from the GA and the storytelling. Koen Rademaekers et al. make a distinction between qualitative and quantitative gaps in a natural disaster. A qualitative gap is for example the political profile of a disaster, or the availability and the time to deploy resources for the disaster.

As we previously mentioned, there is also a need for improved management and coherent coordination in order to provide an overview of the situation and act fast.

Quantitative gaps for floods can be summarized to the lack of sufficient quantities regarding shelter capacity, hospital modules, mobile units of equipment, lack of capacity for rescue and research, etc. Gaps for fires are the lack of organization and preparedness of terrestrial resources that engage with firefighting, limited aerial fire-fighting capacity, therefore a gap in the quantities of aerial and terrestrial resources deployed for fire-fighting on the ground [9].

2.2 Grant Agreement

Following user requirement methodology, identified the following gaps according to the Grant Agreement:

- Information about the accessibility to settlements (roads, bridges, etc.) in an affected area which is crucial for the mission planning and FR (first respondents) reaction.

Central Europe has many big rivers and, for climatic reasons, can experience heavy persistent rains. For example, Bavaria (pilot site) and Germany have many rivers of varying size with an added-up length of about 100.000 km (e.g., Danube, Rhine, Main and Elbe). Severe rain can cause regional floods, the rivers to swell, break dams, flood the area and damage critical infrastructure.

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The first respondents often lack sufficient information regarding the scale of the flooding event, the size of the affected area and the number of the affected people. Information about the accessibility to settlements in an affected area is crucial for the mission planning and FR reaction.

- Low visibility and health hazards due to smoke. Scarcity of accurate information regarding the wider area, leading to suboptimal response strategies:

In the case of wildfires in Sardinia, aircraft intervention is coordinated by and from the Integrated Regional Operations Room (S.O.R.I.), while the Decentralized Functional Center (CFD) is tasked with forecasting wildfire hazard.

Typical problems encountered by CPAs and FRs are low visibility and health hazards due to smoke, as well as a scarcity of accurate information regarding the wider area, leading to suboptimal response strategies.

- Accurate information is crucial in planning, prioritizing and managing response actions:

Forest fires in Kalajoki and Muhos near Kajaani, Finland, and the more common occurrence of extreme weather conditions in the Nordic countries, caused concern among Finnish emergency professionals. The regional emergency services in Kainuu cover an area of 22,687.38 km2 with a population of only 75,415 inhabitants.

Currently, the information available is limited to weather updates and weekly meetings with the Finnish Meteorological Institute. With Kainuu being large, sparsely populated and up to 95% covered by forests, wildfire response times are a severe issue. The FRs lack contextual information, beyond a potential threat warning. Accurate information is crucial in planning, prioritising and managing response actions.

- Access to trustworthy information is crucial for FRs/PPDR organizations:

During the flood in Western Germany, the presentation of the situation was impaired for days. Increased quality, precision, and completeness of the situational picture, in sub-urban/densely populated areas. Global transferability of remote sensing services and products to other geographic regions and disaster types.

2.3 Storytelling

In order to identify the user requirements a template for Story telling (ANNEX II) was distributed among the pilots. The four end user partners KAINUUN HYVINVOINTIALUE (KAHY), DIMOS MANTOUDIOU - LIMNIS - AGIAS ANNAS (D. MALIAN), REGIONE AUTONOMA DELLA

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SARDEGNA*RAS (RAS) and BAYERISCHES ROTES KREUZ (BRK) were asked to tell their story in an interview from a technical partner.

The interviews were as follows:

- DLR with BRK
- AUTH and KEMEA with D. MALIAN
- KAMK with KAHY
- UNIME & ENG with RAS

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2.3.1 BRK

Table 2: Storytelling from BRK

Introduce the disaster	
• Natural Disaster type • Date • Area • Role in NDM: e.g. First responder	Flooding and Flash flood 15th July 2021 Western Germany: Rheinland-Pfalz and Nordrhein-Westfalen (most affected in Germany) Leader of the Medical Task Force 47 Coordinator of the mappings (Copernicus, DLR, BBK)
How were you informed about it? When were you informed about the ND? (Date, Time) How much time did it take to respond?	Information came from different sources (personal checklist): social media (Facebook, Twitter, Instagram), TV and Radio (breaking news), alarm information by email from Civil Protection Department of the BRK, official weather forecast like DWD- Deutscher Wetterdienst (German Weather Service) www.dwd.de, European Meteo Alarm The first warning was issued on the 13/07/2021 by the DWD, 2 days before the flood, but the rescue mission alarm came on 17/07/2021 at 7:00 AM Preparations for the rescue mission started right away: there was a briefing for the rescue teams at app 12:00, and at 18:00 they were on site
Description	
What did the disaster look like? How long did it last?	As a result of the heavy and long-lasting rain in July 2021, there were floods in Rheinland-Pfalz and Nordrhein-Westfalen, Bayern and Sachsen (Germany), and in some cases enormous backwaters on small and medium-sized rivers. Up to 200 litres of rain per square metre fell in some areas. Due to the special geographic location and the nature of the soil, the absorption capacity in some regions was quickly exceeded. Despite the measures taken to avert danger, there was considerable damage. The number of dead has risen to a total of 183 (134 in Rheinland-Pfalz and 48 in Nordrhein-Westfalen, as of the end of August 2021); rescue workers are also among the dead. Over 800 people were injured, some seriously. Three people are still missing in Rheinland-Pfalz. Before and during the flood events (between July 10th and 20th), 256 event-related warning messages were issued in four countries via the modular warning system (MoWaS), which the Federal Office for Civil Protection and Disaster Assistance (BBK) the States and municipalities makes available. In 10 Local authorities were identified as having a catastrophe; in Rheinland-Pfalz and Nordrhein-Westfalen alone, seven local authorities were affected by this measure. The floods officially started on 15/07/2021, and in official document is stated the end of catastrophe was declared 28/08/2021, but the recuperation from the catastrophe is in some areas still ongoing

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How was it measured?	The disaster was measured in human deaths, material damage (in €), number of private houses damaged or destroyed, number of persons affected, number of local authorities affected, damage on the infrastructure like bridges, or roads, as well as the rescue facilities
Impact	
Who does this disaster affect and how? Infrastructures, How many people injured, disruption of services etc.) What was the damage of the disaster? Describe the impact of the ND	In Nordrhein-Westfalen, around 20,000 private households are affected, as well as around 7,000 companies and self-employed people affected. The state of North Rhine-Westphalia has 427 local authorities: 396 Cities and municipalities and 31 districts. From the flood in July 2021, over 180 Municipalities were affected - almost half of all municipal one's local authorities. Destroyed public infrastructure (electrical supply, drinking water, wastewater, gas, telecommunications (incl. digital radio), traffic routes); 62 of 112 bridges destroyed, 13 partially destroyed. In Rheinland-Pfalz, 65,000 people and around 3,000 companies were affected by the flood disaster. The Ahr Valley is most affected with around 42,000 people, of which about 17,000 people have lost all their belongings or face significant damage. In Ahrtal 90% of all houses were damaged by the flood 103 bridges were severely damaged in the Ahr Valley alone or completely destroyed. In Rheinland-Pfalz the homes of 14,000 people were affected and over 40,000 people urgently needed basic help. 183 people lost their lives (134 in Rheinland-Pfalz and 48 in Nordrhein-Westfalen), over 800 persons in Germany were seriously injured, many more of those affected are traumatised by the events connected to the disaster. The complete restoration of public infrastructure and private houses will take years. The flood disaster destroyed large areas of power lines and distribution stations and around 64,400 households were cut off from the power supply - sometimes for weeks. The power supply has been restored, at least provisionally since mid-August 2021. Inpatient healthcare in Eschweiler, Erftstadt and Leverkusen was hit massively. There, 3 hospitals had to be evacuated. The St. Antonius Hospital Eschweiler, the most severely affected hospital, had no electricity, gas or drinking water supply. Since October 2021, the hospital has been back in operation with around 75 percent of its bed capacity. The remaining beds cannot be occupied due to the destroyed areas. Due to the failure of the voltage systems, double protection of the power supply was no longer guaranteed in the Leverkusen Clinic. In addition, two of 38 three compressors for the compressed air and oxygen supply failed. The clinic is now running again with all departments, but with limited capacity. Another 65 out of a total of 341 hospitals throughout North Rhine-Westphalia were slightly affected by storm damage. Around 130 medical practices, 85 dental practices and 50 pharmacies were no longer or only partially able to work. The reconstruction continues.

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	In Rheinland-Pfalz, around 3,000 companies are affected in addition to the 65,000 people mentioned above. The Ahr valley is most affected. Of 75 bridges there, 62 are damaged or completely destroyed. From the 65 main commercial wineries on the Ahr only three are undamaged. The damage to private households alone amounts to around 10 billion euros. Commercial, forestry and agricultural sectors account for around 1.2 billion euros. The damage to the public infrastructure was around 6 billion euros. In Nordrhein-Westfalen, municipalities and districts from four out of five administrative districts are affected. The provisionally estimated total damage amounts to 13.7 billion euros (after deducting emergency aid and damage to federal infrastructure, 12.1 billion euros remain). Private households and companies account for around 4 billion euros. In addition, there are damages from the areas of 6 telecommunications, energy and disposal of around 2.3 billion euros and damage reports from the municipalities and state authorities in the amount of around 5 billion euros.
Means used	
Which technologies did you use to manage the disaster? Software (e.g., Platform, prediction tools, other) Hardware: Sensors (e.g., temperature, humidity, other), Antennas	In the acute phase: MS Office Application (PPT, OneNote), laptop, TETRA radio, mobile phone (WhatsApp), critical crisis communication technology was used only where the coverage existed or means like electricity, signal, antenna (availability of the critical infrastructure), Integrated Command Centre Schweinfurt as focal point for gathering the information. Upon phone call from BRK and self-assessment of the situation, DLR supported with rapid creation of maps based on satellite data and DLR aerial images. The Center for Satellite Based Crisis Information (ZKI) has derived information on flooding for regions in North Rhine-Westphalia from satellite data (Sentinel-1). The evaluation was carried out using AI-based automated processes. The images and so-called 'water masks', which illustrate the extent of the bodies of water, have been made available to the relief workers as printed maps. In addition, the ZKI provided situation maps showing particularly affected areas, which have been identified together with the rescue teams on site. For this purpose, DLR captured aerial image data with resolutions of 10 to 15 centimeters using a camera from the Remote Sensing Technology Institute. The flights were spontaneously organized in cooperation with partners. Some of the maps can be downloaded free of charge: https://activations.zki.dlr.de/en/activations/items/ACT152.html The ZKI relayed the situation information to the Federal Office of Civil Protection and Disaster Assistance (BBK), the German Red Cross (DRK) and the BRK. Furthermore, there was a continuous exchange with the Federal Agency for Cartography and Geodesy (BKG) and its satellite-supported crisis and information service.

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Human Resources Used
Number of people Their role The operative measures in the context of averting danger and eliminating damage were initiated by the management staffs set up in the federal states (at state or district level) and by the Federal Agency for Technical Relief (THW) and the joint reporting and situation center of the federal and state governments (GMLZ) at the Federal Office for Civil Protection and Disaster Relief (BBK). From the German side of the ND, it was the biggest rescue operation since the WW2, and it lasted for 4 weeks. At peak times, a total of up to 23,000 civil protection forces (including the fire brigade, aid organizations, THW) were deployed in North Rhine-Westphalia. Federal Office for Civil Protection and Disaster Relief (BBK) role: Provision of summary situation information including calling up the Federal Forces Situation Report (BKL), o the control and processing of transnational requests for help5 and the assignment of assistance quotas on behalf of the requesting party country, o the preparation and forwarding of international / bilateral offers of help from other states to the affected countries, o the activation of the EU Copernicus Service for Disaster and Emergency Response crisis management, o the control of graphical situation assessment of data analysis and - visualisation DaViS (simulation of the rupture of the Steinbachtalsperre) to the participating organizations), o the dispatch of several liaison officers from the GMLZ to the technical department Operations management Ahrweiler for advice and support in the requirement transnational help German Red Cross (DRK): 19 state organizations of the German Red Cross were included in providing help during the ND. In the first few weeks after the disaster in mid-July, up to 3,500 voluntary and full-time helpers from the DRK were on duty in Rhineland-Palatinate and North Rhine-Westphalia. Today there are still almost 50 helpers from the federal territory plus numerous forces from the district and state association who provide support in the Ahr Valley. 3,500 German Red Cross volunteers who swiftly provided both emergency relief and mid-term rehabilitation items, provided over 90,000 voluntary worker days. From August to September 2021 alone, the DRK distributed 932,933 meals and 2.8 million litres of drinking water. In the first four weeks after the disaster, the DRK at the Nürburgring coordinated up to 100 emergency psychosocial workers to support those affected and the emergency services. A pilot module was also used with extensive materials from the care reserve of the Federal Labor Care 5000, which is still being set up: In close coordination with the BBK and the BMI, eight 300kVa generators, 30 multi-purpose room cells, 1,000 tent beds, 10,000 blankets, 1,000 sleeping bags and two mobile tank systems, a decisive contribution can be made to providing assistance in the Ahr valley. Bavarian Red Cross (BRK): As part of the German Red Cross, the Bavarian Red Cross provided immediate aid and is still contributing to the reconstruction and infrastructural stabilization of the region through various projects. As part of the request for help and the requested help quotas, the Bavarian Red Cross was represented by 1,800 volunteers who worked a total of 130,000 hours, and more than 320 emergency vehicles were used. In addition to immediate aid and the implementation of a care and reconstruction program, the BRK supported, among other things, in ensuring food for helpers and residents on site. The construction of the "Food Center 10,000", which distributed 10,000 hot meals and 10,000 packed lunches to those affected every day, was also made possible with the help of the Bavarian Red Cross. In addition, the local rescue service was maintained by

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volunteers and several sewage treatment plants were put into operation in the affected region in cooperation with the DRK and BRK, which are still active today and guarantee health and environmental protection on site. In addition, the Bavarian Red Cross meets several requirements of the management and situation center of the German Red Cross and provides, among other things, 16 drivers (since July 24th) and five all-terrain vehicles of the mountain rescue service Bavaria (since July 25th).
Technical Relief (THW):
4100 emergency workers pro day in July, later 1000-3000 emergency workers daily, all 668 THW´s local organizations were involved.
Role: Rescue, evacuation of people and search for missing persons, o Pumping work, dam defense of the Steinbach dam, sandbag shoring, o acute electrical supply, emergency repairs, o fast drinking water supply, o clearing work, o supporting damaged structures, o Establishment of logistic structures for Emergency accommodation, transportation and Meals for emergency services and Population, © THW/ Mazzariello o Operation of the largest cross-organizational staging area (Nürburgring), o Combating oil damage by separating and disposing of spilled oil fuel oil, o Operational support & specialist advice.
Federal Criminal Police Office (BKA):
The BKA provided on-site support with its specialists for identifying the bodies found (Identification Commission - IDKO): A total of 70 emergency services were active over a period of 32 days. A total of 148 volunteers were deployed in the period from July 16 to 19, 2021. The BAO was in constant contact with the respective state authorities and offered and implemented appropriate support in the logistical area, among other things.
Federal Police (BPOL) deployed 7,658 emergency personnel for a total of 60 days between July 15 and September 12, 2021, to support the states of North Rhine-Westphalia and Rhineland-Palatinate.
Role: locating and rescuing people with helicopters and boats, the evacuation of endangered areas (e.g. old people's/nursing homes, Hospital), clearing roads and paths, pumping water from dams that are in danger of collapsing, the recovery and transport of corpses, the supply of the population with industrial and drinking water by means of drinking water transport systems, the creation of an emergency power supply, the airborne transport of emergency services and equipment to inaccessible areas, space protection to prevent looting.
Aid organizations present on the site:
Arbeiter-Samariter-Bund Germany (ASB)
Samaritans from all over Germany worked for almost 30,000 person days until the end August 2021. The main task was to procure construction dryers, power generators, submersible pumps, etc. After that, it was mainly volunteers with almost 5,000 man-days who were deployed to distribute relief supplies such as hygiene kits, food kits and tools. The operation of first-aid stations, registering those affected for the payment of immediate aid from donations, building and setting up 19 container accommodations for those affected who have become homeless, PSNV measures and many other directly effective aid measures were also organized. To this day, the ASB is active with large donation-financed projects such as trauma counselling centers or mobile midwives.
German Life Saving Society (DLRG)
From July 14th to August 6th, 2021, around 2,100 DLRG assistants with approx. 7,200-person deployment days will support the rescue of people, dyke defense, evacuation by boat and helicopter, supply and logistics tasks, exploration, situation center and coordination offices as well as press and media work.
Johanniter-Unfall-Hilfe e.V. (JUH)
More than 3,000 emergency services from Johanniter provided support in the rescue service (e.g., with all-terrain vehicles), medical care, air rescue, evacuation and care and catering for homeless people, catering for emergency

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services, measures for psychosocial emergency care, Management support, search for people for the rescue dog squadrons and drone operations to assess damage to buildings. Maltese Aid Service (MHD) By July 31, 2021, a total of 2,170 assistants and over 450 vehicles had been deployed in around 32 key areas. The MHD issued up to 12,000 portions of food and drinks per day. Immediate material aid (construction dryers, heaters, washing machines/dryers, bandages, household tools, etc.) was provided for around 1.5 million euros and other individual measures (provision of food, organization of winter meetings, childcare and much more) for more than 2 million euros. There is also immediate financial aid for around 6,000 households. To support all federal aid, the federal government set up a state secretary's committee on " Federal Flood Aid". Since July 21, 2021, under the leadership of the Federal Ministry of the Interior and the Federal Ministry of Finance and with the involvement of the "Federal Flood Aid" staffs set up in both houses, this has taken over the negotiation, control, and coordination for the creation of the basis for the provision of immediate and reconstruction aid as well as other support measures.	
Story	
What happened during the disaster? How did your team react to this disaster? Please describe your experience during the ND.	Already on Tuesday, July 13th, 2021, the German Weather Service warned of extremely heavy continuous rain with accumulated amounts of water of 80 to 180 litres per square metre in western Germany in the federal states of North Rhine-Westphalia and Rhineland-Palatinate. Quantities in excess of 200 litres could not be ruled out. It was not foreseeable at this point in time that the forecast amounts would be significantly exceeded as early as the following evening. There were also major floods in other parts of Germany. The Ahr valley was hardest hit, which due to the geographic valley structure of the Vulkaneifel did not offer the water any alternative areas and therefore caused immense damage. The high number of over 100 dead is particularly dramatic. Scientists will later report that such extreme flash floods only occur every thousand years. Due to the countless deployment sites and a hitherto unknown extent, also with regard to the towns, regions and areas affected, the local forces were not sufficient to deal with the crisis. For this reason, the Bavarian State Ministry of the Interior, for Sport and Integration, ordered the use of the Lower Franconia Aid Contingent (MFT 47) as part of the supra-local aid in the federal state of Rhineland-Palatinate. On Saturday, July 17th, 2021 at 7:00 a.m., the state office of the Bavarian Red Cross in Munich alerted the standard aid contingent of Lower Franconia/Bavaria with the assignment to provide regional aid to Rhineland-Palatinate. The units should go as quickly as possible to the assembly room, the highway maintenance department in Hösbach, and prepare for a deployment time of at least 72 hours of self-sufficient deployment. The alarm was handled centrally by the integrated control center of the Bavarian Red Cross in Schweinfurt. As part of the deployment planning, various collection areas on the motorways with the appropriate capacity were explored and pre-planned, which proved to be very useful in this case. The Hösbach motorway maintenance depot is located directly on the A3 federal motorway and has the appropriate capacities such as sanitary facilities, sufficient parking space

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	and options for carrying out simple repair work. In the context of training events, starting up the collection room was practiced in the past, which has proven itself in this real application. This also means that the local BRK district association in Aschaffenburg can prepare for admission in the shortest possible time, inform Autobahn GmbH immediately and coordinate the details. Furthermore, the emergency services take care of the pilot service, security measures, registration of the vehicles and other important measures. The police are also alerted, which enables the marching blocks then formed to be safely driven back onto the motorway. The units alerted by the aid organisations involved from all over Lower Franconia were registered immediately upon arrival and divided into two marching packages. After a brief briefing, the first vehicles were able to leave at 1:00 p.m. in the direction of the assembly room at the Nürburgring in the Bad Neuenahr Ahrweiler district. The marching distance is 209 km. Due to the ad hoc alert, there was no time to set appropriate rest areas for a technical stop along the march route. During the march it turned out that none of the branches along the route that had been requested and explored by motorcyclists had enough capacity to accommodate the large number of vehicles. The contingent leadership therefore decided that the vehicles could leave the marching column under their own responsibility if necessary and then join them again and report back to the marching command. This worked in a very disciplined manner and without incident. At 6:00 p.m., i.e. 11 hours after the alarm was raised, the entire formation reached the Nürburgring assembly area. Countless BOS units from Germany and neighbouring countries, as well as strong Bundeswehr forces, including various helicopters, had already arrived here. Due to the logistical requirements of the racetrack, the collection room was very well suited to accommodate the units. Due to the vastness of the area and the countless units, it was difficult to find the right command post. The coincidence that you met well-known colleagues in other federal states, whom you knew from past missions and exercises, was helpful. These provided appropriate information and initial valid information on the situation. An initial briefing was given by a representative of the supervisory and service directorate. There was also the first situation briefing with colleagues from the Bavarian advance command. The Landesblindenschule in Neuwied was selected as the base of operation for MTF 47, which later turned out to be a very good decision. Neuwied is around 50 km away from the damaged area on the opposite side of the Rhine and could be reached quickly by car thanks to good and intact transport connections. The facility mentioned is a special educational facility, not only for children and young people but also for adults. This provided adult-friendly sanitary facilities, large classrooms and an auditorium that optimally met the requirements. The staff room was converted into a staff room and had sufficient infrastructure. The association was managed according to service regulation 100 with the six subject areas, which

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could be shown very well on the premises. Furthermore, there were sufficient parking spaces in the immediate vicinity, also for large vehicles. Since the town and surroundings of Neuwied were not affected by the natural disaster, all infrastructure facilities, such as petrol stations or supermarkets, could be used. Furthermore, it was very good for the emergency services to be able to return to an intact place to regenerate after the demanding work in the crisis area.

During the entire duration of the deployment and especially at the beginning, local managers were present at the staff meetings and were able to give very specific information on the situation and deal with any problems that arose directly with the possibilities on site without having to accept long reporting channels.

On the following day, Sunday, July 18, 2021, there were primarily two deployment sections. On the one hand, support in setting up the central PSNV office at the Nürburgring and, on the other hand, medical and support services in the Ahr Valley.

The local management structure was divided into three equal levels. This consisted of the supervisory and service directorate (ADD), the technical operation management and the health section.

This tactical structure was set up and operated by the state government, at the Nürburgring and at the Federal Academy for Civil Protection and Civil Defense (BABZ) in Ahrweiler.

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From the health section at the BABZ, the Bavarian forces were assigned a section consisting of the villages of Dernau, Mayschoß, Altenahr, Altenburg, Ahrbrück, Hönnig and Liers. The contingent leadership split the association into various rapid deployment groups. The units worked according to contract tactics, solved the tasks on site under their own responsibility and reported the situation to the health staff in charge. The access routes to the areas were explored on the same day so that work could begin immediately the following day. In view of the severely damaged infrastructure and the associated dangers such as unsecured damaged power or gas lines, destroyed roads and bridges and houses in danger of collapsing, an operation was only carried out from sunrise to sunset for safety reasons.

On Monday, July 19, 2021, a third phase was added. An ad hoc aid station in Bad Neuenahr Ahrweiler, as central as possible, had to be explored for five thousand portions a day, set up and operated immediately. A particular challenge was that at this point the drinking water supply and sewage disposal had collapsed. In contrast to the MTF, the standard assistance quota is permitted with two meals. Thanks to these available resources, the self-sufficient supply of their own forces in the state school for the blind could be implemented in addition to the supply of

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	the population. This base in the middle of Ahrweiler should continue to supply the affected population for a few weeks. In the meantime, another Bavarian contingent was alerted to be relieved and arrived in Neuwied on the evening of the same day. After a corresponding handover at the different levels of management, the operational assignment on site was completed at midnight and the relief unit took over the further assignment without gaps. On Tuesday, July 20th, 2021, after breakfast, the units moved to their home locations. This was no longer carried out in a marching formation, but in small marching packages with few vehicles, which meant significantly less travel time, since driving in a convoy was no longer necessary. All those involved reached their home locations in the evening unharmed and without major material or vehicle failures. Here the material was immediately checked and, if necessary, refilled, the vehicles and units were refueled and cleaned, and the personal protective equipment was processed again. This has proven to be very important, as after just a few days individual units moved back to the crisis area to supplement.
Problems	
What problems did you come across and how did you solve each one?	First warning about the floods came from the German Weather Service (DWD) on 13/07/2021, that is 2 days before the floods. The information placed was that it is expected up to 200 L/m2 of rain. **Problems:** the user needs to be able to interpret the information, the warning was unrealistic (200 L/m2 of rain). Normal is to expect up to 10L/m2 at that time of a year. The population affected by the ND was not aware that there is an ongoing warning by the DWD. For assistance to be provided, the units in the affected area need to ask for it/place an order. **Problem:** they asked very late for assistance and when they asked there was no detailed information about the needs and objectives (do they need 1 or 100 ambulances, is the field kitchen needed, etc.) It took 48 hours until first responders from outside of the disaster area came on site to support the affected PPDR´s in the disaster area. The flooding rescue service from the BRK with special equipment (boats, communication vehicles) and experts (like divers) were alarmed 24 hours after the floods started to support the on-site rescue operations. It was not clear what is the area of interest (epicentre) and how large the area is. There was no available information about the situation assessment from the local teams. When first responders came, not enough food, sanitation, nor specific information was provided. Some rescue services did not know who was in command and in charge on site and where that person was located. For some rescue services it took 1 day to find the person in charge to whom they can report.

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	The area affected by the ND was huge Problem: BRK needed to have the strategy which area is the most pressing for rescue mission or assistance (triage). This information needs to be assessed and provided by the local authorities, back office in charge of planning and command posts. But since they were also affected by the ND, they could not perform their task sufficiently. The next points elaborate on the specific problems: First, BRK unit needs to identify who is their counterpart in the local unit/command post (in Germany, this differs from state to state). The commander on site in command for triage was having difficulty in gaining situation awareness, in communicating, sending information to headquarters, and receiving information, because they did not have electricity, or were cut off from the internet/mobile network (loss of critical infrastructure). Everything went analog: printed, written by hand, telephoned. They were very grateful to get satellite-based maps in printed form, even in a first low-accuracy version yet as soon as possible, images and maps to compare before-and-after situation, as well as some on site photographs and maps of the current situation of the affected area. These maps came via WhatsApp to a person who was coming on site from Bavaria and has a close connection in DLR. Large area without any communication. No coverage Affected base stations. Collapsed radio antennas. How they communicated was to write a message on a piece of paper for a person with a motorcycle who went to search for a spot with a mobile phone signal. When they find the signal, they would call operations units for information of the situation. The administration in charge of handling the disaster could not communicate with the units on site, since there was not communication possible. In the areas most affected by the ND the emergency call 112 was not available for 3 days Since the area affected by the ND was huge, local critical infrastructure was also lost, and most of the local PPDRs were affected. Problems encountered and reported by Fire and civil protection inspector in the district of Ahrweiler: Numerous towns trapped by the tide (island-like locations) • Access via forest paths not possible (washouts, landslides) • No picture of the situation • Locations affected up to 90% • Numerous building collapses or were affected, persons missing, injured, dead • Only air rescue possible (in some cases) • (in other cases) no air rescue possible (heavy rain, thunderstorm cells, poor visibility, beginning of twilight) • No communication possible

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	• Failure/destruction of infrastructure (roads/bridges inaccessible, no electricity, water, sewage)

Other Remarks/Lessons Learned
Questions that BRK-DLR team sees as important for defining GAP´s for TEMA, but cannot provide information at the moment are: What was the status of the international cooperation during the ND: were the operators able to reach everybody? How long did it take for Copernicus to provide the information? Some of the on-site lessons learned during the Floods in 2021: What the command on site needs most urgently is, listed by priority: A map even in printed form Evaluated map. What is the area of interest (epicenter) What infrastructure is available (example is there still a bridge and is it safe to use it) One of the most important things for the rescue units and their command is to get any kind of information as soon as possible, which in time needs to be more and more accurate so that the strategy can be planned. The technology used in cases of ND needs to be something that is used every day and simple. When the disaster strikes, and the situation is dangerous and full of adrenaline, a person who is in rescue hasn't got the time to learn about the new technology or to try what are the options that this (new) warning system provides. It needs to be clean and simple to use. Orientation in unfamiliar terrain is extremely difficult because of the massive destruction. "Mapping" of destroyed buildings is also very difficult. Drone images are only suitable to a limited extent for local/small site use only. High cost of post-processing Local radio stations played important role: can place fast information and warnings; are automatically turned on in local crises; can warn precisely – for individual districts or even for certain streets.

2.3.2 RAS

Table 3: Story telling from RAS (Forest Fires)

Introduce the disaster	
Natural Disaster type Date Area Role in NDM: e.g. First responder	Forest fire. 23/07/2021- 6:02 P.M.: Los Lavros (town of Bonarcado). First detection of a fire, the fire is initially extinguished. 24/07/21 - 12:02 A.M.: forest fire restarts. The fire regards the Montiferru area (12.550 ha burned over a total of 48.987 ha available). The municipalities affected were 11: Bonarcado, Cuglieri, Flussio, Magomadas, Sagama, Santu Lussurgiu, Scano di Montiferro, Sennariolo, Sindia, Suni, Tresnuraghes.

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	Civil Protection. Sardinian Civil Protection general direction (DGPC), Forest Service (CFVA), Forest agency (Forestas), Fire department (VVFF) participate in SOUP (permanent unified operative room, which has a coordination role in fire fighting related issues, it is located in the DGPC) joint meeting. Role: The Italian Civil Protection Service is the system that performs the civil protection function consisting of the set of skills and activities aimed at protecting life, physical integrity, property, settlements, animals and the environment from damages or the danger of damages resulting from disasters of natural origin or deriving from human activity Civil Protection targets: Forecasting Prevention Emergency management Emergency overcoming phase. Sardinia Civil Protection Regional Unit: In Directorate: AREA 1 – RISK FORECASTING Tasks: forecasting, support to the evaluation/decision system AREA 2 – EMERGENCY PLANNING AND COORDINATION Tasks: fieldwork, civil protection multi-risk plan Area 3 – VOLUNTEERING SUPPORT, LOGISTICS AND TELECOMMUNICATIONS Tasks: infrastructures, assistance, volunteering forces coordination Area 4 – EMERGENCY OVERCOMING PHASE Tasks: recognition of needs for the restoration of damaged public and private structures and infrastructures, to the recovery of normal living and working conditions Local Offices: (Cagliari- Sassari-Nuoro-oristano) Each office supports municipalities in civil protection local plans, manages the mobile column and coordinates the volunteers. The Decentralized Functional Centre - CFD The CFD is organized by risk areas in order to support the response of the civil protection system to all foreseeable risks. Currently, there are two operating areas, one on the field of geological and hydraulic risk and the other on forest fires, with the goal to provide a continuous service, every day of the year and, when necessary, 24 hours a day, in order to support the decisions of the competent authorities regarding alert and emergency

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	management and to assist the operational needs of civil protection system. The CFD operates 365 days a year, h9/day and, through a warning alert of orange/red level for hydrogeological or hydraulic risk, it operates 24 hours a day in order to guarantee all the monitoring and surveillance functions. SOUP (Unified and Permanent Operations Room): The SOUP is a unified and permanent operations room against wildfires. Its tasks are related to ensure: -the activity of regional forces against wildfires, in coordination with the national forces. -the support of helicopters and Canadair's when necessary In SOUP daily operate, at least: - 4 Forestry Corps (senior and junior) officers, coordinating helicopters for wildfires - 1 Firefighter (senior) officer, giving support for urban-rural interface wildfires - 1 Forests (senior) officer, giving support to Forests Agency staff (around 4000 people in the whole region) - 1 DGPC RAS (senior) officer, giving support for urban-rural interface wildfires officers with Prefectures, municipalities, and so on. Every day the CFD emits the Hazard of Fires bulletin. It predicts the fire hazard: the possibility that any fires can propagate more or less rapidly in a given area is evaluated on a daily basis, due to the specific weather conditions indicated by weather forecasts. The hazard of forest fire expresses the possibility of the occurrence of fire events together with the difficulty of extinction of the fires in each portion of territory. The hazard of fire is classified from green to red based on hazard. The bulletin is published at address: https://www.sardegnaambiente.it/index.php?xsl=2273&s=20&v=9&c=7093&nodesc=2&m=10&y=2022&noselg=1&gg=
How were you informed about it? When were you informed about the ND? (Date, Time) How much time did it take to respond?	Informed through SOUP (permanent unified operative room), located in the Sardinian Civil Protection department (DGPC). 23/07/2021- 5:51 P.M. 24/07/2021 - 12:02 A.M. (fire restart) The first helicopter took off at 5:59 P.M. (8 minutes).
Description	

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What did the disaster look like? How long did it last? How was it measured?	The mayors that were in that location reported that the fire seemed extremely frightening ("It was like hell") and its configuration is similar to a fire that had occurred 20 years ago. On that occasion, the fire spread over a vast area, and it moved up towards the sea. 22 days (23/07/21-14/08/21) Firstly, by using Copernicus data, afterwards by using on-site measurements. First from data from Copernicus, then with measurements in loco The survey of the damage was conducted by filling in forms with the aid of a specific App, called Survey 123, for field surveys which returns the information in tabular and geo-referenced format. Survey 123 is connected to the cloud platform (Arcgis online or Arcgis Enterprise) which allows the data collected in the field to be collected and displayed on the map.
Impact	
Who does this disaster affect and how? Infrastructures, how many people injured, disruption of services etc.) What was the damage of the disaster? Describe the impact of the ND	1400 evacuated. 40 livestock farms reported a total of 950 dead, wounded, missing livestock. 8 beekeeper cooperatives have undergone damage to their beehives. 52 buildings ha damage: 9 non-agricultural businesses with damage to 31 buildings linked to public interest or property. Damage to telecom fixed telephone lines. The burned area relative to sites of community interest were 1300 ha.
Means used	
Which technologies did you use to manage the disaster? Software (e.g., Platform, prediction tools, other) Hardware: Sensors (e.g., temperature, humidity, other), Antennas	Copernicus Communication (radio network) Fleet used in the field during fire: •6 helicopters from the regional fleet •1 military helicopter •11 Canadair (European Emergency- even 1 Canadair from France and 1 from Greece fleets) Radio network communication: during the event was used an analogic network, now substituted by a digital network with Tier II and Tier III technology.

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	SIPC (Sistema informative Integrato di Protezione Civile) web platform: SIPC consists of a single web-based platform which brings together in a single system and in a single architecture all the platforms and stand-alone information systems in use at the DG SIPC follows the latest integration indications provided by the DPC (of EU derivation) for the best homogenization and consolidation of the wide array of Information Systems used in all the DG. Systems to be integrated: Telephone system manager (Sirsam) Data archiving system manager (*File system, essentially*) Resource management System to manage in real time all the resources available at the various territorial levels: Municipality, Inter-municipal Centre, Province and Region, Volunteer organizations (*ZeroGIS*) Real time meteo data monitoring network AIB fleet viewer AIB fire positioning tool AIB forecasting functionalities. Hydro-geologic forecasting functionalities Modelling systems (Hydraulic, Hydrologic, Geomorphologic) Web-GIS Inner chat functionality Reporting and alerting system Warehouse management PC planning manager Other to be implemented. All functionalities will be replicated in a software environment (*Mobile App*) compatible with the most popular mobile systems (*Android, iOS*) Paradigm: Services Oriented Architecture to have maximum interoperability between the different application systems to be integrated and the optimal use of resources that are also heterogeneous and/or distributed across the different application domains Architecture: Entirely based on Open-Source technologies and components (GeoServer, PostGreSQL with PostGIS, Open Layer, etc.) with appropriate extensions • Map Server: GeoServer, using the most popular OGC standards (WMS, WFS, WCS, WPS), with specific extensions for transparent interaction with clients such as Google Earth and commercial software in general through approaches based on REST and GeoJSON protocols for distribution simplified vector data.

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	• Database: Cartography: Raster data are stored in an open-source database engine DBMS PostgreSQL, that has been chosen due to its characteristics of robustness, performance and scalability. Cartographic vectorial data are also stored in the PostgreSQL database, by means of the PostGIS spatial extension. Non-map data are stored in a non-SQL database (*MongoDB*) • Platform architecture integrates the OpenLayers JavaScript libraries for displaying cartographic information, generating, and navigating maps, and technologies such as Angular and Bootstrap. • The back end contains all the *business logic* application components that implement the platform functions. The development of some back-end components is based on the use of the open source framework Node.JS, which allows the use of the javascript language, typically used in the "client-side", also for writing "server-side" applications. Other backend modules are developed in Java and will reside under the Apache Tomcat application server. • glueing substrate of each element of the architecture: a totally open source middleware platform that ensures scalability and integration between applications; this element constitutes the cornerstone of the service-oriented architecture (SOA).
Human Resources Used	
Number of people i Their role 417 people were employed for fire-fighting operations, 50 canadair pilots and 68 regional helicopter pilots.	
Story	
What happened during the disaster? How did your team react to this disaster? Please describe your experience during the ND.	The conversations of the first 24 hours are reported, they refer to the communications that occurred between the SOUP (which has a coordination role) and all other subjects that are involved in extinguishing and fighting the fire. Day 23/07/2021 5:59 P.M. - Helicopter take off from Fenosu. (the request was initiated by the Province operative centre (C.O.P.), because the teams on the ground were not sufficient to extinguish the fire). 6:02 P.M.- the mayor of Santulussurgiu is notified about the fire.

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	6:09 P.M.- The mayor of Santulussurgiu is notified regarding the arrival of 2 vehicles of the regional helicopter fleet, furthermore he is notified that the area of interest is Bonarcado. 6:10P.M.- The mayor of Bonarcado is notified about the Loc. Sos Lavros fire. A helicopter is in transit from Bosa helicopter base, and another one from Fenosu helicopter base. The mayor has already been notified about the fire by the Seneghe forestry station, which is intervening by foot. 06:13 P.M. A helicopter takes off from Bosa. 6:35 P.M. A helicopter takes off from Anela helicopter base. 6:54 P.M. - The mayor of Santulussurgiu is present on site, he communicates that the flames are extremely high and that the fire is spreading towards the Montiferru area, and that a canadair will be necessary. The operator responds that a third helicopter is on its way. 6:59 P.M. - The mayor of Santulussurgiu confirms that the third helicopter has arrived; in addition, SOUP reports that the Super puma (a type of helicopter characterised by a large water tank) is on its way. The mayor asks for a canadair, but he is informed that this type of aircraft is not available, because they are all engaged in other fires. 7:10 P.M.- The helicopter Super puma takes off from Fenosu. 07:12 P.M.- The mayor of Santulussurgiu reports that a canadair is necessary and that the Super puma has not yet arrived. He is informed that a canadair has operative running times equal to 45 minutes and that it will arrive only if requested by DOS (extinguishing operative director). 07:42 P.M. - SOUP informs the Santulussurgiu mayor that 3 helicopters and 1 super puma are active, and that the canadair will not be sent, because there is no wind, therefore he believes that there is nothing to worry about. 8:25 - 8:54 P.M.- The fire is believed to be extinguished. All helicopters land at their respective bases: end of helicopter operations for the current day (fire fighting helicopters cannot fly during the night time). 9:09 P.M.- SOUP informs the sector manager (CFVA) that the fire has been reclaimed and that the CFVA will resume operations in the SOUP conference room at 7 A.M. 24/07/2021. Day 24/07/21 9:14 A.M. - The Bonarcado mayor is informed that a helicopter is arriving from Fenosu for the reclamation of the fire. The mayor reports that the situation is under control and that he will visit the site to make sure.

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	9:16 A.M helicopter takes off from Fenosu. 12:02 A.M. - The Santulussurgiu mayor informs the SOUP that the fire has restarted and he would like more information. The SOUP answers by telling him that there are teams on the ground and a CFVA helicopter for the reclamation. 12:07 A.M. - Super puma takes off from Fenosu. 12:13 A.M.- helicopter takes off from Bosa. Ore 12:23 A.M - The Bonarcado mayor is informed that a canader airplane is on its way. Ore 12:31A.M.- The "Sala Italia" (National Civil Protection emergency joint meeting conference room) telephones in order to have information about the Bonacardo fire, it is informed that 2 helicopters are intervening (one of which is a super puma) and that 2 canadair aircrafts are on their way. We also inform them that public safety is maintained, nevertheless the area is full of orchards that could burn. 12:44 A.M.- SOUP informs the Bonarcado mayor that 2 canadair are on their way. 12:50 A.M.- SOUP informs the Santulussurgiu mayor that two canadair are on their way from Rome. 1:09 P.M.- 2 canadair take off. 02:13 P.M.- Bonacardo mayor reports that other vehicles are necessary, the fire is spreading towards Cuglieri and 2 canadair are not enough. He also reports that there are south-easterly winds and that the fire will probably spread up to the sea. 2:27 P.M.- It is reported that the canadair is in distress, therefore one of the canadair present on the regional territory, that has been repaired, will join the other canadair. 2:35 P.M.- The Santulussurgiu mayor is extremely distressed, and he reports that the fire is not under control, the fire situation is extremely grave. 3:20 P.M.- A third canadair takes off. 03:43 P.M.- Bonarcado mayor reports that the fire has restarted in the low-lying area, where it was on the 23rd, at 3 km from the town of Bonarcado. 04.05 P.M.- Santulussurgiu mayor reports that the fire is moving towards the town and he is considering the evacuation of the population, he asks if we (SOUP) have photos from above in order to understand how to proceed, but there are no photos. 4:16 P.M.- SOUP communicates with the Santulussurgiu mayor in order to evaluate the possibility of evacuation. 4:20 P.M - SOUP informs Sala Italia that the fire has been declared an interface fire. There are now 4 canadair which are intervening.

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	At the present time the affected area is not the inhabited center, but a rural wooded area where businesses and companies are present. 4:20 P.M. - The SOUP room informs the DGPC Director that in the room the CFVA chief/marshall is present and he is evaluating whether to summon the regional operative board (C.O.R.). The DGPC director decides to summon the C.O.R. 4:21 P.M. - The SOUP room warns the Oristano prefecture of the grave situation due to the fire of Bonacardo-Santulussurgiu. They are starting to evacuate the town and are preparing the PCA (advanced command post) with VV.FF, CFVA and the municipality. Ore 04:22 P.M.- The regional environmental councillor (political figure) requests information on the current situation. He is told that there are 3 canadair, two of which are refueling, a fourth one is on its way, in addition there is the Super puma and other 2 regional helicopters. 4:230 P.M.- A fourth canadair takes off. 4:39 P.M. - The municipality of Santulussurgiu is evacuating roughly 40 houses. 5.46 P.M. - The SOUP room calls the regional environmental councillor and reports that there are 4 helicopters, 1 operative canadair, another is on its way, and other 3 are refueling. 5:52 P.M.- The director of DGPC reports that the vice chief of National Civil Protection they are reserving/sending 3 more canadair and they are also sending another one. 5:00 P.M. - The mayor of Bonarcado reports that the fire has moved in Funtana Maiore location which is rich of orchards and olive trees. SOUP answers that the vehicles (aircraft, helicopters) are focusing in Santulussurgiu due to the evacuation. 05:11 P.M. - Sala Italia requests updates regarding Bonarcado. It is said that the fire is not controllable anymore and that they are evacuating more or less 50 homes located in Santulussurgiu. Wind intensity is expected to increase and temperatures are very high. 5:12 P.M. - The mayor of Santulussurgiu requests if it is possible to perform targeted (water) drops on the houses. The request is denied because it is not technically possible. 5:15 P.M. - SOUP room informs the mayor of Santulussurgiu that a helicopter “drago” of the VV. FF (fire fighters) is on its way, this helicopter can perform water drops on the houses. 5:17 P.M.- The COP (province operative center) of Sassari points out that there are volunteers ready to intervene in Santulussurgiu. 5:39 P.M. The barracelli (rural municipal forces) of Illorai are requested to intervene in Santulussurgiu.

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	5:43 P.M. San Giovanni SOGIT (voluntary association) is requested to intervene in Santulussurgiu. 5:47 P.M. - Sala Italia is informed on the current situation of the fire. 6:10 P.M. 200 folding beds are requested for the regional civil protection mobile unit.
Problems	
What problems did you come across and how did you solve each one?	It would be useful to know which teams are involved, where and with what tasks. Furthermore, it would be useful to have footage in the SOUP room that could be acquired by the teams on the ground to understand the extent of the event and how it is developing. As reported at the start of section "Story", the initial fire that seemed to be extinguished, restarted the day after.
Other Remarks/Lessons Learned	
It is important, as much as possible, to achieve a local map with the variable wind and temperature described hour by hour (we have only information at regional level by meteo models.) Sharing information and data regarding fire (how it is developing, etc.) during events. During an event of fire have sufficient data and information to understand how and where the fire is evolving and detailed information regarding forces in the field to fight it It can be useful to use a model of fire propagation in SOUP room during a big fire. Tools- instruments technologies to reveal fires as they start (as soon as possible, to have quick information) - at present we have only human lookouts- we have not found yet technologies better than the human operators).	

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Table 4: Story telling from RAS (Flood)

Introduce the disaster	
Natural Disaster type Date Area Role in NDM: e.g. First responder	Flood 27-29 November 2020 – Municipality of Bitti Mainly the city center Civil Protection. Sardinian Civil Protection general directorate (DGPC), and Volunteer organisations. Role: The Italian Civil Protection Service performs the functions aimed at protecting life, physical integrity, properties, settlements, animals and the environment, protecting them from damages deriving from natural or man-made disasters Civil Protection targets: Forecasting Prevention Emergency management Emergency overcoming phase Sardinia Civil Protection regional Unit: AREA 1 – RISK FORECASTING Tasks: forecasting, support to the evaluation/decision system AREA 2 – EMERGENCY PLANNING AND COORDINATION Tasks: fieldwork, civil protection multi-risk planning Area 3 – VOLUNTEER SUPPORT, LOGISTICS AND TELECOMMUNICATIONS Tasks: infrastructures, assistance, volunteering forces coordination Area 4 – EMERGENCY OVERCOMING Tasks: recognition of needs for the restoration of damaged public and private structures and infrastructures, to the recovery of normal living and working conditions Local Offices (Cagliari- Sassari-Nuoro-Oristano): - support municipalities in civil protection local plans; - manage the mobile column - coordinate the volunteers The Decentralised Functional Centre - CFD The CFD is organised by risk areas in order to support the response of the civil protection system to all foreseeable risks. Currently, there are two operating areas: - hydrogeological and hydraulic risk - forest fire hazard

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	with the aim of providing a continuous service, every day of the year and, when necessary, 24 hours a day, in order to support the decisions of the competent authorities regarding alert and emergency management and to assist the operational needs of the civil protection system. The CFD operates 365 days a year, h9/day and, during the validity of warning of orange/red level for hydrogeological or hydraulic risk, it operates 24 hours a day in order to guarantee all the monitoring and surveillance functions. The CFD issues and publishes a daily Hydrogeological and Hydraulic risk bulletin considering weather forecast and territory vulnerability. The bulletin is published at web link: https://www.sardegnaambiente.it/index.php?xsl=2273&s=20&v=9&nodesc=1&c=7092 SORI (Regional Operating Room): The SORI is a unified and permanent multirisk coordination centre. Its tasks are related to: - supporting municipalities in case of calamities - coordinating the activity of regional forces against flood, and other calamities
How were you informed about it? When were you informed about the ND? (Date, Time) How much time did it take to respond?	● **Via SORI.** The event was forecasted by CFD that issued a red alert notice two days in advance for the disaster affected area. Based on this warning, the CFD pre-alerted the dam operators to follow the hydraulic event evolution and entered H24 mode, from 18:00 on 27 November to 18:00 on 30 November. ● 28/11/2020- 5:51 P.M. ● 28/11/2020 – about 8:00 A.M. Fibre cable and cellular antennas were damaged which caused a telecommunications (telephone and data) outage and subsequent isolation of Bitti, Lula and Onanì's 4428 inhabitants) . They were restored the following day through the use of the regional civil defence radio network.
Description	

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What did the disaster look like? How long did it last? How was it measured?	The event immediately appeared very serious and it was immediately known that 3 human lives had been lost. Mainly 2 days (28/11/2020 – 29/11/2020) Copernicus data and survey in the city center Firstly, by using Copernicus data, afterwards by using on site measurements. The survey of the damage was conducted by filling in forms with the aid of a specific App, called Survey 123, for field surveys which returns the information in tabular and geo-referenced format. Survey 123 is connected to the cloud platform (Arcgis online or Arcgis Enterprise) which allows the data collected in the field to be collected and displayed on the map. The surveys regarded the following categories: 101 expert reports on damage to public assets; 54 reports for damage to production activities, whose survey started as early as 11/29/2020 at 11.23 in the morning; 166 reliefs for damages to private individuals; 162 reliefs for damage to registered furniture. The census phase took place following the preparation of the forms by the General Directorate of Civil Protection, whose staff was involved in the transformation of the forms for the field apps (i.e. from xlsform, opened with excel, it is acquired by "Survey123 connect" and transformed so that it can be used by "Survey123"); later the same staff took care of illustrating and coordinating their use in the field to the 14 employees of the Territorial Services of the Civil Protection of the Sardinia Region who carried out the field surveys in the various areas affected by the emergency.
Impact	
Who does this disaster affect and how? Infrastructures, how many people injured, disruption of services etc.) What was the damage of the disaster? Describe the impact of the ND	Bitti population, with 3 dead and 73 evacuated Several main Roads were damaged. 120 buildings were damaged. Damages were registered in network facilities such as aqueducts and sewerage system. Damages to electricity transport system caused a black out to 2000 people until 17:10 of Sunday 29 November Systems of phone communication and data transmission were interrupted from 28 November until several hours of 29 November.
Means used	

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Which technologies did you use to manage the disaster? Software (e.g. Platform, prediction tools, other) Hardware: Sensors (e.g. temperature, humidity, other), Antennas	● Copernicus ● Zerogis – Sirsam (software Platform with a big database with phone address book– system for loading and consult local civil protection plan- system for alerting territory and municipalities with sms, mail, PEC) ● SARF - system for predicting landslides on the basis of precipitation forecast ● Meteo prediction Models ● Hydrogeological (inflows/outflows) and Hydrodynamic models - APR systems (some flights) - drones with camera sensor for recognition and checking of recovery work progress - Regional meteo monitoring network (In all sardinia there are about 124 rain gauges and e 59 hydrometers) ● Radar ● Communication (radio network) Nowadays the new SIPC (Sistema informativo Integrato di Protezione Civile) web platform would be used, instead of Zerogis and Sirsam: SIPC consists of a single web-based platform which brings together in a single system and in a single architecture all the platforms and stand-alone information systems in use at the DG. SIPC follows the latest integration indications provided by the DPC (of EU derivation) for the best homogenization and consolidation of the wide array of Information Systems used in all the DG. Systems to be integrated: ● Telephone system manager (Sirsam) ● Data archiving system manager (File system, essentially) ● Resource management System to manage in real time all the resources available at the various territorial levels: Municipality, Inter-municipal Centre, Province and Region, Volunteer organisations (ZeroGIS) ● Real time meteo data monitoring network ● AIB fleet viewer ● AIB fire positioning tool ● AIB forecasting functionalities ● Hydro-geologic forecasting functionalities ● Modeling systems (Hydraulic, Hydrologic, Geomorphologic) ● Web-GIS ● Inner chat functionality ● Reporting and alerting system ● Warehouse management ● PC planning manager ● Other to be implemented

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	All functionalities will be replicated in a software environment (Mobile App) compatible with the most popular mobile systems (Android, iOS) Paradigm: Services Oriented Architecture to have maximum interoperability between the different application systems to be integrated and the optimal use of resources that are also heterogeneous and/or distributed across the different application domains Architecture: Entirely based on Open-Source technologies and components (GeoServer, PostGreSQL with PostGIS, Open Layer, etc.) with appropriate extensions • Map Server: GeoServer, using the most popular OGC standards (WMS, WFS, WCS, WPS), with specific extensions for transparent interaction with clients such as Google Earth and commercial software in general through approaches based on REST and GeoJSON protocols for distribution simplified vector data. • Database: ● Cartography: Raster data are stored in an open-source database engine DBMS PostgreSQL, that has been chosen due to its characteristics of robustness, performance, and scalability. Cartographic vectorial data are also stored in the PostgreSQL database, by means of the PostGIS spatial extension. ● Non-map data are stored in a non-SQL database (MongoDB) • Platform architecture integrates the OpenLayers JavaScript libraries for displaying cartographic information, generating, and navigating maps, and technologies such as Angular and Bootstrap. • The back end contains all the business logic application components that implement the platform functions. The development of some back-end components is based on the use of the open-source framework Node.JS, which allows the use of the javascript language, typically used in the "client-side", also for writing "server-side" applications. Other backend modules are developed in Java and will reside under the Apache Tomcat application server. • gluing substrate of each element of the architecture: a totally open-source middleware platform that ensures scalability and integration between applications; this element constitutes the cornerstone of the service-oriented architecture (SOA).
Human Resources Used	
Number of people i Their role	

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The following Units took part in the field: -Police -guardia di finanza -carabinieri (70 units in 30 patrols) Army: 47 units with 14 light vehicles used for transporting personnel and equipment, 3 heavy vehicles for transporting aggregates, 3 earthmoving machines. Fire brigades 42 units with operational and coordination functions - 15 rescue and transport vehicles equipment, 12 trucks for the transport and handling of solid material. Italian red cross: 6 operators including 4 in charge of health care and coordination and 2 operators of military red cross with a light earthmoving vehicle and a truck under the coordination of the Army. ASSL Nuoro. 7 operators including doctors and nurses assisted by 3 healthcare operators made available by the Municipality of Bitti for a total of 10 units used for health screening using swabs as a measure of contrast and prevention of the spread of the Sars CoV-2 virus. Corpo Forestale e di Vigilanza Ambientale (Forestal corp) 21 operators and coordination officials were operating on site, with 8 pickups equipped with fire-fighting modules and 3 heavy vehicles. Forestas agency staff: 130 operators from the offices of Cagliari, Lanusei, Nuoro, Iglesias, Tempio and Sassari were operating on site. They were organized into 48 teams with 40 light vehicles used to transport personnel and equipment, 3 tankers for drinking water, 14 heavy vehicles for the transport of aggregates, 5 heavy vehicles and 6 light vehicles, bobcats and mini backhoe loaders, for moving earth, 3 dewatering pumps. Civil protection volunteer organizations: 139 operators were present, organized into 33 teams, with 21 pickups for transporting personnel and equipment, 1 tank truck for drinking water, 2 wheelbarrows, 4 mini backhoe loaders, 2 bobcats, 1 mini excavator, 10 light trucks, 1 mobile kitchen with two marquees. Activities: Support and assistance to the population, removal of debris and mud, suction of water from homes and basements, cleaning of surfaces and floors with fire-fighting modules, management of the field kitchen with the preparation of around 250 meals and breakfasts distributed to all the operators involved in the various operations.	
Story	
What happened during the disaster? How did your team react to this disaster? Please describe your experience during the ND.	Day 27/11/2020 The Mayor of the municipality of Bitti orders the activation of the Municipal Operations Center (COC) Day 28/11/2020 The Prefect of Nuoro limited to Saturday 28 November, due to severe bad weather, has assumed the unitary direction of all the emergency services at the provincial level. Due to interruptions to the telecommunications system on 28 and 29 November, the connection between the COC and SORI was ensured using the regional radio network.

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	The rescue teams described above arrived within a few hours at the site of the disaster and were used for various works for the return to normality (the main activities of the rescue teams lasted for about 10 days), including: · Sediment removal work, particularly regarding roads, and transfer to landfill · Waste was emptied from basement floors · Carried out drainage works · Executed network service facilities restore jobs To ensure the preparation of meals for the personnel involved in relief activities, voluntary organizations have set up field kitchens. The volunteers prepared and distributed about 700 sandwiches, 350 meals and hot drinks every day. In addition, 10 portable toilets were rented and made available for one week. The SOUP Room has received several reports regarding different types of problems: a) ELECTRIC BLACKOUT from 08:00:56 of 28/11/2020 to 06:39:31 of 29/11/2020. b) the prefecture was informed about FLOODS that occurred from 05:56:50 on 28/11/2020 on the provincial road SP 46, following a report from the CFVA. c) HELP AVAILABILITY from 10:01:18 of 11/30/2020 to 08:35:16 of 12/16/2020.
Problems	
What problems did you come across and how did you solve each one?	● geolocate people who need immediate help and are in danger of life (maybe a smartphone app could be useful) ● Systems for text messaging to citizens to direct them on the actions to take in order not to put themselves in danger or to save themselves ● Systems that warn of the closure of schools and public facilities in order to prevent people from taking car in dangerous roads in case of heavy rain events ● Know exactly the size of the affected area, especially on days like these in which damage and calamities have occurred in various other parts of Sardinia. ● Systems that support to correctly address: 1. Adequate equipment to operate in the local operational scenario 2. Adequate number of specialists able to support recovery operations

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	● Share the local civil protection plan ● Rescue teams must share data and radio communication channels ● Needs of systems that allow you to see from the coordination rooms what is happening in the field (even using local cameras) and to easily exchange data regarding needs on the field in real time ● needs of Drone flights for reconnaissance (even at night) and assistance to operations night and day ● Ability to operate in rescue activities at night or in heavy rains ● To be noted at the present time, satellite images are needed that are clearer in the interpretation of thunderstorm phenomena; clouds do not allow for the best delineation of the areas crossed by the phenomenon. ● Models are needed that clearly identify areas where the phenomenon did not occur and then be able to extract real-time information through shp ● Create real-time maps for data sharing for public authorities. For example, it was found in some emergencies that the same reconnaissance activity had been done by different authorities (PC/Fire Department).
Other Remarks/Lessons Learned	
Know the exact extensions of the affected areas and the permanence of problems (e.g., which roads are not passable due to debris) Effective information to the population on risks before and during expected heavy rain events. Continuity of communication channels – and sharing of the same between different relief forces operating in the field Effectively and continuously exchange information and data between coordination rooms and field teams. Possibility of carrying out reconnaissance activities in difficult weather conditions	

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2.3.3 D. MALLIAN

Table 5: Story telling from D. Mallian

Introduce the disaster	
Natural Disaster type Date Area Role in NDM: e.g. First responder	Flood, caused by a Mediterranean cyclone named "Zorbas". 29th of September 2018 Mantoudi area. Mantoudi is a small town with the river Kireas flowing through it. Head of the environment and civil protection department
How were you informed about it? When were you informed about the ND? (Date, Time) How much time did it take to respond?	Before the start of the event One day before the ND from the Directorate of Civil Protection, Forecasts and tv were informing about imminent high rainfall with a risk of flooding. They were expecting heavy rain and that they should be on standby but in no case such an extended and devastating phenomenon. After the start of the phenomenon No direct information from the Fire department service was received. The evolution of the phenomenon was rapid.
Description	
What did the disaster look like? How long did it last? How was it measured?	Mantoudi area was more affected. The volume of water was unmanageable. The flooding was 1-2 km wide. The flood caused 2 human losses, damage to houses, cars, and roads. Vehicles were swept away by the rushing waters and people were at risk. Next to the river was a bazaar and suddenly people found themselves floating in 1.5-2 metres of water. Damage was also caused in the road network between Mantoudi and Prokopi and the political leadership was trapped in Prokopi. There was a power failure, but the telephone networks were operating. Two days. 29th of September 2018 till 30th of September 2018.
Impact	

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Who does this disaster affect and how? Infrastructures, how many people injured, disruption of services etc.) What was the damage of the disaster? Describe the impact of the ND	3 missing people. Two of them lost their lives. A couple of 67 and 58 years old died while moving in the area with their car. The flooding water caused damage in houses, roads, cars, and people were at high risk. The flood extended between Prokopi and Mantoudi and between Spathari and Mantoudi, starting from the lower areas of the river, from the downstream.
Means used	
Which technologies did you use to manage the disaster? Software (e.g., Platform, prediction tools, other) Hardware: Sensors (e.g., temperature, humidity, other), Antennas	No technology was used. No technology is available.
Human Resources Used	
Number of people: Few people, those who were available. Their role: After the end of the flooding (on Monday afternoon) they started the recording of damages for compensation purposes, the restoration of roads and water supply networks. The Ministry's services started recording the damaged houses. During the disaster, the Local Coordination council chaired by the Mayor with representatives from the Forest Service, Coast Guard, Hellenic Police, Fire Brigade, and municipality's Technical service tried to handle the situation but when the disaster got worse exceeding the limits of the municipality, the Prefecture took the control where again representatives from the above services took part.	
Story	

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What happened during the disaster? How did your team react to this disaster? Please describe your experience during the ND.	There were calls to the Fire Department Service from citizens whose houses were next to flooded torrents. Very suddenly Kireas river flooded and the whole valley turned into a flowing river. In the Fire Department in Mantoudi, there was only one lady left in the Secretariat. The crews were all out in the field. People got onto the terrace to avoid being swept away by the river. The flood lasted from Saturday night (Sept. 29th) until 3-4 am Sunday morning (Sept. 30th) and then from 9am on Sunday morning the second wave of rain came with greater intensity. About 375mm of water fell and more or the same the other day. An investigation by the Fire Department Rescue service began in the early hours of Sunday. After the night the missing people were found and there was one more washed away car in Nileas river. There was no citizen notification system.
Problems	
What problems did you come across and how did you solve each one?	Mud had to be removed; there was half a meter of mud left after the end of the flooding. Municipality's capabilities were negligible in comparison with the volume of destruction. Prefecture provided people and mechanical equipment to restore the water supply network, rehabilitation of central and rural roads. The Ministry's services worked towards the recording of damages in order to provide compensations and financial assistance for damages in plant and animal properties.
Other Remarks/Lessons Learned	
- Weather data and data from sensors could be used to provide timelier (even half an hour earlier) and valid warning about the magnitude of the upcoming disaster - After the event it would be nice to use a mapping of the area before and after the flood to estimate the extent of the damage and provide an estimation of what is needed for the rehabilitation. E.g., there are muds, what machinery would be needed to use to clean up the area, etc.	

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2.3.4 KAHY

Table 6: Story telling from KAHY

Introduce the disaster	
Natural Disaster type Date Area Role in NDM: e.g. First responder	Forest fire 26.7.2021 Finland, Northern Ostrobothnia, Kalajoki First responder
How were you informed about it? When were you informed about the ND? (Date, Time) How much time did it take to respond?	Emergency call from civilians 26.7.2021 13:55.
Description	
What did the disaster look like? How long did it last? How was it measured?	At first the forest fire was a small fire which started from the wind turbine construction site. From the effect of dryness and a strong wind it spread quickly. It took around two weeks to put out the fire. The first responder unit was at the scene in 25 minutes. During this period workers from the construction site used eq. excavators to limit the fire spreading. The first units did not get the situation under control because of strong wind and the type of forest. In a few hours fire was too intense to the straight extinguish attack.
Impact	
Who does this disaster affect and how? Infrastructures, How many people injured, disruption of services etc.) What was the damage of the disaster? Describe the impact of the ND	Total area was 227 hectares. In Finland it is the second largest forest fire in history. For the environment effects stayed on the local level. When the forest is destroyed, its monetary value is lost. To the local rescue department, the financial effects were significant. Effects on civilians, animals, houses etc. were minimal.
Means used	

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Which technologies did you use to manage the disaster? Software (e.g., Platform, prediction tools, other) Hardware: Sensors (e.g., temperature, humidity, other), Antennas	PC, tablets, smartphones, VIRVE-devices, vehicle computers (rescue department's own, not factory installed) Weather information came from the Finnish Meteorological Institute to the command center. Nationally there is a portal where the FMI informs rescue authorities about incoming natural disasters and gives predictions. The portal is meant only for authorities and access is restricted. National leading system PEKE. (Communication between units, situational awareness, GPS)., VIRVE to voice communicate between units. (VIRVE is going to be updated in the near future. At this point only voice communication is possible. After the update, there are possibilities to send different kinds of data from the field. GSM network to communicate between units. Smartphone apps to use terrain maps and GPS. And partially communicate between units. (Commercial apps) UAS to gather situational awareness. Helicopters and planes were used to extinguish the fire and give information from the air (live feed, voice communication, video, still photo)
Human Resources Used	
Number of people Their role Total amount of human resources during the forest fire was 1500 persons. Their roles were mostly professional first responders but there were also volunteers in supporting tasks like housing, logistics etc..	
Story	
What happened during the disaster? How did your team react to this disaster? Please describe your experience during the ND.	At first the fire was an ordinary small fire, but then it spread quite quickly into a large uncontrollable fire. Teams reacted calmly and acted how they were teached.
Problems	

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What problems did you come across and how did you solve each one?	Situational awareness can always be better. Location of the first responders, how the fire acts, how the environment affects the fire, how fast the fire spreads, planning the use of resources, gathering resources to the scene.
Other Remarks/Lessons Learned	

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3 Questionnaire

3.1. Scope

This Questionnaire aims to collect and analyze the common needs in the deployment of the tools and services that will be provided by the TEMA platform.

The questionnaire shared by the end users of the consortium to the end users within their organization and to relevant stakeholders.

The questionnaire has 21 questions that have the scope to analyze the profile of the end user and the organization and the requirements of them in a natural disaster cycle (prevention preparedness response and recovery).

All the project outputs have an international outreach and are applicable to civil protection as well as other first responder agencies which will have the chance to access and integrate in their own mission cycle.

3.2 Questionnaire

The questionnaire was filled by 46 end users from Greece, Germany, Austria, Finland and Italy. The questionnaire was provided online through EU Survey platform in the following link:

https://ec.europa.eu/eusurvey/runner/5b2ca86e-2e7b-0495-ffc5-874256dc7e14

Table 7: End Users who filled in the questionnaire.

A/A	Organization:	Country
1	Rotes Kreuz Österreich, Landesverband Oberösterreich	Austria
2	Federal Agency for Technical Relief	Germany
3	No Answer	No Answer
4	Direzione Generale della Protezione Civile - Servizio territoriale di Cagliari	Italy
5	COMUNE DI CAGLIARI	Italy
6	DIREZIONE REGIONALE VIGILI DEL FUOCO PER LA SARDEGNA	Italy
7	BRK / Wasserwacht	Germany

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8	Austrian Red Cross, Regional Branch Styria	Austria
9	Regione Sardegna-Servizio territoriale di Oristano	Italy
10	Bavarian Red Cross	Germany
11	North Karelia rescue department	Finland
12	Comune di Sassari	Italy
13	Direzione Generale Protezione Civile - Servizio Territoriale di Nuoro	Italy
14	No Answer	Germany
15	Deutsches Rettungsrobotik-Zentrum e.V.	Germany
16	Agenzia Forestas	Italy
17	General Directorate of Civil Protection	Italy
18	General Directorate of Civil Protection	Italy
19	Corpo Forestale e di Vigilanza Ambientale (CFVA) Forestry and environmental surveillance corps	Italy
20	Emergency Services College	Finland
21	No Answer	No Answer
22	Fire department of Satakunta	Finland
23	Pohjois-Pohjanmaan pelastuslaitos	Finland
24	Pelastuslaitos	Finland
25	Pohjois-Pohjanmaa Rescue Department	Finland
26	Bavarian Red Cross	Germany
27	German Red Cross - Mountain Rescue	Germany
28	ASSOCIATION OF VOLUNTEER FOREST FIREFIGHTERS	Greece
29	Fire Brigade	Greece

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30	Fire Brigade	Greece
31	Fire Brigade	Greece
32	Disaster Competence Network Austria	Austria
33	No Answer	No Answer
34	No Answer	No Answer
35	Fire Brigade	Greece
36	Bavarian Red Cross	Germany
37	Bavarian Red Cross	Germany
38	Austrian Red Cross	Austria
39	No Answer	No Answer
40	Kainuu Rescue Department	Finland
41	ASSOCIATION OF VOLUNTEER FOREST FIREFIGHTERS	Greece
42	Fire Brigade	Greece
43	Hellenic Police	Greece
44	Fire Brigade	Greece
45	D.MALLIAN	Greece
46	D.MALLIAN	Greece

The answers of the questionnaire were not mandatory to respond, so six of the participants did not mention their organization or/and their countries. In this context, at Table 7 above the responses are depicted as “No answer”.

3.3 Analysis of Questionnaire

In this section it will be analyzed the responses of the questionnaire. In the next figure it is presented the countries that filled in the questionnaire.

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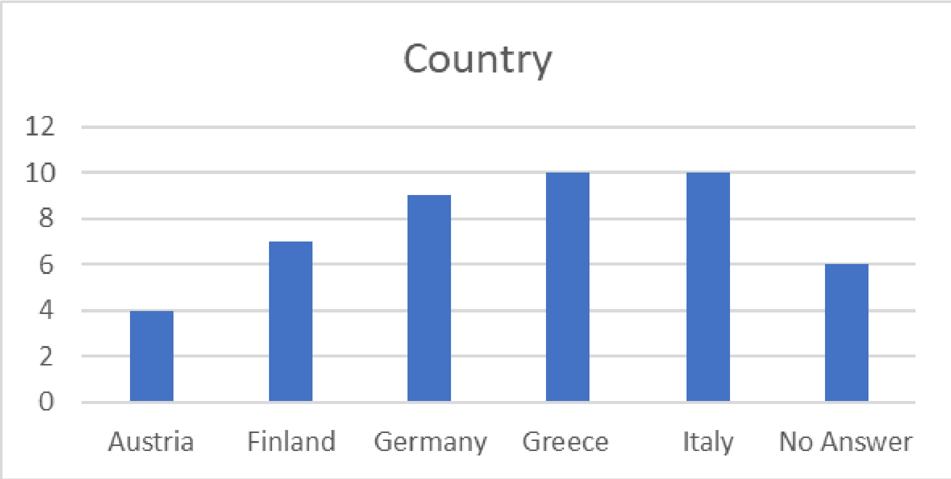

Figure 2: Countries that filled the questionnaire.

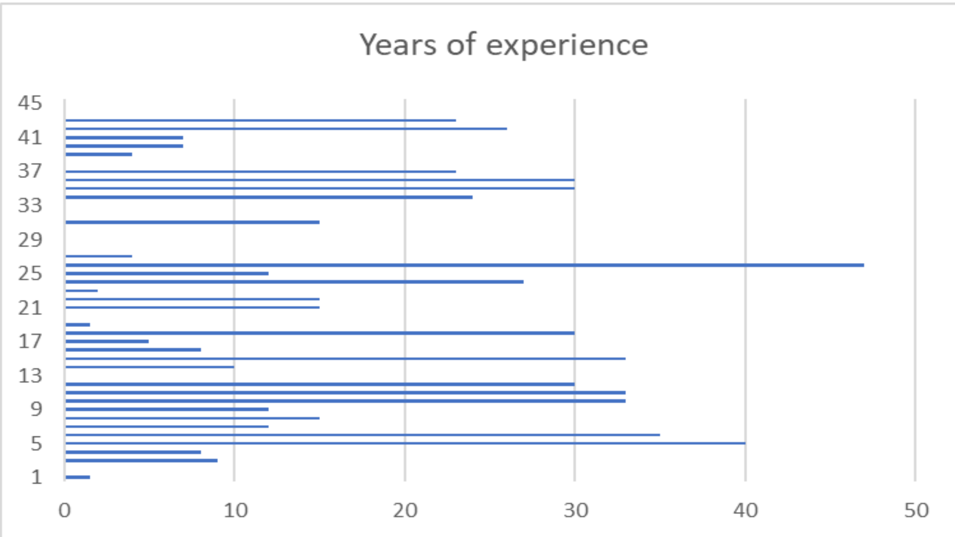

Figure 3: Years of experience

In the above diagram it is presented the years of the experience that the responders have in their organization. As we can see the responders have an average of 18.4 years of experience. This means that they are qualified and informed regarding their needs and requirements.

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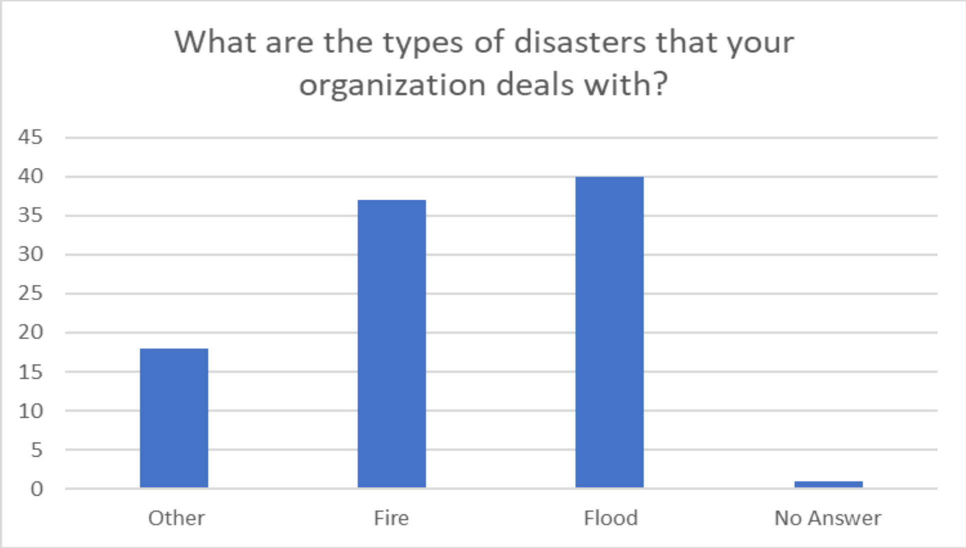

Figure 4: The type of disaster that each organisation deals with

In the above diagram is presented the types of the disaster that each organization deals with. As it is shown most of the responders deal with fires and floods that TEMA is focusing on.

Other:

- Hazmat
- snow and other
- other various kind of risk as Tsunami, marine risk etc
- all risks subject to civil protection activities: seismic, tsunami, industrial, health
- Many other EMS and civil protection scenarios
- Avalanches, land slopes
- all types relevant in DRM and DRR
- Pandemic, accidents
- any other
- Housefires, accidents including hazardous substances, traffic accidents, accidents in water...
- Human made disasters.
- Man Made
- EMS, SAR, AMP
- Storm, Heavy Show(fall), Earthquake, Tsunami, Cyclone, Flash Flood
- Pandemia, Immigrants
- refugees
- humanitarian crisis

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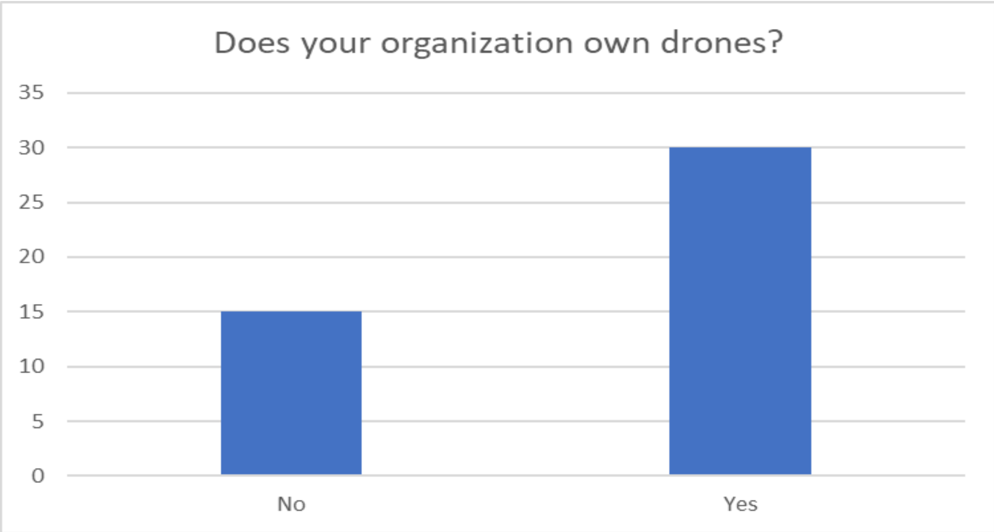

Figure 5: Diagram if the organisation owns drone or not.

In the above diagram it is presented if an organization owns a drone or not. Most of the responders replied that their organization owns drones.

If yes, which type/model?

- DJI
- DJI Matrice 300 RTK, DJI Mavic 2 Enterprise Dual, Scarabot, more
- DJI MAVIC 3 – DJI MATRICE 300
- diving drone Chasing M2 Pro
- DJI Matrice 30
- SPARK DJI
- DJI Mavic
- Dji Mavic 2 dual enterprise
- DJI NAVIC II PRO
    - Dji mavic3-E, mavic-3T. M30T, Matrice 300 +lidar
    - DJI Matrice, DJI Mavic
    - DJI spark, Matrice 300 with lidar sensor, DJI M 300, M30 T, DJI Mavic classic enterprise, Mavic 3Ewith thermal camera sensor
    - DJI spark, Matrice 300 with lidar sensor, DJI M 300, M30 T, DJI Mavic classic enterprise, Mavic 3Ewith thermal camera sensor
    - DJIMA2FMC, MAVIC DJI AIR FLY MORE COMBO, DJI MINI DUE COMBO FLY MORE, DJI MAVIC 2 ENTERPRISE DUAL

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- DJI MAVIC 2 Enterprise dual, Matrice 200, Phantom 4
- DJI mavic 2 enterprise dual and DJI matrice 210 v2
- DJi Mavic enterprise 2
- I can't say exactly
- DJI, different models
- Do not know the specifications - big, six-rotor model
- In the field our partners use different typ of drones (mountain rescue / fire brigade)
- several types and models
- Commercial drones
- Commercial drones like DJI
- multicopters and hybrid (Vertical Takeoff Landing)

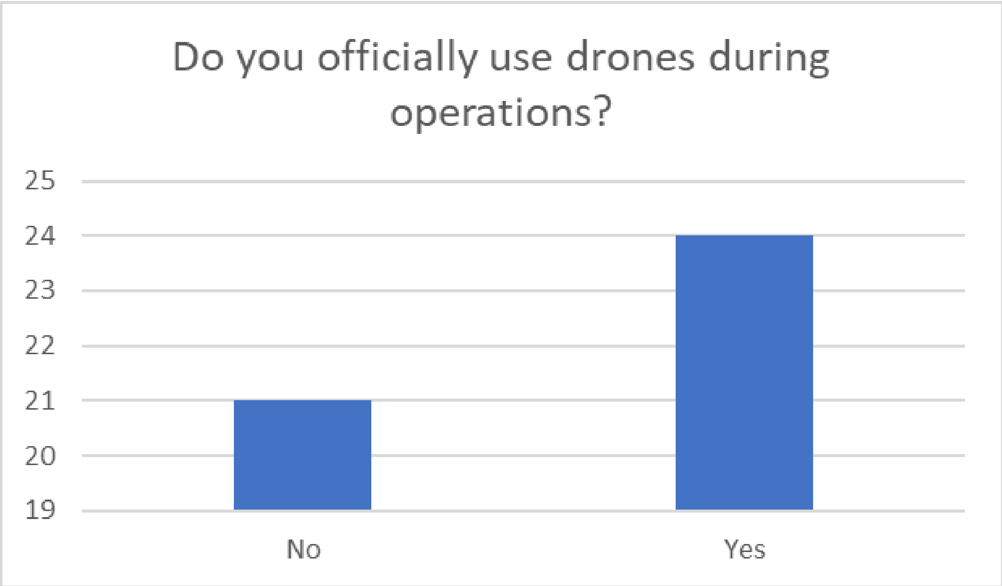

Figure 6: Diagram if the organisation officially uses drones during operations.

In the above diagram it is presented that each organization uses drones in their operations. It is worth mentioning that the organizations that own drones differentiate themselves from the organizations that use drones in their missions.

In the next diagram it is presented the number of the operations per year. As it depicts, there are many operations in some organizations, however most of the organizations do not have too many operations per year.

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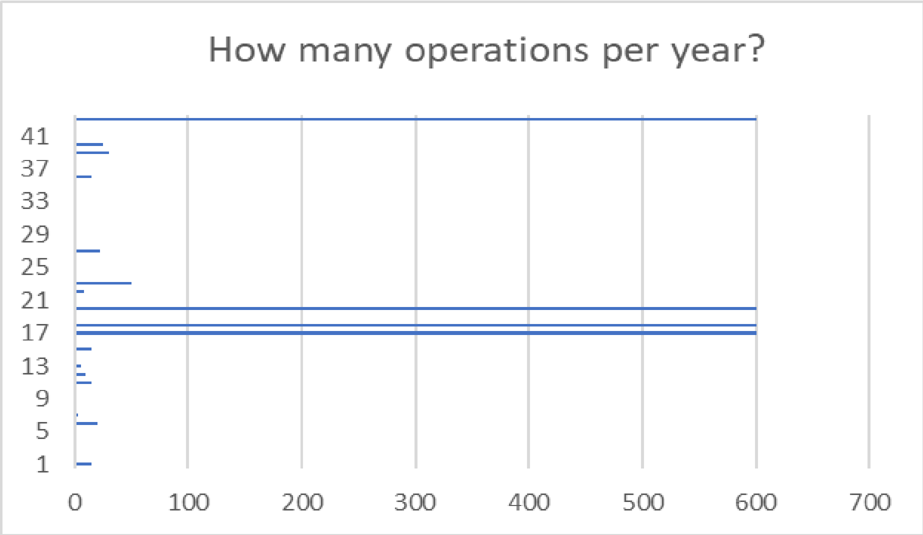

Figure 7: Diagram of how many operations take place from each organisation per year

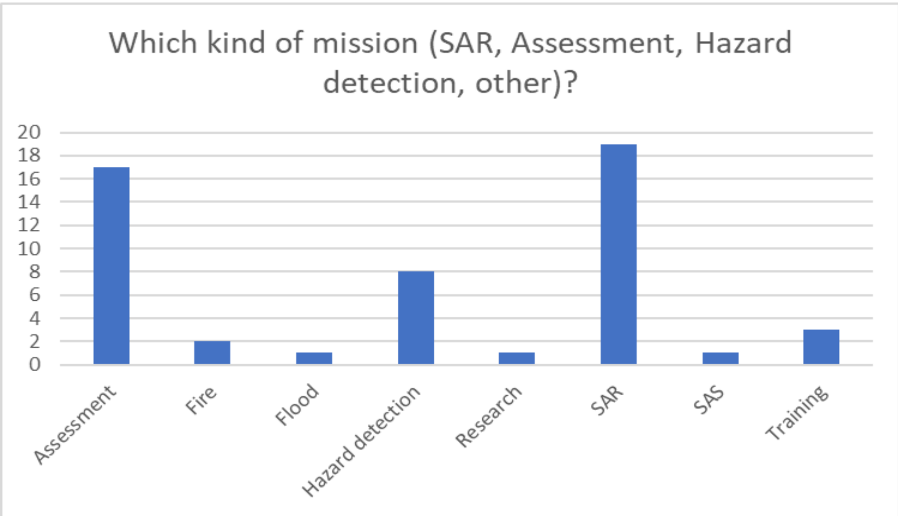

Figure 8: Diagram of the kind of mission that the organisation uses drones.

In the above diagram it is presented the kind of mission that uses drones. Most of the replies are in Search and Rescue and in Assessment.

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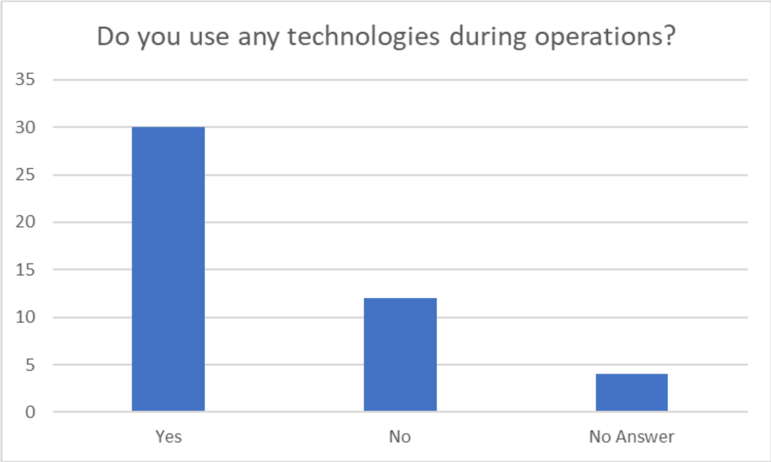

Figure 9: Diagram for the use of technology in operations

In the above diagram it is presented the use of technologies in each reply. As it is presented many of the replies to use technologies in their operations as follows.

Software:

- QGIS
- VOST
- ArcGis
- Mobile high-water gauge
- Web Map Server
- Virtual reality application for education
- app radar civil protection
- google maps
- ZeroGis
- Central Dispatch System
- Mapping System
- UGSC enterprise
- Metashape
- Loc8
- DJI Terra
- DJI Thermal Analysis Tool
- Flyhub 2
- Hydrological and Hydraulic models
- Fire Hazard models
- Fire propagation models

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- fire monitoring system (Fire Cloud),
- civil protection information system (SIPC)
- required platform national air competition
- Live video feed
- Aviamaps
- Terrain information

Hardware:

- Drones
- VR Equipment
- VISUAL CAMERA
- INFRARED CAMERA
- Mobile Phones detection for SAR
- PCs, Tablets, Smartphones
- The above Mentioned, Laser Scanner
- Advanced Notebook (drones)
- Camera thermal camera
- satellite communication

Data:

- Internet Data, Social Media Data, Drone data (aerial picture)
- Map Data
- satellite
- all format raster and vector
- DTM, DSM, Ortofoto, Thermal camera output (drones)
- The prediction of water level increase or decrease, weather forecast
- GOOGLE EARTH
- Satellite info
- Resource system (material/personnel)
- Live streaming videos in Operational Centres

In the next diagram it is presented the level of confidence of the responders in technology. As it is shown many of the operators feel ok and confident using the technologies.

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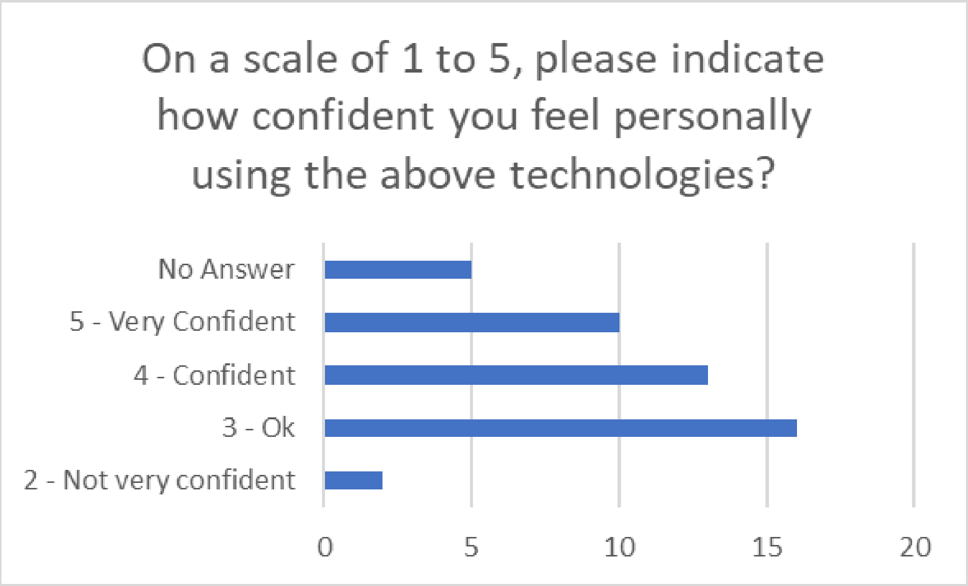

Figure 10: The confidence of the end users in above technologies

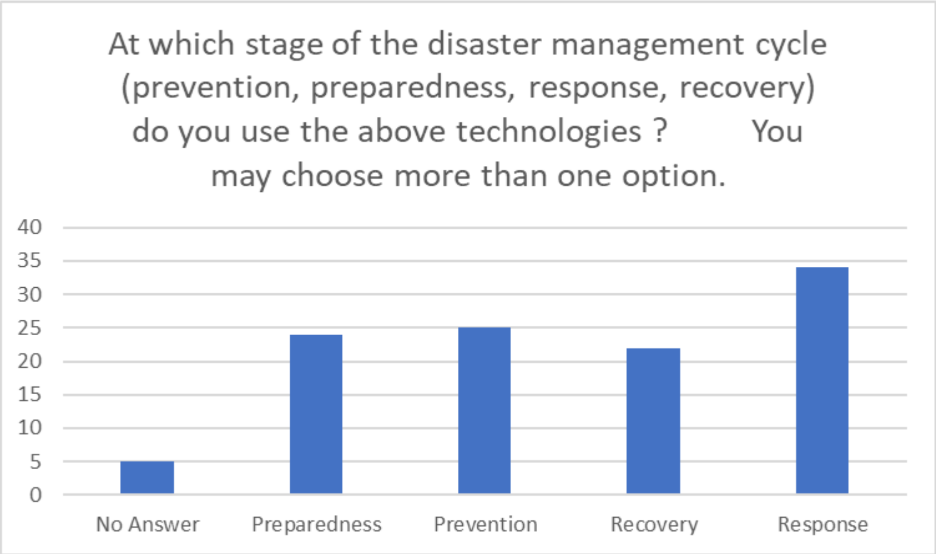

Figure 11: The stage of the disaster management cycle

In the above diagram, it is presented at the stage of the disaster management cycle (prevention, preparedness, response, recovery) they use technologies. Most of the responses use the technologies in response stage and later in prevention and preparedness.

Moreover, regarding the need for AI technologies to be ethically adherent and lawful, in Figure 12 one may see that most End-users and stakeholders agree or strongly agree that these technologies should be compliant with EU and National legislation.

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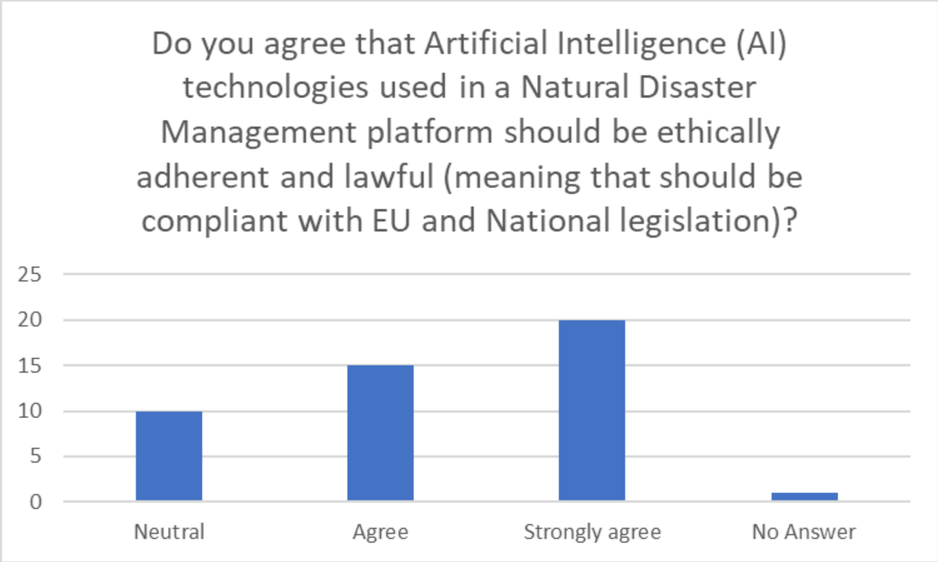

Figure 12: Need for ethical adherence and lawfulness of AI technologies.

Regarding the interest of participants in using tools which provide explanations, evidence, and/or reasoning for each provided output, helping operators to understand the decisions or predictions made, Figure 13 presents their replies, exhibiting their strong interest in using such tools. Moreover, for the above question, respondents noticed also that i) depending on the situation operators must be able to assess the output differently, ii) if there is a possibility to get the explanation for the generated outputs it would strengthen the argument for these said outputs, iii) to fully understand the output the reasoning is crucial, iv) this would make a lot of sense, especially in the case of weather-related areas and risk developments during large-scale local operations, v) already analyzed information is most informative to the operators.

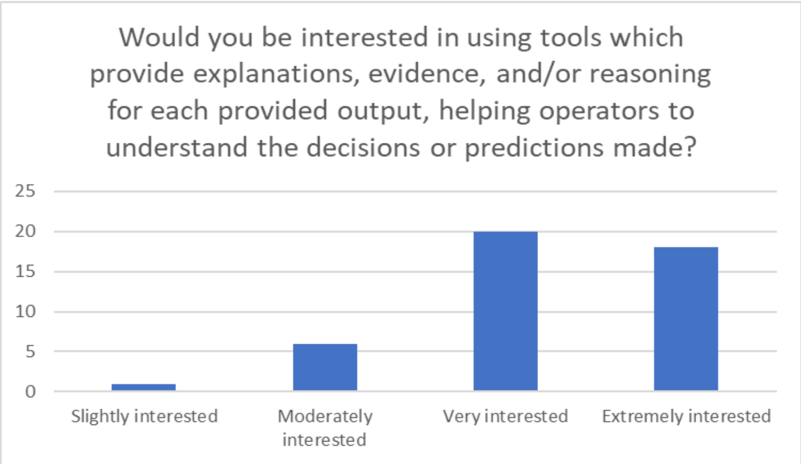

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Figure 13: Interest of End-users in using tools which provide explanations, evidence, and/or reasoning for each provided output.

Participants were also asked if they would be interested in tools for fire/smoke/flood detection, in order to receive an early notification of the imminent natural hazard. As expected, and shown in Figure 14, the majority of respondents are very or extremely interested in such tools.

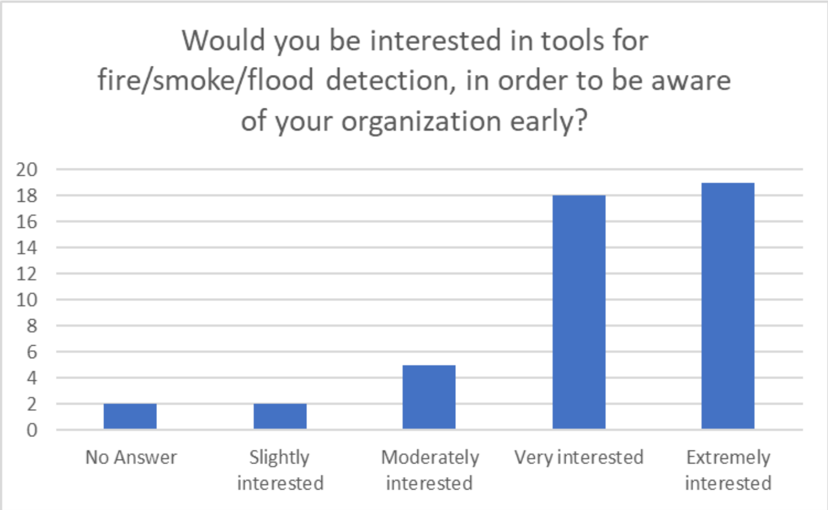

Figure 14: Would you be interested in tools for fire/smoke/flood detection, in order to be aware of your organisation early?

Moreover, End-users and stakeholders were asked to rate which technologies and/or data would be useful for their organization to have access in. The results are presented in Tables 1,2 and Figures where the number of participants for each technology and score is presented. As one may notice most participants consider the referred technologies and data as very important or extremely important to have access in.

Table 8: Rating the usefulness of each technology. Presenting the number of participants choosing a specific rate for each technology.

Technologies	Fire detection	Smoke Detection	Flood detection	Image/video recognition	3D Maps	3D Maps of smoke concentrations	Object Detection
Not at all important	4	4	0	0	0	2	0
Slightly important	4	4	2	2	4	7	4

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Technologies	Fire detection	Smoke Detection	Flood detection	Image/video recognition	3D Maps	3D Maps of smoke concentrations	Object Detection
Moderately important	5	7	9	9	11	9	5
Very important	13	11	15	19	13	11	18
Extremely important	19	18	17	14	17	13	14

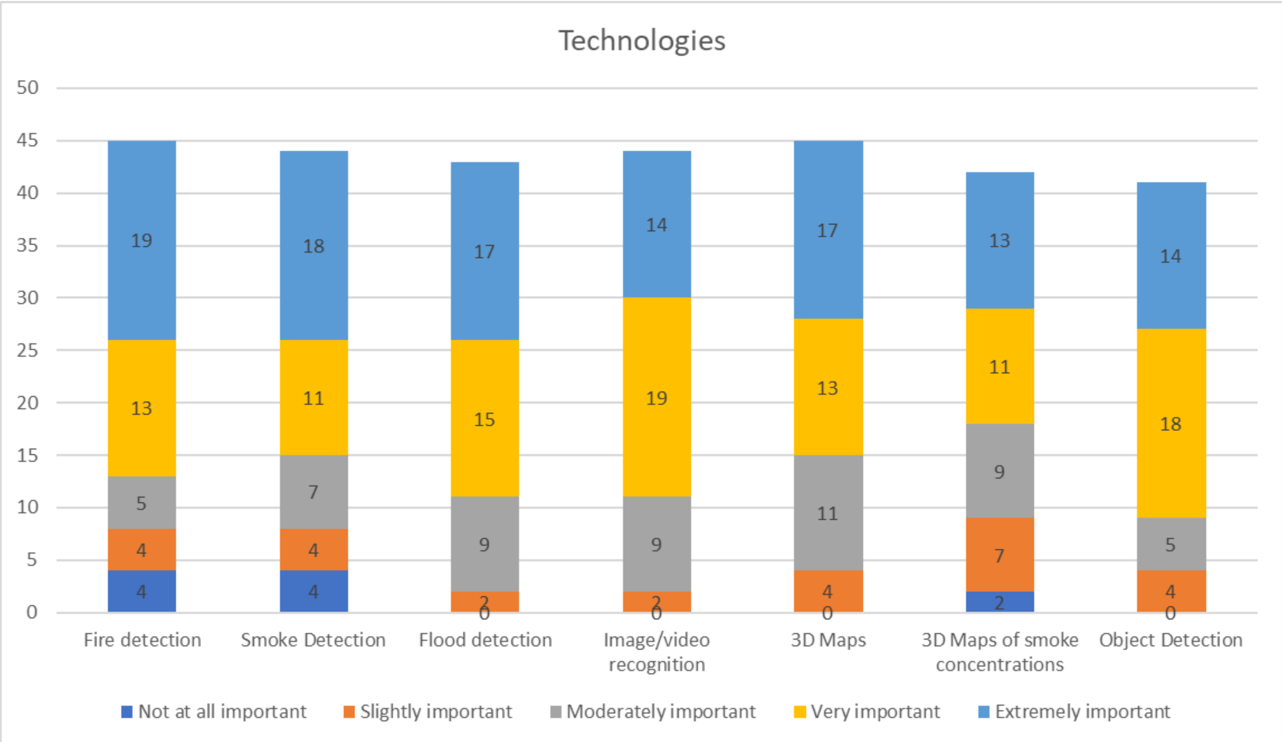

Figure 15: Number of participants choosing a specific rate for each technology

Table 9: Rating the usefulness of each type of data. Presenting the number of participants choosing a specific rate for each data type.

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Data	Satellite Data	Drone Data	Social Media Data
Not at all important	0	0	1
Slightly important	0	1	3
Moderately important	9	1	13
Very important	15	15	11
Extremely important	21	26	10

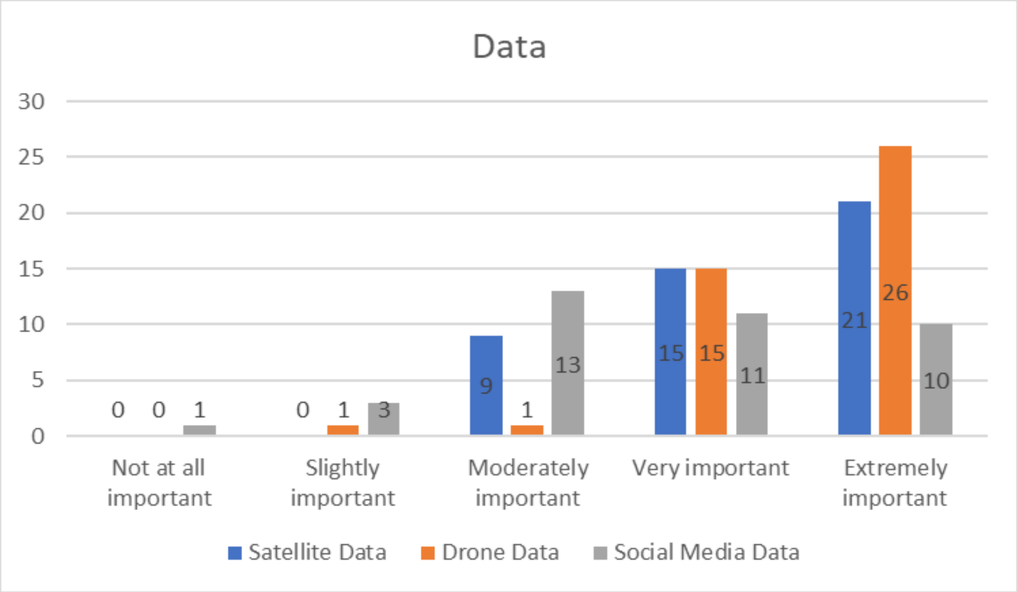

Figure 16: Number of participants choosing a specific rate for each type of data.

Furthermore, the interest of End-users in applications for detecting objects/people, (from aerial views or other image/video footage), in order to find people and vehicles that are not visible to the naked eye, is presented in Figure 17 where it is evident that the majority of respondents are very interested or extremely interested.

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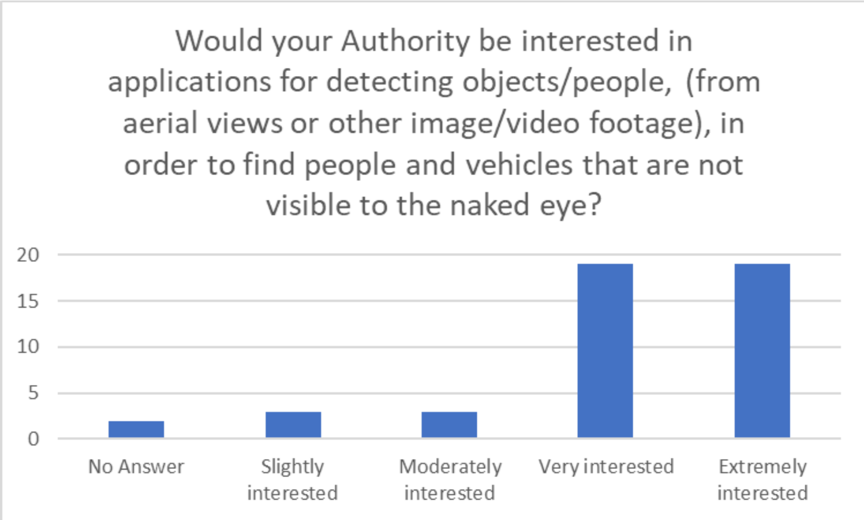

Figure 17: Interest of End-users in applications for detecting objects/people, in order to find people and vehicles that are not visible to the naked eye

With regards to the interest of each Authority in technologies offering reliable early warnings for fire and flood prevention and preparedness, the response of participants is depicted in Figure 18 where the intense interest of Authorities for the above technologies is clearly depicted.

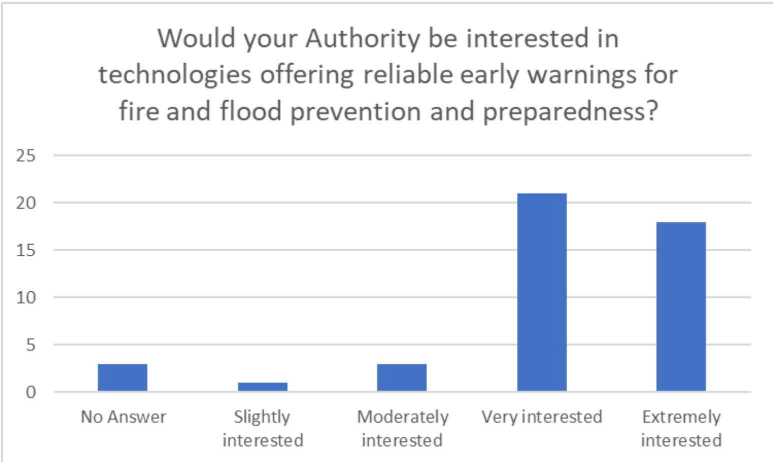

Figure 18: Interest of Authorities in technologies offering reliable early warnings for fire and flood prevention and preparedness.

Additionally, regarding the above technological capabilities, respondents noticed that they also use similar technologies such as:

- GeoSphere, Hydrographischer Dienst des Landes Oberösterreich, AGES
- FeWIS

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- Bollettino regionale (ARPAS) - Avvisi Servizio Meteorologico Aereonautica Decimomannu
- GDACS
- Sentinel Hub EO
- National Meteorological Data
- Sardinian Meteorological service (By ARPAS agency -Meteorological department, mainly)
- Copernicus EFFIS
- Flood Service

Concerning the interest of each Authority in technologies offering real-time, realistic 3D maps of smoke concentrations of a forest fire, Figure 19 presents the responses of the participants. It is obvious that most respondents are very interested.

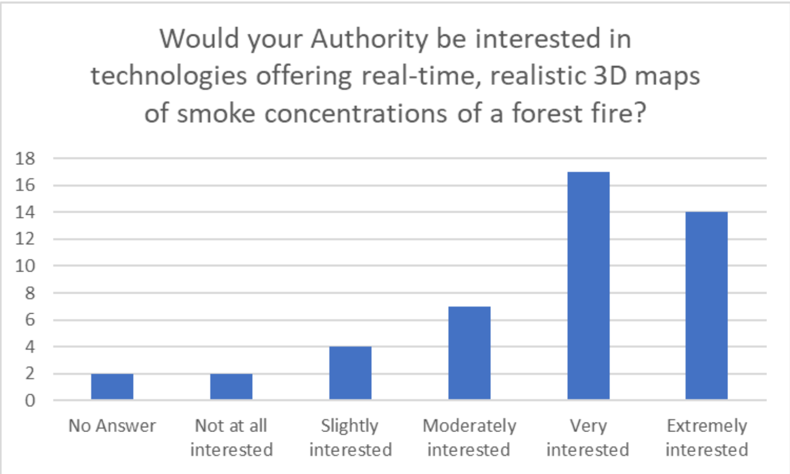

Figure 19: Interest of Authorities in technologies offering real-time, realistic 3D maps of smoke concentrations of a forest fire.

Regarding the interest of each Authority in technologies offering early warnings on fire and flood detection through social media, Figure 20 presents the responses of the End-users where one may see that most participants are moderately or very interested.

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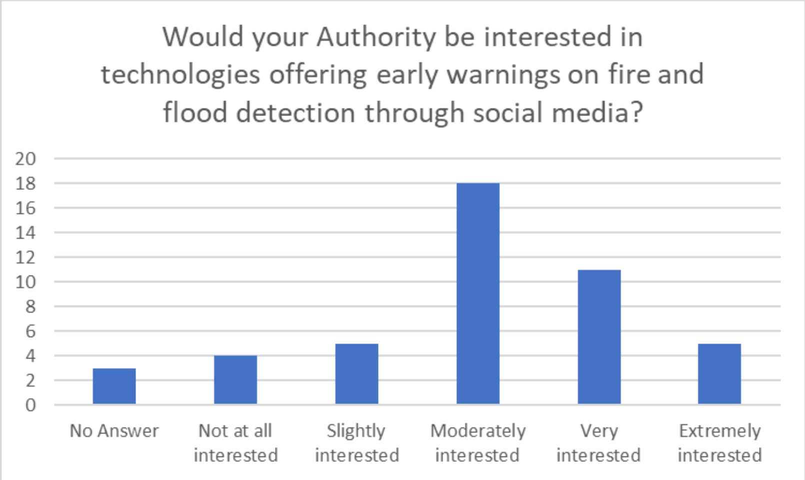

Figure 20: Interest of Authorities in technologies offering early warnings on fire and flood detection through social media.

End-users were also asked if their Authority would be interested in a Natural Disaster Management platform which would encompass GDPR (General Data Protection Regulation) provisions for the protection of personal data and the free movement of them. As presented in Figure 21 the majority of End-users are very or extremely interested in such a platform.

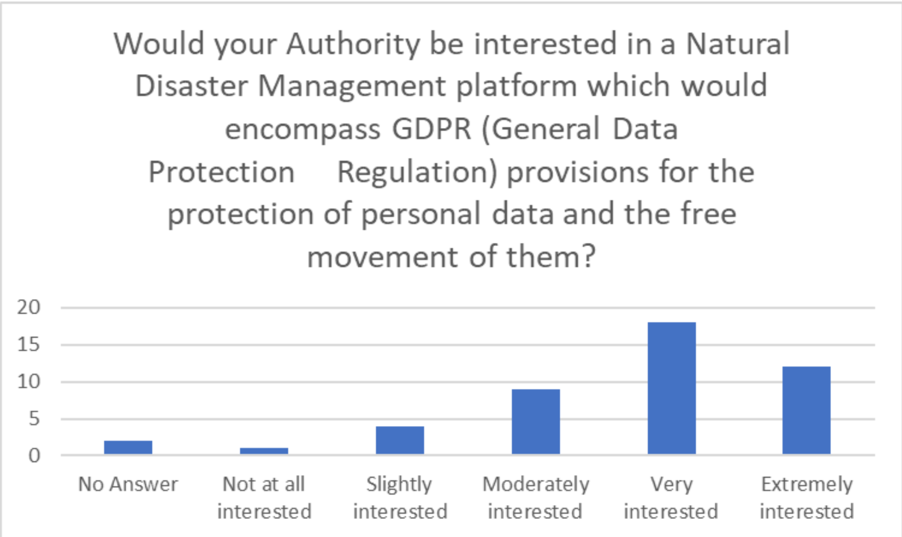

Figure 21: Interest of Authorities in a Natural Disaster Management platform which would encompass GDPR provisions for the protection of personal data and the free movement of them.

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Concerning the importance of near-real-time processing for a Natural Disaster Management platform which aims to increase responsiveness, the End-users, as shown in Figure 22, agree or strongly agree that it is an important capability.

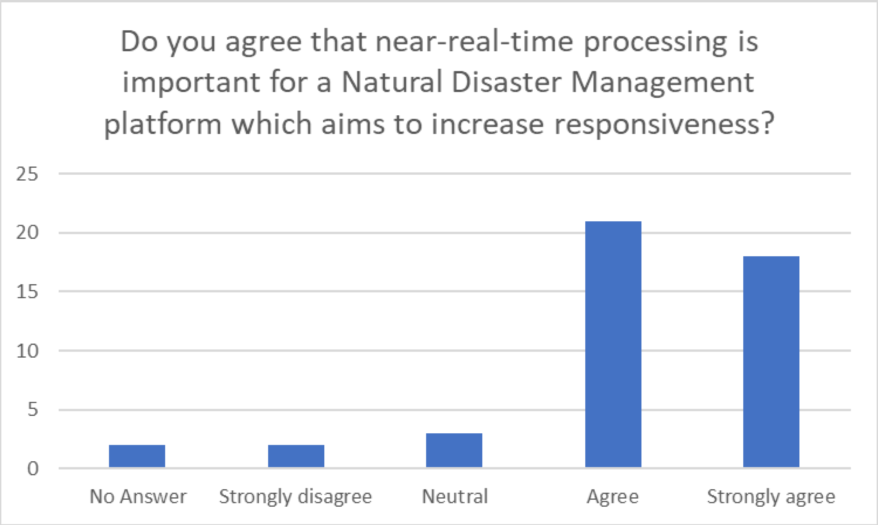

Figure 22: Number of End-users who agree that near-real-time processing is important for a Natural Disaster Management platform which aims to increase responsiveness.

Regarding near-real-time processing, the participants provided the following replies on how fast they would need to receive the output of a specific technology:

- minutes to hours depending on data, event, and stage of event.
- Hours
- not longer than 12 h
- 2-3 Hours
- During a dynamic scenario, results should be available in minutes. For Recovery, hours or even days might be acceptable.
- minutes
- It depends on the type of risk: usually ½ hour is sufficient.
- It depends on the technology and the type of disaster.
- It depends on the task.
- 6 hours before
- One day before
- 30 minutes

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- For control centers in particular, the fastest possible information for assessing possible dangers is essential. The sooner the information can be evaluated, the better.
- It depends, some information is needed in seconds, some can take longer time.
- A few days before

With regards to an Operational Forest Fire Simulator which provides highly accurate and near real-time wildfire models, End-users exhibited their strong interest as depicted in Figure 23. Moreover, as shown in Figure 24, only a few End-users already use such a simulation tool. The specific simulation tools used by them are the following:

- Piloting version Proms
- Propagator (developed by Cima Foundation – Savona Italy).
- Wildfire Analyst, Flamap, Firesite

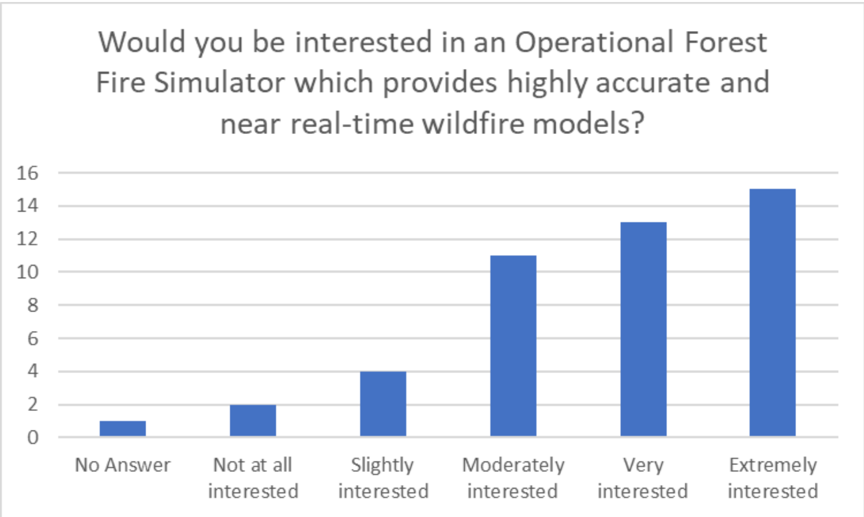

Figure 23: Interest of End-users in an Operational Forest Fire Simulator which provides highly accurate and near real-time wildfire models.

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Figure 24: Number of Authorities already use such a simulation tool.

Additionally, the interest of End-users in a tool that provides estimation of the damages after the natural disaster is presented in Figure 25 where it is clearly depicted that most End-users are very or extremely interested. In Figure 26, the type of damage that the End-users are interested in is presented. The preferred types are i) building damage detection, ii) burnt area estimation, iii) collapsed bridges detection, iv) mud detection, v)road network damage. Additionally, End-users also declared the following types of damage that they are interested in i) agriculture fields damage, herding damages and ii) human made disasters.

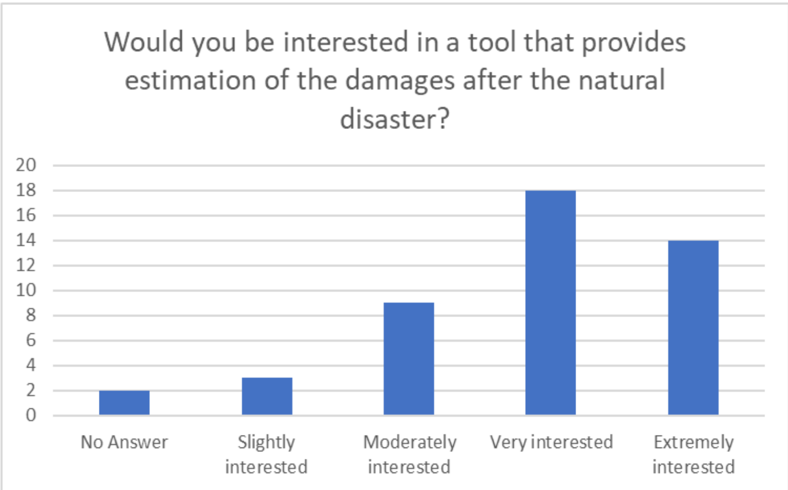

Figure 25: Interest in a tool that provides estimation of the damages after the natural disaster.

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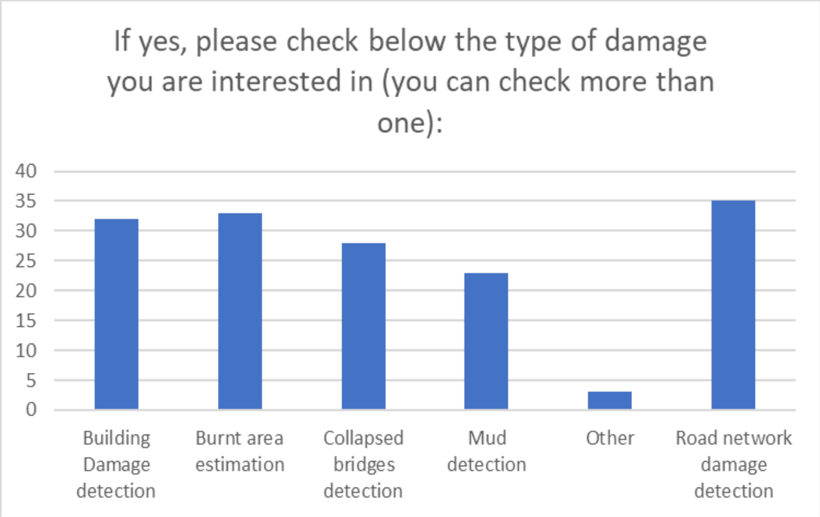

Figure 26: Types of damage end-users are interested in.

Regarding the interest of End-users in a platform which integrates all proposed technical solutions or their interest in a set of different tools, as shown in Figure 27, they are mostly interested in an integrated platform.

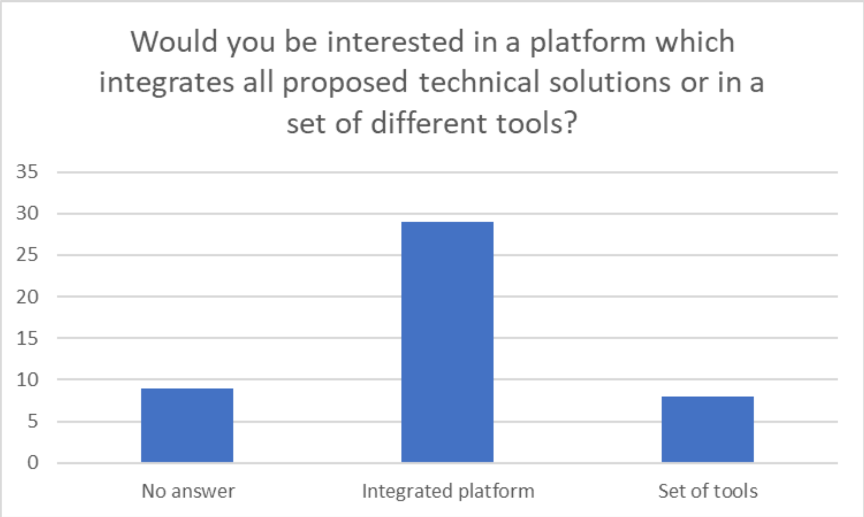

Figure 27: Interest in a platform which integrates all proposed technical solutions or in a set of different tools.

The interest of End-users in an innovative tool/platform that combines information from multiple sources in order to provide an enhanced situational awareness picture is presented in Figure 28. As depicted most respondents are very or extremely interested.

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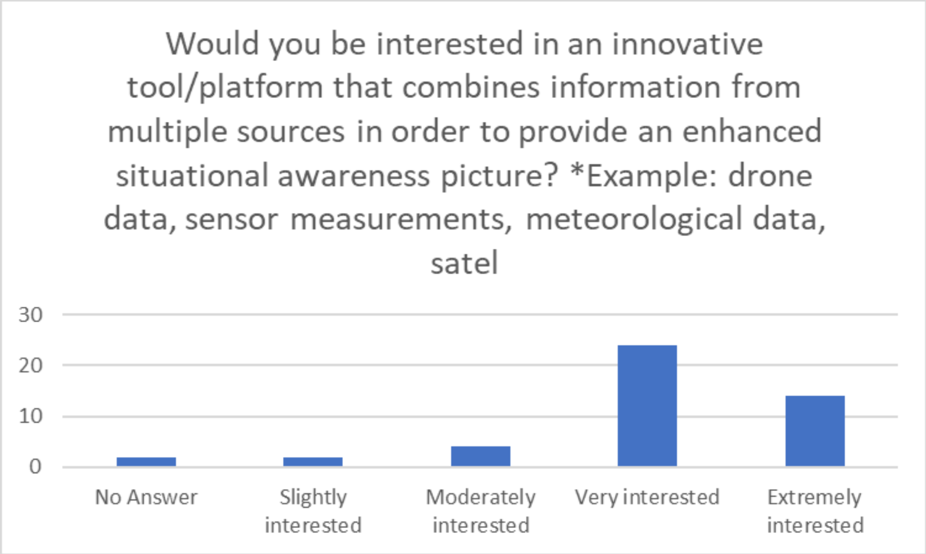

Figure 28: Interest in an innovative tool/platform that combines information from multiple sources in order to provide an enhanced situational awareness picture.

In Figure 29, the replies of participants are presented regarding how useful it would be for them to get information on possible and upcoming satellite data availability for an area of interest. As shown, for most End-users it is very or extremely useful.

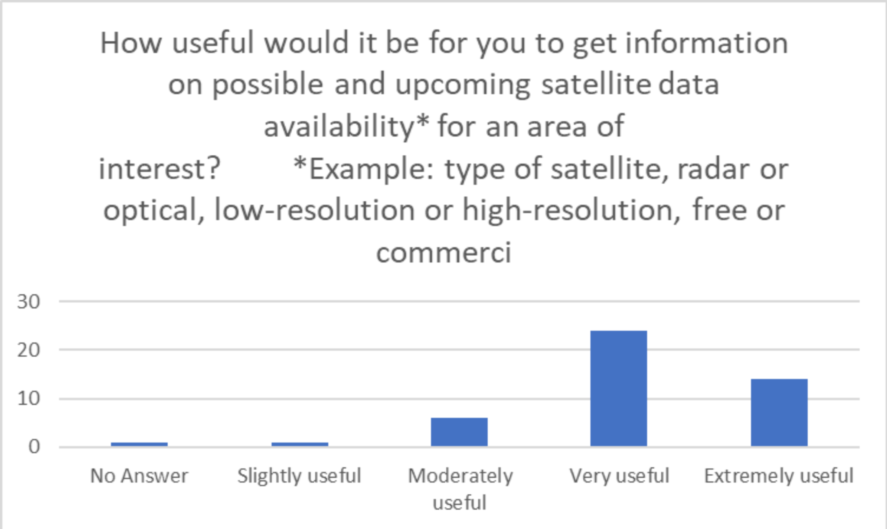

Figure 29: How useful would it be for you to get information on possible and upcoming satellite data availability* for an area of interest?

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Moreover, in Figure 30, the replies of participants are presented regarding how useful it would be for them to get information on the expected time (e.g. in hours/days) until they are provided with the resulting satellite data products. As presented, for most End-users it is very or extremely useful.

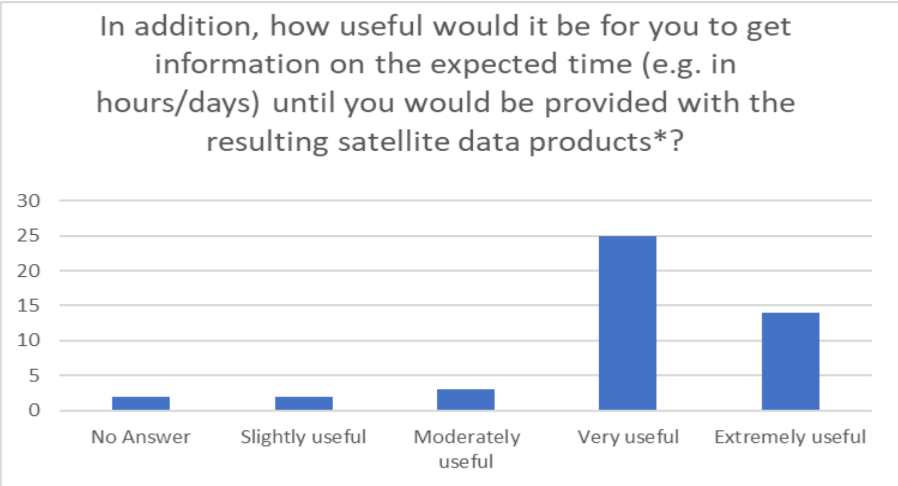

Figure 30: Usefulness of getting information on the expected time (e.g. in hours/days) until you would be provided with the resulting satellite data products

With regards to the interest of End-users in receiving or being shown decision proposals about their options for their customized satellite-based product in a human-like way, their replies are shown in Figure 31 where most End-users are very interested.

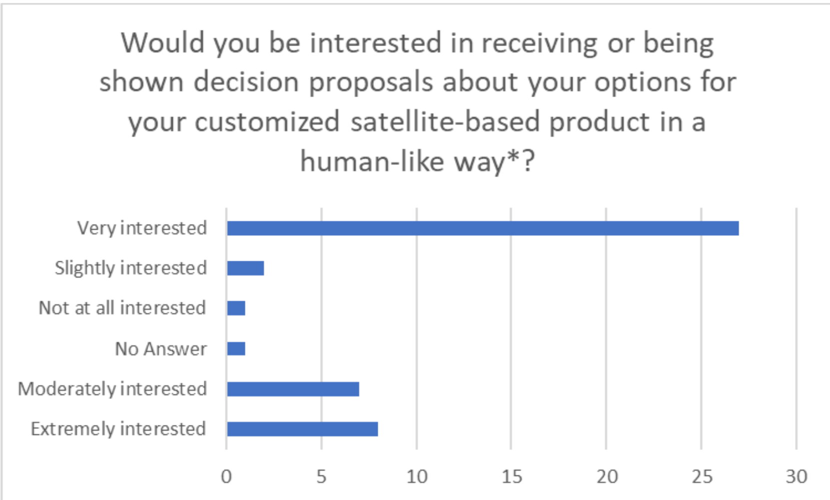

Figure 31: Interest in receiving or being shown decision proposals about your options for your customised satellite-based product in a human-like way.

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Concerning the interest of participants in having access to a tool that will reflect the physically affected area into a virtual model in real-time it is shown in Figure 32 that the majority of Ens-users are very or extremely interested.

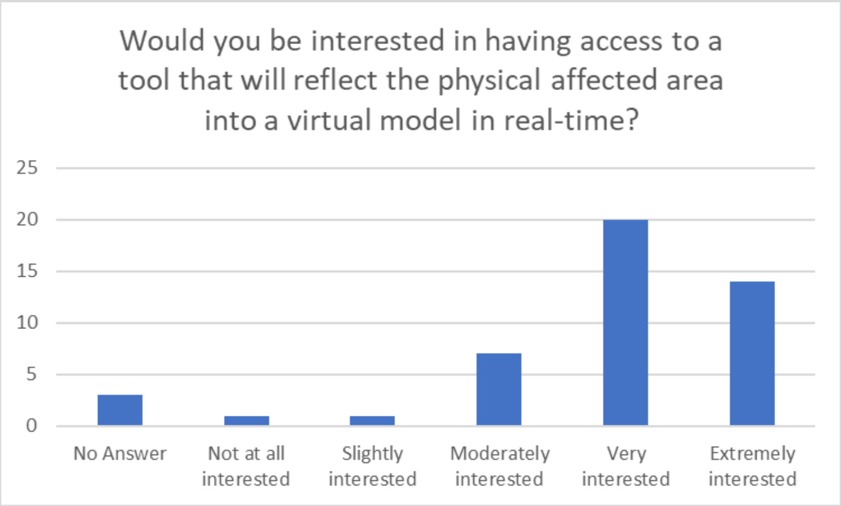

Figure 32: Interest in having access to a tool that will reflect the physical affected area into a virtual model in real-time.

Finally, with regards to the interest of End-users in training material in order to use the aforementioned technologies, most participants, as depicted in Figure 33, replied that they are very or extremely interested while other comments that End-users would like to share are the following:

- For the platform to be easy to use
- I cannot answer the questions considering "my authority."
- The platform needs to be simple to use and accurate on the output.

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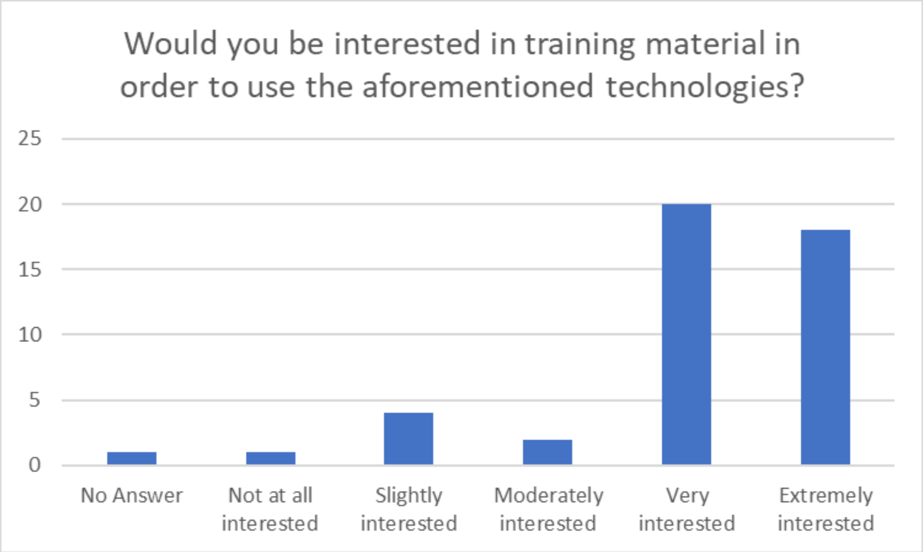

Figure 33: Would you be interested in training material in order to use the aforementioned technologies?

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4 End User Requirements

4.1 End User Requirements on TEMA

Following the methodology and the scope of this deliverable, in this chapter will be analyzed the end user requirements.

The end users' requirements were extracted by the gaps analysis, the responses from the questionnaire and the constant communication with the end users of the consortium.

In this context, twenty-three (23) requirements were identified and analyzed as follows.

The requirements are discriminated against in functional and non-functional requirements. Functional requirements define what the TEMA should do, what its features and functions are. Nonfunctional requirements describe the general properties of the system.

4.1.1 Non-Functional Requirements

Table 10: End User Requirements on TEMA (Non-Functionals)

Category	Req ID	Requirement	Description
Non-Functional Requirements	EU-RQ-NF-01	The technology used in cases of ND needs to be clean and simple to use	A person who is in rescue hasn't got the time to learn about the new technology or to try what are the options that this (new) warning system provides.
	EU-RQ-NF-02	Privacy, Ethics and Data Policy protection	The tools that the responders use need to be compliant with ethics, privacy, and data policy policies. The data is available only to those who are related to performing the emergency.
	EU-RQ-NF-03	Information provision as soon as possible	It is crucial during the Natural Disaster event the FND Managers have information about the area as soon as possible.
	EU-RQ-NF-04	Sharing information and data regarding ND	Sharing information and data regarding fire (how it is developing, etc.) during ND events
	EU-RQ-NF-05	Coordination between authorities during reconnaissance activities	It would be useful to create real-time maps for data sharing for public authorities

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	EU-RQ-NF-06	Ability to operate in rescue activities at night or in heavy rains	Need for clearer satellite images in difficult circumstances
	EU-RQ-NF-07	Solution of the absence of communication means	During a Natural Disaster event, there is the possibility of affecting the electricity and the base stations, the collapsed radio antennas.
	EU-RQ-NF-08	Valid warnings	Sensors are essential for detecting and measuring environmental conditions

4.1.1.1 The technology used in cases of ND needs to be clean and simple to use (EU-RQ-NF-01)

During the natural disaster response all the Public Protection and Disaster Relief (PPDR) units have in mind one task- save lives and help the population affected by the ND. To have a NDM solution that offers a lot but is also complicated to use, demands a lot of (pre)training, will not be an optimal solution. That is the reason why one of the requirements for the TEMA solution is to be simple to use (clean) and intuitive.

4.1.1.2 Privacy, Ethics and Data Policy protection (EU-RQ-NF-02)

The tools that the responders use need to be compliant with ethics, privacy, and data policy policies. The data is available only to those who are related to performing the emergency. It is necessary to have secure tools that work even in emergency situations and environments that are not stable. First responders and citizens can be in real danger if someone who is not allowed to reach the data can access it.

4.1.1.3 Information provision as soon as possible (EU-RQ-NF-03)

The First Responders in a Natural Disaster event in order to make correct decisions, it is needed to have information of the affected area as early as possible. For example, in the case of a recently reclaimed fire, if the drones are equipped with thermal imaging cameras, they could check immediately if there are points that could be refired.

4.1.1.4 Sharing information and data regarding ND (EU-RQ-NF-04)

This requirement addresses the problem in mobilizing resources and coordinating response efforts between different agencies and PPDR (public protection disaster relief) involved in civil protection. It is particularly problematic in situations where natural disasters are ongoing or evolving dynamics, such as during floods or severe weather events. Additionally, there can be challenges in sharing information between different stakeholders involved in disaster management, such as between local authorities, emergency services, and national- and international-level agencies.

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4.1.1.5 Coordination between authorities during reconnaissance activities (EU-RQ-NF-05)

During or after a Natural Disaster event, it will be useful for the support forces and the Natural Disaster managers to know the exact extension and magnitude of calamity events. Reconnaissance activities would be very useful to share information regarding the territories in order to act in a coordinated manner among various rescue forces.

4.1.1.6 Ability to operate in rescue activities at night or in heavy rains (EU-RQ-NF-06)

First Responders have to intervene as soon as possible in affected areas, in order to save peoples' lives. Local weather conditions could be severe (heavy rain, hail, etc.) and it is difficult for FR to operate. Furthermore, there are activities that require to be carried out at night.

4.1.1.7 Solution of the absence of communication means (EU-RQ-NF-07)

Natural disasters can disrupt communication infrastructure, such as cellular networks, internet services, and landline phones, because antennas are broken, power lines are cut or damaged and there is no energy available, sensors on the rivers are washed away. This all is making it difficult for PPDR services to acquire data needed for the emergency response and natural disaster management, but also for the affected communities to communicate with emergency services. This can be particularly problematic in situations where the disaster has led to widespread power outages or damage to communication infrastructure, such as radio antennas or cell towers. This can prevent affected communities from accessing important information, such as weather updates or evacuation orders, and can slow down response efforts.

However, this requirement does not fall under the technological solutions of the TEMA project. For this reason, it will not be foreseen to cover this need.

4.1.1.8 Valid warnings (EU-RQ-NF-08)

Weather data and data from sensors could be used to provide timelier (even half an hour earlier) and valid warning about the magnitude of the upcoming disaster. Therefore, the first responders will be prepared in time so that they can face the magnitude of the impending natural disaster.

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4.1.2 Functional Requirements

Table 11: End User Requirements on TEMA (Functional)

Category	Req ID	Requirement	Description
Functional Requirements	EU-RQ-FUNC-01	Information (footage, images, maps etc.) from the site of the disaster to define event area and extent	Information (footage, images, maps etc) in the control room that could be acquired by the teams on the ground to understand the extent of the event and how it is developing.
	EU-RQ-FUNC-02	Geo-Social Media Information	Social Media will contribute to a NDM due to its awareness, immediate response and geolocation characteristics.
	EU-RQ-FUNC-03	Monitor the development, the size of the affected area	It would be beneficial if there are information regarding the size of the affected area (flood/fire, preferably a map)
	EU-RQ-FUNC-04	Local information about weather variables/data (early warning)	Weather data is crucial for predicting the likelihood and severity of extreme weather events
	EU-RQ-FUNC-05	Reveal fires as they start	Tools- instruments technologies to reveal fires as they start (as soon as possible, to have quick information)
	EU-RQ-FUNC-06	Teams involved	The information regarding the teams that are involved in a ND event and in what tasks are assigned is very important.
	EU-RQ-FUNC-07	Geolocation of people who are in danger of life	It would be useful a system for text messaging to citizens to direct them on the actions to take in order to save themselves and warn of the closure of public facilities in order to prevent people from dangerous roads in case of heavy rain events
	EU-RQ-FUNC-08	Model of fire propagation	It can be useful to use a model of fire propagation in SOUP room during a big fire
	EU-RQ-FUNC-09	Monitor the area of interest for fire revival	The initial fire that seemed to be extinguished, restarted the day after.
	EU-RQ-FUNC-10	Response planning for extinguishing fires	Detailed information regarding the available as well as the already deployed fire fighting forces in the field.
	EU-RQ-FUNC-11	Available water extinguishing resources from nearby swamps, ponds etc..	extinguishing water source e.g., swamps, ponds... (if accessible by heavy trucks, amount of water)

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	EU-RQ-FUNC-12	Flood propagation modelling	It would be useful to know how the flood will propagate
	EU-RQ-FUNC-13	Estimation of the damages	It would be beneficial if there are informations regarding the extension of a flood/fire (preferably a map) and the damages
	EU-RQ-FUNC-14	Scarcity of information about the accessibility to settlements (roads, bridges, etc.) in an affected area and relevant resources.	Map with available infrastructure, the condition of roads, terrain etc. during or after an event of Natural Disaster.
	EU-RQ-FUNC-15	Resource planning	When support is requested, more information is required from the additional responders. A means to plan and prepare tasks for the additional support and to oversee planned tasks.

4.1.2.1 Information (footage, images, maps etc.) from the site of the disaster to define event area and extent (EU-RQ-FUNC-01)

Real-time or near-real time information on the site would be useful for the FR. For example, georeferenced footage from the area where disasters are occurring would be very useful, with the aim of defining the size of the affected area, the magnitude of the event and its chronological evolution. Their origin should be classified according to the type of user authoring the images.

4.1.2.2 Geo-Social Media Information (EU-RQ-FUNC-02)

The near-real time information on the situation and rescue needs will be beneficial for NDM. The data from social media networks can make a great contribution as it can provide a near-real time representation of a disaster situation. In such a crisis, official reports, first-person accounts, and pictures/videos are shared through diverse social networks which allows a better insight into the actual situation in the crisis area. For this, posts with a concrete geo-reference are particularly important. Based on this multimodal information, prevailing themes and sentiments on the ground can be derived. A great advantage, apart from the variety of potentially accessible information, is the timeliness of social media data. While other data sources (e.g., drones or satellites) often require long waiting times, streams from social networks can be accessed very quickly.

4.1.2.3 Monitor the development, the size of the affected area (EU-RQ-FUNC-03)

The satellite-based maps, images, maps to compare the before-and-after situation, as well as on-site photographs and maps of the current situation of the affected area and etc. are valuable resources for disaster response teams and decision-makers to assess the scale and severity of damages, plan response efforts, and allocate resources.

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4.1.2.4 Local information about weather variables/data (early warning) (EU-RQ-FUNC-04)

Generally, public organisations receive from national authorities every morning the daily forecast of the wider territory of their responsibility. However, the scale of the forecast is bigger than a public organisation requires. Furthermore, the scale of forecast maps must have the highest possible resolution, especially regarding very short-term forecasts. This requirement will address the problem of qualitative knowledge of the weather of their geo restrictions. This will help the local responders to act and react before or during a Natural Disaster event.

4.1.2.5 Reveal fires as they start (EU-RQ-FUNC-05)

This requirement concerns new areas, where no fire has occurred, but the available data could suggest potential fire. At present, firefighters raise their preparedness based on the forest fire index. The forest fire index uses data on air humidity, wind speed, air temperature, solar radiation, and precipitation to model the index in each 10 km x 10 km grid across the whole country. At the moment, the majority of information on fire outbreaks comes from sightings.

4.1.2.6 Teams involved (EU-RQ-FUNC-06)

The First Responders, in order to operate efficiently and quickly, have to know important information. The operating centre in an ND event has to be prepared. That it is not an easy task for any organisation. It is important to know who is in charge of giving the order, and how can this person be reached, the location of the reception desk, the location of the command post, national and international teams on site with different equipment (who responded and with what equipment did they come) and information about the task and mission area

4.1.2.7 Geolocation of people who are in danger of life (EU-RQ-FUNC-07)

During a wildfire or a flood, some people could be in danger. In these cases, it would be very useful to know where they are located and the local scenario, in order to intervene promptly.

4.1.2.8 Model of fire propagation (EU-RQ-FUNC-08)

To predict fire spread, firefighters periodically assess the terrain surrounding the active fire and weather conditions. Based on the periodical assessment, firefighters can make a rough estimate on how the fire could spread further. This method requires significant time to manually collect environment and weather data, and to generate estimates. The time could be used instead in managing and coordinating teams in the field.

4.1.2.9 Monitor the area of interest for fire revival (EU-RQ-FUNC-09)

During forest fire emergencies, once the surface fire is extinguished, the firefighters move one to continue their work in other areas under fire. However, sometimes the fire can reignite due to various reasons. The reignited fire can pose a threat to the firefighters by encircling them. In most

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cases, firefighters do not have sufficient manpower available to monitor extinguished areas. The monitoring period for extinguished areas can be up to 72 hours after the extinguishing.

4.1.2.10 Response planning for extinguishing fires (EU-RQ-FUNC-10)

An organised and well-prepared emergency response plan would be helpful in preventing controlled damage in case of emergencies. The purpose is to facilitate and define the actions during natural disaster events. Making a response planning for the operators and their responsibilities during a fire is an effective way to be ready for an unexpected situation.

4.1.2.11 Available water extinguishing resources from nearby swamps, ponds etc..(EU-RQ-FUNC-11)

When fires occur away from built up areas, firefighters do not have access to water infrastructure and rely on nearby rivers, lakes, swamps and ponds for extinguishing water. Beside basic satellite images, terrain maps or drone footage to estimate potential water reserves, there is no information on the amount of water, and firefighters might be forced to relocate to another body of water for pumping. Having estimates that the water is at least of a certain depth would be beneficial in securing extinguishing water.

4.1.2.12 Flood propagation modelling (EU-RQ-FUNC-12)

Suitable flood management strengthens the resilience of infrastructures and of society. During a flood event it is crucial to have the right measures that can reduce their limit and impact. In this context, a flood propagation model that operates within the framework of a real-time flood forecasting service should be used during a flood event. Therefore, the command control and responders of the Natural disaster event would be aware of what they expect and how they could manage it.

4.1.2.13 Estimation of the damages (EU-RQ-FUNC-13)

Accurately assessing the scale and severity of damage and the size of the affected area is essential for effective disaster response and recovery efforts. This important information is the basis for the plan of action. Based on that the operation rooms send the required units in the field. However, in some cases, there can be delays or inaccuracies in these assessments, which can impact the speed and effectiveness of response efforts.

4.1.2.14 Scarcity of information about the accessibility to settlements (roads, bridges, etc.) in an affected area and relevant resources (EU-RQ-FUNC-14)

During a Natural Disaster event, such as floods, fires or landslides, the infrastructures of the area (roads, railways, bridges closures etc.) have been damaged. This can severely impact response efforts. First Responders need to have an overview (preferably on a map) of their responsible area

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and be aware where the road is accessible or not if a bridge is collapsed or not. In this context, the First Responders could know which route their vehicles could take in order to approach an affected area as well as to send help.

4.1.2.15 Resource planning (EU-RQ-FUNC-15)

During large scale incidents, coordination among fire brigades can be challenging. Between teams and brigades, there is little information on what equipment and human resources are available. In addition to their own resources, civilians, and their equipment (tractors, trucks, construction equipment) are often used to support firefighters. As shifts change and different people join or leave, having a way to share the available knowledge easily could improve coordination at all levels.

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5 TEMA Solution

5.1 Big Data Requirements

In the face of extreme events like floods and forest fires, harnessing and analysing big data from heterogeneous sources becomes crucial for effective disaster prevention, management and response. These catastrophic events pose unique challenges due to their unpredictable and rapidly evolving nature, imposing rigorous data requirements. The first essential requirement is the ability to collect and integrate data from diverse sources, including:

- satellite images,
- drone-based sensor data,
- drone-captured images and videos,
- smart sensor data,
- topographical data,
- meteorological data,
- web data (predictions/warnings published in the Web),
- geosocial media data (including texts, images and videos),
- data from emergency response systems.

This necessitates the development of advanced data collection mechanisms capable of handling huge amounts of unstructured data, that are continuously generated at high speed. Typical examples are drone-captured videos and satellite imagery, where a single drone recording video (4K, 25fps) for 20 minutes produces about 9GB of data (after compression), while a single satellite image (11458 width x 10980 height) requires about 1 GB of storage. Secondly, storage and processing capabilities must be tailored to handle the immense volume, velocity, variety, and variability of data generated during such extreme events. This involves implementing scalable and distributed storage systems, efficient data compression techniques, and high-performance computing infrastructures. Additionally, the data must be cleansed, normalised, and standardised to ensure consistency (veracity) and facilitate meaningful analysis across different sources. Finally, advanced analytical techniques, including machine learning algorithms and artificial intelligence, need to be employed to derive actionable insights (value) from the collected data. These techniques can aid in predicting the spread of disasters, identifying vulnerable areas, optimising resource allocation, and enabling timely decision-making. In summary, the big data requirements for heterogeneous sources under extreme conditions such as floods and forest fires encompass data collection and integration, scalable storage and processing, data cleansing and standardisation, and advanced analytics, all crucial components for effective disaster management and mitigation efforts.

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5.2 TEMA Technologies

TEMA will focus on the development of technologies that are clustered thematically per project objectives, in Subsections 5.2.1, 5.2.2 and 5.2.3, below.

5.2.1 Trustworthy Federated Analytics

Table 12: Overview of Trustworthy Federated Analytics technologies

ID	Technology	Description
TFA-tech-01	Concept discovery for latent space interpretability of deep neural networks	Meaningful decompositions of the latent feature space of DNNs to advance concept-based explanations
TFA-tech-02	Human-comprehensible presentation of concept-based explanations	Easily graspable explanation formats for concept-based explanations
TFA-tech-03	DNN robustness	Robustification of DNN learning against input noise/perturbation.
TFA-tech-04	Explainability for transformer base neural networks	Apply explainability techniques and algorithms to convolutional neural networks used for image analysis.
TFA-tech-05	Fire/smoke/flood/person detection	DNN-based methods for fire/smoke/flood detection/recognition
TFA-tech-06	Fire/flood/background segmentation	Semantic segmentation could serve for producing fire/flood and background masks.
TFA-tech-07	Person re-identification	Person detection tool, multi object tracking and re-identification in multiple streams.
TFA-tech-08	Satellite-based flood detection and assessment	Multi-source, AI-based remote sensing data processing for spatio-temporal detection/assessment of floods
TFA-tech-09	Satellite-based Forest fire detection and assessment	Multi-source, AI-based remote sensing data processing for spatio-temporal detection/assessment of forest fires

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TFA-tech-10	Privacy preservation during visual analysis	On-the-fly/real-time generating gender-neutral image samples to replace any detected identity identifiers.
TFA-tech-11	Geo-social media analysis	Textual information (including topic modelling & semantic and sentiment/emotion analysis) and imagery. Hot spot and cold spot analysis;
TFA-tech-12	Sentiment analysis for short texts	Combining images with text snippets (from e.g., tweets) to predict sentiments (e.g., anger, fear)
TFA-tech-13	Contrastive image-language models	Given an image and an associated text, extract characteristics of the text and the image in order to correlate the degree of similarity.
TFA-tech-14	Federated Learning	Deployed on a large geographical area, single nodes of a sensor network train local detection models.
TFA-tech-15	Data scarcity, synthetic data generation pipeline	Models of image detection or segmentation without the need to be trained with many samples.

5.2.1.1 Concept discovery for latent space interpretability of deep neural networks (TFA-tech-01)

Deep neural network-based models are black-boxes. Traditional post-hoc attribution methods aim to explain individual predictions by assigning scores that quantify the importance of each input feature towards the prediction. The insights these methods offer into the inner workings of the models can be limited, e.g. for segmentation models, that are of particular importance in NDM. Here, the explanation often resembles the prediction itself. In these cases, a structured analysis of what the latent features learned by the model encodes can lead to more informative explanations that are decomposed into the concepts used by the model. FHHI will work on meaningful decompositions of the latent feature space and thereby advance concept-based explanations.

As input, the developed methods require DNN models, potentially pre-trained by other partners and samples to be explained.

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5.2.1.2 Human-comprehensible presentation of concept-based explanations (TFA-tech-02)

Explanations for the decisions of black-box machine learning models for individual samples are mostly presented as heat maps that overlay single samples, representing important scores. For data domains like natural images and when the explanations only contain a single heatmap, this is a sensible choice. However, in the realm of non-interpretable data representations like time series or multiple heatmaps for a concept-based explanation, this explanation format might become hard to comprehend for the human end-user. FHHI will work on interpretable representations on different levels and easily graspable explanations formats, in particular for concept-based explanations.

As input, the developed methods require DNN models, potentially.

5.2.1.3 Explainability for transformer base neural networks (TFA-tech-03)

In the realm of deep learning, transformer-based neural networks have emerged as a game-changer, pushing the boundaries of performance in a wide range of tasks, including natural language processing, computer vision, and even automatic image tagging. One of the most intriguing aspects of these networks, however, is their innate complexity, which often leads to a lack of transparency and understanding of their internal workings.

The role of explainability in these networks is explored in this context. Explainability techniques aim to make the decisions made by these complex models more understandable to humans. These techniques can help uncover the "why" behind a model's prediction, contributing to increased transparency and trust. In the context of image tagging, this might involve providing visual explanations that highlight the parts of the image that were most influential in determining the assigned tags.

In conclusion, the integration of explainability techniques in transformer-based neural networks holds significant promise for the future of automatic image tagging and deep learning as a whole. By shedding light on the decision-making process of these complex models, explainability not only aids in improving model performance and efficiency but also plays a pivotal role in building trust in these advanced systems.

5.2.1.4 DNN Robustness (TFA-tech-04)

Robustification of deep neural networks (DNNs) is a critical aspect in enhancing their performance and reliability. One approach that has gained attention is the utilisation of geometric-inspired loss functions. These loss functions aim to incorporate geometric properties into the training process of DNNs, enabling the networks to better handle uncertainties and adversarial perturbations. By

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incorporating geometric principles, such as metric learning and manifold regularisation, into the loss formulation, DNNs can acquire enhanced generalisation capabilities and improved robustness to outliers and perturbations in the input data. Geometric-inspired loss functions provide an effective means to guide the network's learning process towards regions of the input space that exhibit desirable geometric properties, such as compactness or separability, thereby promoting more discriminative representations. Furthermore, these loss functions encourage the network to exhibit desirable behaviours, such as smoothness and invariance to specific transformations, contributing to the overall stability and robustness of the learned models. By robustifying DNNs through the integration of geometric-inspired loss functions, we can foster the development of more reliable and resilient deep learning systems capable of handling real-world challenges and adversarial scenarios.

In the context of TEMA robustification techniques are expected to be applied either during the training process of deep neural networks or as a post processing step, accepting as input the parameters and metadata of pretrained models and extracting new, robust ones.

5.2.1.5 Fire/smoke/flood/person detection (TFA-tech-05)

Deep object detection is a prominent field in computer vision that has revolutionized the ability to identify and locate objects within complex visual scenes. It encompasses a set of techniques and algorithms that leverage deep learning models, particularly convolutional neural networks (CNNs) and Transformers, to achieve highly accurate and efficient object detection. By employing multiple layers of convolutional operations and multihead attention blocks, these models can effectively extract rich feature representations from input images, enabling the detection of objects across various scales and orientations.

Deep object detection algorithms play a vital role in enhancing safety and security across different domains. Whether it is identifying smoke in fire-prone areas, detecting flames for early fire prevention, recognizing flood-affected regions, or monitoring human presence for security purposes, these advanced algorithms and techniques enable proactive decision-making, rapid response, and effective mitigation strategies.

Deep object detection algorithms take as input visual data, typically in the form of images or video frames, and output the locations and classifications of objects present within the input data. The input to the algorithm consists of one or more RGB images or video frames, which are represented as a matrix of pixel values. These images or frames are expected to be captured through drone-based cameras. Regarding the outputs, object locations are represented as bounding boxes that enclose the detected objects. These bounding boxes are defined by their coordinates, typically represented as the top-left corner coordinates, width, and height. They provide information about

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the spatial extent of each detected object within the input data. Additionally, the object detection algorithm also provides object classifications, which involve assigning a label or class to each detected object. Common object classes related to TEMA context can include people, cars, buildings, animals, vegetation, smoke, fire, or flood. These labels provide semantic information about the type of object present within each bounding box, enabling further analysis and decision-making.

For the training process, the model utilizes both real-world and synthetic data. The real-world dataset comprises a myriad of fire and smoke images, collected under various conditions and environments. This diverse dataset enables the model to learn from a multitude of scenarios, enhancing its generalizability. Synthetic data is generated to simulate more specific or rare fire and smoke conditions that might not be adequately represented in the real-world dataset. The combination of both data types ensures a comprehensive training ground, allowing the model to learn and distinguish between different intensities of fire and various levels of smoke density effectively.

Throughout the project, continuous data collection and synthetic data generation is employed to further refine the model. Regular retraining with new and diverse data allows the model to adapt to evolving scenarios and conditions, improving its accuracy and predictive power over time. To avoid overfitting and ensure robustness, the model is validated against unseen data, which includes a blend of both collected and synthetic images. This constant feedback loop of training, validation, and data generation aids in creating a model that is not only highly accurate but also adaptable to a wide range of real-world conditions.

The performance metrics of the model, including precision, recall, and mean Average Precision (mAP), are periodically evaluated to track the impact of the new data on its effectiveness. The use of explainability techniques remains central to this process, providing insights into how the new data affects the model's decision-making process. By highlighting the specific areas of an image that lead to the detection of fire or smoke, these techniques can indicate where the model has improved or if certain areas require more training data. This approach not only enhances the model's performance but also builds trust in its decisions, making it a reliable tool for fire and smoke detection in diverse and evolving scenarios.

5.2.1.6 Fire/flood/background segmentation (TFA-tech-06)

Fire/flood/background segmentation based on deep neural networks utilises advanced computational techniques to classify and distinguish different regions within drone-based images or video frames. During the segmentation process, the deep neural networks analyse the input data

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using their learned knowledge and hierarchical representations to identify and delineate the distinct regions of interest.

The system for semantic segmentation specifically targets images featuring fire, smoke, or flooding. Semantic segmentation refers to the process of partitioning an image into segments, each of which corresponds to an object or part of an object, with the aim to understand the image at a pixel level. In this case, the system is designed to identify and segment regions of an image associated with fire, smoke, or flooding. This year has seen incredible developments in semantic segmentation, Microsoft's X-Decoder or Segment Anything from Meta have become the state of the art in this field. During TEMA development all these advances will be tested and eventually incorporated to this segmentation tool.

The output of the segmentation process will be a pixel-level segmentation map or a binary mask that indicates the spatial extent and boundaries of fire, flood, and background areas within the input images. Each pixel in the output map is assigned a label corresponding to its predicted class, such as fire, flood, or background. This segmentation map enables effective and efficient analysis, visualisation, and subsequent decision-making based on the identified regions of interest. By segmenting the input data, this deep neural network-based approach provides crucial insights for various applications, including disaster management, surveillance, and environmental monitoring.

5.2.1.7 Person re-identification (TFA-tech-07)

Multi-camera person re-identification systems operate on a sequence of intricate processes that leverage the power of deep learning techniques. The fundamental objective of these systems is to recognize an individual across various non-overlapping camera feeds. These systems are predominantly used in surveillance scenarios.

Given the varying conditions across different cameras (such as changes in lighting, perspective, and occlusion), these systems incorporate mechanisms to handle these disparities. Techniques such as domain adaptation or normalisation methods are used to ensure consistent feature representation across different cameras. Some systems may also employ attention mechanisms to focus on more discriminative features, thereby enhancing the robustness of the re-identification process.

Within TEMA, this system could be applied in disaster scenarios to detect, track and re-identify people, whether they are first responders or victims.

5.2.1.8 Satellite-based flood detection and assessment (TFA-tech-08)

The machine-learning-based flood processor for Copernicus Sentinel-1 and -2 satellite sensors continuously monitors floods, detects anomalies, can alert automatically and outputs flooded areas, permanent water and secondary products such as flood duration. Complementary to the

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systematic water monitoring, methods are provided that can perform object detection in very high-resolution satellite and aerial images on an ad-hoc basis.

During the TEMA project, DLR-DFD will work on supporting additional sensors, improving the generalisation ability of models as well as examining whether multiple tasks can be combined such as the monitoring and assessment of floods and burnt areas.

It requires as input data coming from different data sources:

- **Satellite and aerial images**: The flood processor takes as an input satellite imagery of sensors Sentinel-1 Ground Range Detected (GRD), and Sentinel-2 MSI. Object detection is based upon the analysis of on-demand satellite VHR optical, as well as on-demand aerial VHR optical such as drones images.
- **Auxiliary data**: It uses the Copernicus Global and European Digital Elevation Model (Copernicus DEM) as base data.

Output data can be provided in different formats:

- Flooded areas, permanent water and secondary products: OGC WMS and STAC
- Detected objects (e.g. vehicles, buildings): GeoJSON

5.2.1.9 Satellite-based Forest fire detection and assessment (TFA-tech-09)

The **deep-learning-based burnt area processor for Copernicus Sentinel-3 and MODIS satellite sensors** monitors in near-real time (NRT) burnt areas, enables the monitoring of fire evolution over time, can use very high resolution satellite and aerial images and outputs burnt areas and burn severity.

During the TEMA project, DLR-DFD will work on improving the generalisation ability of trained learning machines in terms of geographical coverage and usage of various sensors. In addition, novel methods for handling data scarcity during DNN training will be examined, wildfire burnt areas derivation automated and the frequency of wildfire burnt area product availability increased.

It requires as input data coming from different data sources:

- **Optical satellite and aerial images**: The burnt area processor takes as an input satellite imagery of sensors Sentinel-3 OLCI, Aqua/Terra MODIS, Sentinel-2 MSI and on-demand aerial VHR optical such as drones images
- **Auxiliary data**: It uses the NASA FIRMS and ESA WorldCover as base data

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Output data can be provided in different formats over an API:

- **Burnt areas (NRT)**: OGC WFS and GPKG

5.2.1.10 Privacy preservation during visual analysis (TFA-tech-10)

TEMA technologies require access to large amounts of visual data, which can potentially contain sensitive or personally identifiable information. To address this concern, privacy-preserving techniques based on deep neural networks will be employed to safeguard the privacy of individuals within the analysed data. The outputs of TEMA technologies such as flood and background segmentation and smoke, fire, flood and person detection are expected to fed into deep neural networks generating on-the-fly/real-time gender-neutral image samples to replace any detected identity identifiers (e.g., faces, clothes, vehicle plates, etc.) with aesthetically pleasing and utilisable substitutes to be exploited in the remainder of the analysis performed by TEMA. The substituted representations ensure that sensitive information is not exposed, allowing for further analysis without compromising individuals' identities or violating privacy regulations.

5.2.1.11 Geo-social media analysis (TFA-tech-11)

Social media platforms can provide manifold information in different modalities (text, imagery, location) in near-real time. Most importantly, TEMA uses georeferenced social media posts, i.e., posts with a geographic position (e.g., GPS) attached, which adds information about the geographic context of a post.

For use in disaster management, this huge pool of data has to be filtered. This is done by 1.) identifying semantic topics that are related to a disaster, and 2.) by multi-dimensional relevance classification, i.e. taking spatial, temporal and semantic relevance into account.

Based on the textual content, hotspots of affected areas can then be detected, using state-of-the-art machine learning and geostatistical methods.

Furthermore, sentiment analysis algorithms provide information about how severely people and geographic areas are affected by a disaster and how people feel in the disaster area (desperate, contained, hopeful, etc.).

The system will use the outputs of these analyses, which can be provided as diverse geodata formats (e.g. GeoJSON, WFS). Data from a PostgreSQL / PostGIS database is envisaged as input.

5.2.1.12 Sentiment analysis for short texts (TFA-tech-12)

Text sentiment analysis plays a crucial role in comprehending public opinion and emotions expressed on various social media platforms. Specifically, when examining Twitter posts pertaining to natural disasters, Transformer based deep neural architectures have emerged as a powerful tool

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for extracting sentiment information. Deep neural networks are adept at capturing the intricate contextual nuances and inherent complexities present in tweets related to such calamities. By leveraging their ability to learn hierarchical representations, these networks can effectively analyse the sentiment expressed in the text, enabling a more comprehensive understanding of the emotional states of individuals affected by natural disasters. Through their sophisticated architectures, deep neural networks facilitate the identification of sentiment polarity, including positive, negative, or neutral sentiments, within the context of disaster-related tweets. This capability provides valuable insights to stakeholders, such as emergency response teams and humanitarian organisations, aiding them in assessing the immediate impact of natural disasters on affected populations. Consequently, the application of deep neural networks for sentiment analysis on Twitter posts regarding natural disasters holds significant potential in enhancing disaster response strategies, facilitating targeted support, and fostering a more proactive and empathetic approach towards mitigating the effects of such catastrophic events.

The inputs to these networks typically consist of preprocessed textual data, which may include tweet texts, user handles, hashtags, and other relevant features. Text preprocessing techniques, such as tokenization, stemming, and removal of stop words, are applied to ensure the data is in a suitable format for analysis. The output of the sentiment analysis process is a sentiment label or score associated with each tweet, indicating whether the sentiment expressed is positive, negative, or neutral. These outputs provide valuable insights into the emotional response of Twitter users towards natural disasters, enabling decision-makers and researchers to gauge the overall sentiment and public perception surrounding such events.

5.2.1.13 Contrastive image-language models (TFA-tech-13)

Contrastive Image-Language models, epitomised by OpenAI's CLIP (Contrastive Language–Image Pretraining), represent a groundbreaking development in the realm of AI. These models are trained on a large number of images and their associated text, learning to understand and map the intricate relationships between visual and textual data. The underlying principle of CLIP and similar models involves training the model to recognize which images and text pairs are from the same data point (a positive pair) and which are not (negative pairs). This is accomplished through a contrastive loss function that aims to reduce the distance in the model's latent space between an image and its corresponding text for positive pairs and increase it for negative pairs. As a result, the model learns to generate embeddings that bring together semantically similar images and text, thereby facilitating tasks like zero-shot learning across a wide range of natural language instructions and diverse image types.

These models will be used in TEMA to analyse the semantic coherence of posts such as tweets, allowing the system to provide evidence that there are floods or fires being reported by citizens.

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5.2.1.14 Federated Learning (TFA-tech-14)

Federated Learning (FL) is a cutting-edge technology framed within the distributed and intelligent systems field. This was born from the twofold need of taking advantage of several devices deployed all around the world and maintaining a high level of privacy and reservation while applying artificial intelligence (AI) methods.

In the context of TEMA, mobile (e.g., drone) and stationary (e.g., weather station) devices collect data in batch or stream for training AI models. A legacy approach would lead to building multiple models for resolving the same task. Each model would be based on different and often not independent and identically distributed (IID) dataset, resulting in inconsistent inference values. Instead, FL integrates all local models (related with the resolution of a specific task) on a unique computing point, creating a global model by applying an algorithm strategy (e.g., FedAvg). The model is, therefore, distributed all over the deployed devices. This turns into having always a unique model for solving the specific task. The FL is generally applied over a client-server model, where the clients train the local model and the server averages the global model. Further architectures of FL are applied over a decentralised network infrastructure, while using a peer-to-peer model.

We will build a framework for both centralised and decentralised FL. Input data are the weights extracted (e.g., get_weights()) from the AI local models built on the edge and the output data are the average weights computed in the aggregator. Such data are, therefore, set and updated (e.g., set_weights()) in the local models.

5.2.1.15 Data scarcity, synthetic data generation pipeline (TFA-tech-15)

Diffusion models have emerged as a powerful tool in the generation of synthetic images, and their application can significantly address the issue of data scarcity, particularly in specialised fields such as fire, smoke, and flood detection.

The process of training robust detectors for fire, smoke, and floods often encounters a significant challenge: the lack of abundant and diverse real-world data. These events, while critical to predict and understand, are thankfully not everyday occurrences, leading to a paucity of available training data. This is where diffusion models can play a pivotal role.

Diffusion models, in essence, reverse the process of adding noise to an image, gradually refining a random noise sample into a coherent image that resembles those in the training set. This unique ability allows them to generate realistic and diverse synthetic images, replicating various scenarios of fire, smoke, and floods.

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By supplementing the real-world data with these synthetic images, the training dataset can be significantly expanded. This increased data diversity can help the detector model learn more comprehensive representations and generalise better to unseen scenarios. The synthetic images can simulate a wide range of conditions, such as different fire intensities, smoke densities, or flood levels, which may not be adequately represented in the available real-world data.

Furthermore, the quality of synthetic images generated by diffusion models can be controlled, enabling the simulation of both common and rare scenarios, thereby ensuring the model is well-prepared for a broad spectrum of situations.

In conclusion, diffusion models can effectively mitigate the issue of data scarcity in training detectors for fire, smoke, and floods. By generating high-quality synthetic images, they can enhance the diversity and comprehensiveness of the training data, leading to more robust and reliable detection models.

5.2.2 Phenomenon Prediction and Decision-Making

Table 13: Overview of Phenomenon prediction and decision making technologies

ID	Technology	Description
PDM-tech-01	Forest Fire Simulation	Operational forest fire simulator (FireSim) that provides the expected fire progression and behaviour layers results in space and time.
PDM-tech-02	3Di Hydrodynamic simulation	Hydrodynamic simulation software to simulate climate events to map, mitigate, and manage the impact of floods. Flood maps with water depths, arrival time and flood extents are delivered.
PDM-tech-03	Realistic 3D smoke modelling and fire detection	System consisting of ground-based sensors and autonomous drone-carried sensors for smoke detection and corresponding forest fire localization in non-visual domain (using wind sensors and chemical(CO_2) sensors for smoke).
PDM-tech-04	Drone planning	Functionality to optimally plan the trajectories of drones and deployment of sensors suitable for monitoring. The technology will allow autonomous navigation of the drones to optimal sampling locations in order to facilitate data collection.

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PDM-tech-05	Information fusion	Combination of different sources of information to obtain an accurate monitoring of a forest fire or flood.
PDM-tech-06	Data-fusion-based decision support and process triggering	Data-fusion-based decision support service for early remote sensing data acquisition and processing

5.2.2.1 Forest Fire Simulation (PDM-tech-01)

Forest fire simulation will be provided in TEMA through Wildfire Analyst FireSim. It is a basic tool in the control and management of these natural disasters. The possibility of knowing the arrival times of the front at each point of the territory, as well as other variables such as main fire paths, rate of spread, etc., allows for improved decision making and the establishment of an optimal operational system.

Wildfire Analyst - FireSim is a software that provides real-time analysis of wildfire behaviour and simulates the spread of wildfires. Behaviour analysis and simulations are completed in seconds, providing results that afford timely decision making. For wildland fire, time is of the essence, and FireSim was specifically architected to support initial attack situations, giving the operational team in charge of fire management the critical intelligence needed to support suppression and resource allocation. FireSim provides a range of analytical outputs, available as GIS files and maps, that empower more accurate and timely decision making.

In TEMA, TSYL will adapt and improve their operational forest fire simulator by conducting research regarding the data assimilation model and the simulation results calibration model, as well as through the use of calibrated HR weather input data, with the goal to provide highly accurate near-real-time wildfire models.

5.2.2.2 3Di Hydrodynamic simulation (PDM-tech-02)

To increase the predictive capabilities of TEMA in respect to Flood, 3Di will be used. 3Di is a Physics-Based model which is able to simulate the behaviour of water in both rural and urban areas. With 3Di TEMA is able to simulate the impact of heavy rainfall and/or river flooding. Flood mitigation and flood duration provide valuable insight to assess damage, blocked infrastructure and in worst case loss of life.

3Di is very suitable for use within TEMA:

- The mathematical approach (subgrid) enables the simulation engine to calculate large areas taking into account high resolution DEM without losing computational time in respect to a non-subgrid approach.

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- It is at this moment one of the few calculation cores that runs interactive. Users are able to pause, interact with the model and continue a simulation. For example, deploy a mobile barrier. Especially interesting for doing live what if scenarios.
- 3Di is developed with (open)API based. Every action, every control is activated (can only be activated) via the (open)API of the software. It will seamlessly integrate in TEMA.

In TEMA 3Di will be linked to PDM-tech-05. It will send flood simulation and recieve satellite data to cross check flood extents. By performing an assimilation between the current flood forecast and the satellite imagery an improved state is created that is forced to the next flood simulation. This feedback can continue upfront, during and after a flood event. Creating valuable life saving information for stakeholders involved in disaster risk management.

When flooding hits, you want the information as soon as possible delivered to the end users. This will be challenged in TEMA for improving the computational time. There are three approaches that are under investigation: (i) improve mathematical approach, (ii) use different hardware (CPU), and (iii) parallelisation. This will surely lead to (near) real-time flood forecasts that in future support a more data driven approach in disaster risk management.

5.2.2.3 Realistic 3D smoke modelling and fire detection using model-based and AI-based methods to detect possible forest fires. (PDM-tech-03)

The use of drones for forest fire detection and monitoring historically relied on visual sensors working in visible (RGB) and infrared (TIR) parts of the electromagnetic spectrum. Although the latter offer instantaneous information about spatial location of fire front lines and hotspots, information about wind directions and speed – which is one of the major factors impacting fire propagation – as well as accurate smoke concentration characterization remains elusive. Moreover, especially in early phases of forest fires the amount of generated smoke might not be sufficient to be detectable with visual sensors. Instead, chemical sensors that respond to the elements present in the smoke, such as particles, or increased CO2 levels, can be used in addition to (or even instead of) visual sensors. Furthermore, these sensors can also be used to compute accurate 3D models of the smoke concentration distribution that, combined with other fire modelling tools, wind speed measurement and modelling, can provide an increased situational awareness and more complete forest fire dynamics.

The latter is a complicated dynamical process. Its perception is further complicated by the restrictions of typical chemical sensors: they are often rather slow, and provide a concentration value at a single point (in-situ sensors). This requires use of side information or domain knowledge

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to compensate for these deficiencies. To address these issues the envisioned technology will therefore make use of several key components:

Swarm of Drones: Use of multiple cooperative robotic platforms (drones). This will allow sampling the smoke concentrations and wind speeds at spatially different locations more efficiently. Moreover, the swarm should also provide a distributed computing infrastructure on the edge, akin to federated learning.

Information Fusion: Fusion of information in visual and nonvisual domains. This will allow for a more stable reconstruction of smoke and wind dynamics and its tight coupling to other information sources. The diverse sources of information, such as satellite-based forest fire detection, forest fire simulation, visual fire and smoke detection, drone-based imagery and photogrammetry are fused together to generate side constraints/boundary conditions for the corresponding smoke propagation modelling and wind mapping.

Physics-Based Modelling: Physics-based, or more specifically, Partial Differential Equation based modelling of the smoke and wind dynamics in data-scarce regime. Physics-based approach used in the project will, on the one hand, compensate for high uncertainty in the smoke from fires in the absence of the training data sets that would allow for a purely data-driven approach. On the other hand, this will also permit a better interpretability of the obtained results. Moreover, the resulting models can be utilized for enabling information-seeking behaviour of the drones – autonomous generation of drone flight trajectories towards optimal measurement locations.

5.2.2.4 Drone planning (PDM-tech-04)

It is an automated response planning engine for optimal dynamic UAVs placement. The plans will be shown to the human operator as recommendations (see T5.3) and, in the case of drones, optionally executed autonomously by the vehicles carrying the sensors (see T6.1). This engine endows the following processing modules:

- Plan builder / optimizer
- Plan refining
- Task allocation
- Plan merging
- Task and synchronisation managers

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5.2.2.5 Information fusion (PDM-tech-05)

An information fusion engine for optimal estimation of the status of events (fires/floods). It will integrate multi-modal, temporal and spatial multi-resolution information provided by the processing of satellite imagery, drone images, in-situ sensors (meteo data, smoke & gas concentration, wind speed and temperature) using fire propagation models, 3D terrain models. The fused information can be used for: precise phenomenon prediction, drone planning and sensor placement, and geovisual analytics. This engine endows the following processing modules:

- Optimal information fusion using georeferenced Bayesian Filtering tools
- Data association
- Observations consistency filtering

5.2.2.6 Data-fusion-based decision support and process triggering (PDM-tech-06)

The novel decision support service for wildfires and floods processes disaster-related WWW data (i.e. official alerts) and spatiotemporal event simulation results fully automatically in order to detect disaster AOIs and event times. Furthermore, it retrieves satellite position and acquisition data fully automatically and informs end-users quickly when and which remote sensing data will be available for a crisis region.

The decision support service provides end users with information on upcoming satellite data acquisitions for a defined area of interest (from end-user perspective) which significantly reduces up to half of the latency between warning, e.g., provided by hydrometeorological services, EFAS, EFFIS and data information products delivered by Copernicus EMS rapid mapping. Workload from manual retrieval of satellite position and acquisition data is reduced though the automatization of previously manual operations in the satellite-based rapid mapping process.

It requires as input data coming from different data sources:

- Public disaster alerts: data provided over REST APIs by GDACS and others
- Disaster simulations: data provided by TEMA partners TSYL and NS
- Satellite acquisition data: provided by DLR over gRPC

Output data can be provided in different formats over an API:

- Human-readable decision proposals: Provided via e-mail or any other channel in text-based format

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- Machine-readable geospatial data fusion product: GraphQL

5.2.3 Data acquisition, simulation and visualisation

ID	Technology	Description
SV-tech-01	Drone-based image and data acquisition	Functionality to acquire images and other data from drone sensors
SV-tech-02	Digital Enabler	The Digital Enabler is the Engineering's Urban Platform
SV-tech-03	3D computer vision (SfM)/ Photogrammetry	Co-Exploitation of multiple heterogeneous visual data modalities
SV-tech-04	Geovisual Analytics	Cluster-based system for rapid retrieval of large-scale geospatial data using in-memory technologies to perform spatial data processing and map visualization
SV-tech-05	Geospatial information retrieval	DNN-based geospatial information retrieval (GIR) algorithms for rapid retrieval of large-scale geospatial data.
SV-tech-06	Extended Reality-based interactive visualisation system	Merging of the geospatially referenced Digital Twin with geovisual map into a common, detailed semantic 3D TEMA map
SV-tech-07	Smartdesk	Smartdesk is a solution for collaboration in situation management with a user-friendly interface with touch controls.

5.2.3.1 Drone-based image and data acquisition (SV-tech-01)

Development for drones with capabilities to transparently acquire images and data from its sensors and make them available (transparently of the involved technologies and autopilots) to the rest of TEMA modules. The cameras and sensors are TBD. The drones receive plans from the operator recommended by drone planning and the acquired images and data will be used fused information can be used for: drone images analysis and segmentation, phenomenon prediction (fire, flood, smoke status prediction), information fusion, geovisual analytics, and the HE TEMA visualisation tools.

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The drones will be based on multi-copter platforms endowed with the following functionalities:

- Accurate pose estimation (GNSS+IMU)
- Autonomous navigation capacity (controller, trajectory following functionalities)
- All required sensors
- Sufficiently good communication capacities.

5.2.3.2 Digital Enabler (SV-tech-02)

Digital Enabler (DE) is a **data-driven, native cloud, ecosystem platform**. It allows you to discover, integrate, harmonise, visualise scattered and multi-source data.

DE is based on the **NGSI FIWARE API** uses the Ngsi/Ngsi-LD information model to manage context data internally.To acquire data from external devices and sources, it can rely on a number of adapters that allow it to interact with devices supporting disparate protocols and formats, (e.g., LWM2M over CoaP, JSON or UltraLight over HTTP/MQTT, OPC-UA, Sigfox or LoRaWAN). These are non-exhaustive examples of the adaptation possibilities.

It requires as input data coming from different data sources, as:

- **Open Data**: It can federate OpenData services, collecting and making available datasets from disparate sources
- **Social Network**: It can collect data for processing through its object storage and big data management capabilities
- **Drone and Satellite data**: in general, all audio-video media, could be collected in the object storage and/or big data storage provided by the DE in the same way as data from SN
- **IoT**: It is able to receive near real time data from devices and sensors in different formats and standard protocols

DE allows creating dashboards through a large set of widgets library:

- to manage different kind of datasets (File, REST, Query, etc...)
- to create (self-service) interactive dashboards, like:ù

○ Maps

○ Charts

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- External applications
- IoT Control widgets

- to reduce the time to market of applications.

5.2.3.3 3D computer vision (SfM)/Photogrammetry (SV-tech-03)

TEMA will advance the SoA for generating precise Digital Twins of the afflicted areas in real-time, using 3D computer vision (Structure from Motion)/photogrammetry methods. Multiple, heterogeneous visual data modalities (e.g., photographs from ground units, footage from drone-mounted cameras, satellite images) will be co-exploited. All these data will be geospatially referenced (e.g., using GNSS RTK PPK).

5.2.3.4 Geovisual analytics (SV-tech-04)

The term "geovisual analytics" refers to the science of using interactive visual interfaces to enhance analytical reasoning with spatial data. It focuses on novel approaches to analysis rather than novel approaches to visualisation or computational methods alone. The proposed technology is constituted of a cluster computing system for processing large-scale geospatial data. It provides a range of tools for geospatial analytics, including spatial data processing, indexing, and visualisation. The system will use in-memory technologies to handle both the data processing and map visualisation at the same time. This will remove the need for extra components to manage the process and will also eliminate the need to access the disk during the process. The inputs needed for this system are large-scale geospatial data. Several formats are supported, e.g., Geojson, GeoTiff, CSV, etc.

5.2.3.5 Geospatial information retrieval (SV-tech-05)

Deep geospatial information retrieval based on drone images or video frames involves leveraging the capabilities of deep learning algorithms to extract and analyse valuable geospatial information from aerial imagery. Deep neural networks are trained to extract relevant features and identify geospatial objects or patterns from the images. The extracted features are georeferenced and analysed within the context of the real-world coordinates. This involves associating the identified objects or patterns with specific geographic locations. Spatial analysis techniques can then be applied to derive meaningful insights from the extracted geospatial information.

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The geospatial information retrieved from the drone images can be queried and retrieved based on specific search criteria or user requirements. This can include searching for specific objects, measuring areas or distances, or identifying changes over time. Geospatial information retrieved from drone images can be used in conjunction with the constructed digital twin enhancing the capabilities of analysis and visualisation. The digital twin provides a virtual representation of the physical environment, allowing for real-time synchronisation and integration of geospatial data from drones. This integration enables interactive exploration and manipulation of the retrieved information within a comprehensive and dynamic virtual environment.

5.2.3.6 Extended Reality-based interactive visualisation system (SV-tech-06)

A powerful and versatile XR-based application that provides all necessary information for operators and first responders while being easy-to-use and easy-to-understand. The visualisation will provide information to the operator about:

- XAI-based decisions
- Fire/flood propagation
- Georeferenced points of interest
- Weather situation
- etc.

5.2.3.7 Smartdesk (SV-tech-07)

A smart desk is a table with a touchscreen embedded inside it, it can be built in many different ways, but one in the demo case in KAMK is TV inside wooden-frame surrounding it, plugged into a computer with a touch-enabling frame outside the protective glass panel on top of the TV.

Smart desk should have different input sources from analytics or other services:

- T3.2 Remote sensing and processed data
- T4.1 Event (fire/flood) model evolution

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In the TEMA project, Smart desk would be used as a command centre to visualise and direct workers on site. Workers on site could have smartphones or other devices that can receive input from a “command centre” (smart desk).

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5.3 Matching technologies with end-user requirements.

The following table presents the requirements that matched with the technologies that will be implemented in the TEMA Solution. As it depicts all the user requirements will use TEMA technologies for their solutions.

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No Functional Requirements

	TFA-tech-01	TFA-tech-02	TFA-tech-03	TFA-tech-04	TFA-tech-05	TFA-tech-06	TFA-tech-07	TFA-tech-08	TFA-tech-09	TFA-tech-10	TFA-tech-11	TFA-tech-12	TFA-tech-13	TFA-tech-14	TFA-tech-15	PDM-tech-01	PDM-tech-02	PDM-tech-03	PDM-tech-04	PDM-tech-05	PDM-tech-06	SV-tech-01	SV-tech-02	SV-tech-03	SV-tech-04	SV-tech-05	SV-tech-06	SV-tech-07
EU-RQ-NF-01	X	X	X	X												X	X				X						X	X
EU-RQ-NF-02					X		X			X	X	X	X	X								X	X					
EU-RQ-NF-03		X						X	X		X	X	X	X		X	X	X	X		X	X	X		X	X		
EU-RQ-NF-04																				X			X	X			X	X
EU-RQ-NF-05																							X	X		X	X	X
EU-RQ-NF-06			X		X	X									X			X				X						
EU-RQ-NF-07																												
EU-RQ-NF-08																				X	X						X	X

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Functional Requirements																												
	TFA-tech-01	TFA-tech-02	TFA-tech-03	TFA-tech-04	TFA-tech-05	TFA-tech-06	TFA-tech-07	TFA-tech-08	TFA-tech-09	TFA-tech-10	TFA-tech-11	TFA-tech-12	TFA-tech-13	TFA-tech-14	TFA-tech-15	PDM-tech-01	PDM-tech-02	PDM-tech-03	PDM-tech-04	PDM-tech-05	PDM-tech-06	SV-tech-01	SV-tech-02	SV-tech-03	SV-tech-04	SV-tech-05	SV-tech-06	SV-tech-07
EU-RQ-FUNC-01	X	X	X	X	X	X		X	X		X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X
EU-RQ-FUNC-02	X	X	X	X						X	X	X	X	X						X	X		X		X	X	X	X
EU-RQ-FUNC-03	X	X	X	X	X	X		X	X					X	X	X	X	X	X	X		X	X	X			X	X
EU-RQ-FUNC-04														X		X	X	X	X				X					X
EU-RQ-FUNC-05					X	X					X	X	X	X		X		X	X	X	X	X	X	X	X	X	X	X
EU-RQ-FUNC-06	X	X	X	X	X		X			X	X		X	X					X	X		X	X	X		X	X	X
EU-RQ-FUNC-07	X	X	X	X	X		X			X	X		X	X					X	X		X	X	X		X	X	X
EU-RQ-FUNC-08					X	X								X	X	X		X	X	X		X	X	X			X	X
EU-RQ-FUNC-09					X	X			X		X	X	X	X		X		X	X	X		X	X	X	X	X	X	X
EU-RQ-FUNC-10		X			X	X					X		X	X		X		X	X	X		X	X	X			X	X
EU-RQ-FUNC-11	X	X	X	X	X	X		X						X					X			X	X	X	X	X	X	X
EU-RQ-FUNC-12					X	X					X	X	X	X	X		X		X	X		X	X	X	X	X	X	X
EU-RQ-FUNC-13	X		X	X	X	X		X	X		X	X	X	X						X		X	X	X	X	X	X	X
EU-RQ-FUNC-14	X	X	X	X	X	X	X	X	X		X		X	X					X	X		X	X	X	X	X	X	X
EU-RQ-FUNC-15					X	X														X			X	X	X		X	X

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5.4 Prioritization on user requirements

In this sector it will be described the prioritisation of the end user requirements. The twenty-three (23) requirements were scaled based on how important each requirement is for the end users. This was achieved by the discussion of the end users when the user requirements were finalised. The categorization of the prioritisation is represented by colour. Red is marked as the category that must definitely be carried out in the TEMA. Orange is marked as the category that should be implemented in TEMA and green as the category that these requirements are nice to have at the solution in TEMA. There is also, one category as grey that it is a requirement that does not fall under the technological solutions of the TEMA project, and it will not be foreseen to cover this need.

Table 14: Scale of Prioritization

Color	Scale
(red)	Must
(orange)	Should
(green)	Nice to Have
(grey)	Not covered

Table 15: Requirements with prioritisation

Req ID	Requirement
EU-RQ-NF-01	The technology used in cases of ND needs to be clean and simple to use
EU-RQ-NF-02	Privacy, Ethics and Data Policy protection

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EU-RQ-NF-03	Information provision as soon as possible
EU-RQ-NF-04	Sharing information and data regarding ND
EU-RQ-NF-05	Coordination between authorities during reconnaissance activities
EU-RQ-NF-06	Ability to operate in rescue activities at night or in heavy rains
EU-RQ-NF-07	Solution of the absence of communication means
EU-RQ-NF-08	Valid warnings
EU-RQ-FUNC-01	Information (footage, images, maps etc.) from the site of the disaster to define event area and extent
EU-RQ-FUNC-02	Geo-Social Media Information
EU-RQ-FUNC-03	Monitor the development, the size of the affected area
EU-RQ-FUNC-04	Local information about weather variables/data (early warning)
EU-RQ-FUNC-05	Reveal fires as they start
EU-RQ-FUNC-06	Teams involved
EU-RQ-FUNC-07	Geolocation of people who are in danger of life

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EU-RQ-FUNC-08	Model of fire propagation
EU-RQ-FUNC-09	Monitor the area of interest for fire revival
EU-RQ-FUNC-10	Response planning for extinguishing fires
EU-RQ-FUNC-11	Available water extinguishing resources from nearby swamps, ponds etc..
EU-RQ-FUNC-12	Flood propagation modelling
EU-RQ-FUNC-13	Estimation of the damages
EU-RQ-FUNC-14	Scarcity of information about the accessibility to settlements (roads, bridges, etc.) in an affected area and relevant resources.
EU-RQ-FUNC-15	Resource planning

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6. Trial Use cases of TEMA

This chapter will describe the first design of the pilot use cases that will be defined in TEMA. As this Task is in an early stage of TEMA project, as well as in the next deliverables with dedicated Task for the pilots, it will be an analytical approach. This Task only provides for a first overview of the use cases that will be refined and linked to the technologies in D2.2 and later in D6.1.

6.1 BRK Floods

Use Case 1.1	
Description	This pilot trial will be based on a historical event and historical data from the flash flood that took place in July 2021 in the Arthal Region, Germany which will be played in real time for TEMA validation. Description of the event: As a consequence of a lengthy and severe rain, which continued for five days, several villages and towns in the German region Ahrtal were flooded. The severe flood caused in this region of Germany led to many search-and-rescue missions while roads and bridges were flooded or destroyed making the work of rescue more difficult.
Goal	The TEMA platform will be used to contribute to early warning of the responsible authorities, PPDR´s and the population, to generate alerts and visualise information of the affected area, to analyse gathered information to gain a better understanding of the natural disaster extent, to provide information on the accessibility of the affected region (regarding roads, bridges, etc.), to gain understanding on how ND is progressing leading to improved NDM.
Area	Ahrtal, Germany

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Technologies tested	• Digital Enabler • Satellite-based flood detection and assessment • Data-fusion-based decision support and process triggering (Decision Support Service for Remote Sensing) • Flood/person detection • Flood/background segmentation • Geospatial information retrieval • Sentiment analysis for short texts (e.g., tweets) • Privacy preservation during visual analysis • DNN Robustness • Federated Learning • Extended Reality-based interactive visualisation system • Information fusion • Drone-based image and data acquisition • Response planning & recommendations • Concept discovery for latent space interpretability of deep neural networks • Human-comprehensible presentation of concept-based explanations • Person re-identification tool • Contrastive image-language models • Data scarcity, synthetic data generation pipeline • Geo-social media analysis (semantic topics, sentiments, hot/cold spots, relevance score, single posts) • Smartdesk • Explainable and robust analytics, Novel trustworthy AI algorithms • Real-time semantic visual analysis and remote sensing, Novel semantic visual analysis and remote sensing AI algorithms • Precise phenomenon prediction • Precise Digital Twin • Geovisual analytics • Augmented Reality and rapid visualisation • Visualisation of AI prediction explanations

This project has received funding from the European Union – European Commission under grant agreement No 101093003

End-Users involved	BRK
Technical Partners involved	AUTH, DLR, ENG, ATOS, USE, ND, NS, PLUS, FHHI, UNIME, KAMK

Data sources and Data used	• Image, video from UAV
	• Satellite images
	    ○ Sentinel-1 Ground Range Detected (GRD) and Sentinel-2 MSI
	    ○ High-res on-demand satellite VHR optical
	• in-situ sensors
	• Topographical data
	• Meteorological data
	• Geosocial media data (text, image and videos)
	• Historic public disaster alerts

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Scenario Flow	Prior to the event ● Test the TEMA solution based on the historical data ● Set-up and calibration of the flood model for the area of interest based on information retrieved from historic flood events, including a wide range of multimodal data. ● Digital Enabler collects data coming from devices installed near the area of interest, analyse and visualise them. ● Based on an historic disaster alert of GDACS and historic information on satellite overpasses before and during the disaster event, decision proposals are manually prepared using the Decision Support Service for Remote Sensing which contain information on when and which remote sensing data would have been available for the AOIs. During the event ● Meteorological data provide an alert for an imminent flood. ● Decision Support Service for Remote Sensing provides for the meteorological alert an updated decision proposal which states when satellite data products are expected to become available to the operator at which time(s) - again, this is prepared based on historic information ● User receives a decision proposal, e.g. as an email, with the satellite data acquisition options for the next few hours/days (based on historic information). ● Data coming from in-situ sensors, installed near the area of interest, exhibit a fast increase of the water level. ● Activate first responder rescue teams and provide the first information ● Flood/person detection services are used to verify the phenomenon and search for people in danger. ● Through geospatial retrieval, detected flood is localised on the constructed digital twin or geo-visual map. ● Interaction between the field and the sat. operation rooms ● First responder create a plan of action for the rescue operations and they brief the teams ● Satellite images are used to detect flooded areas, permanent water, as well as secondary products such as flood duration based on multi-source, AI-based remote sensing data processing for spatio-temporal detection/assessment of flood events, and automated alerting. ● Drone planning will generate aerial robots plans & trajectories for image and data acquisition. ● Drones will survey the area taking images for their processing and segmentation.

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	• Information fusion module will gather results of processing of satellite images, drone images and in-situ sensors to provide the near real-time status of the flood. • If available: High-res satellite and drone images are used to detect objects of interest such as vehicles and buildings (TBD). • Video analysis tools detect people, re-identify them and detect the actions they are performing. • A first situational awareness map is generated after hours followed by more and more accurate versions once additional remote sensing data is acquired over time. • The analysis of social media texts is used to gain a better understanding of the natural disaster extent, and for cross validating the results of detection and segmentation technologies. Remarks: A permanent exchange between sat- providers and the PPDR in the field After the event • Drones survey the area of interest searching for people and providing the size of the affected area.

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Use Case 1.2	
Description	After a heavy rainfall at least nine people have been killed by flooding and mudslides in the southern part of Germany in the region of Bayern, with many presumed missing. As many as 20,000 residents are being forced to evacuate, according to the local authorities. More than 20 rivers have burst their banks across the region, causing 280 landslides, meanwhile up to 27,000 people have been left without power, electricity, and gas. The rescue operations are ongoing.
Goal	The TEMA platform will be used to contribute to early warning of the responsible authorities, PPDR´s and the population, to generate alerts and visualise information of the affected area, to analyse gathered information to gain a better understanding of the natural disaster extent, to provide information on the accessibility of the affected region (regarding roads, bridges, etc.), to contribute to detecting missing persons or those in need of rescue, to gain understanding on how ND is progressing, leading to improved NDM.
Area	Bavaria, Germany

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Technologies tested	• Digital Enabler • Satellite-based flood detection and assessment • Data-fusion-based decision support and process triggering (Decision Support Service for Remote Sensing) • Flood/person detection • Flood/background segmentation • Geospatial information retrieval • Sentiment analysis for short texts (e.g., tweets) • Privacy preservation during visual analysis • DNN Robustness • Federated Learning • Extended Reality-based interactive visualisation system • Information fusion • Drone-based image and data acquisition • Response planning & recommendations • Concept discovery for latent space interpretability of deep neural networks • Human-comprehensible presentation of concept-based explanations • Person re-identification tool • Contrastive image-language models • Data scarcity, synthetic data generation pipeline • Geo-social media analysis (semantic topics, sentiments, hot/cold spots, relevance score, single posts) • Smartdesk • Explainable and robust analytics, Novel trustworthy AI algorithms • Real-time semantic visual analysis and remote sensing, Novel semantic visual analysis and remote sensing AI algorithms • Precise phenomenon prediction • Precise Digital Twin • Geovisual analytics • Augmented Reality and rapid visualisation • Visualisation of AI prediction explanations

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End-Users involved	BRK, Germany
Technical Partners involved	AUTH, DLR, ENG, ATOS, USE, ND, NS, PLUS, FHHI, UNIME, KAMK
Data sources and Data used	● Image, video from UAV ● Satellite images ○ Sentinel-1 Ground Range Detected (GRD) and Sentinel-2 MSI ○ High-res on-demand satellite VHR optical ● in-situ sensors ● Topographical data ● Meteorological data ● Geosocial media data (text, image and videos) ● Public disaster alerts ● Satellite acquisition data
Scenario Flow	Prior to the event ● Test the TEMA solution from PPDR under field conditions ● Set-up and calibration of the flood model for the area of interest based on information retrieved from historic flood events, including a wide range of multimodal data. ● Digital Enabler collects data coming from devices installed near the area of interest, analyse and visualise them. ● After constantly monitoring public disaster alerts (GDACS + BBK) Decision Support Service for Remote Sensing automatically detects an early warning for the crisis area, identifies the affected AOIs, retrieves satellite position and acquisition data, provides information on when and which remote sensing data will be available for the AOIs. During the event ● Meteorological data provide an alert for an imminent flood. ● Decision Support Service for Remote Sensing provides for the meteorological alert an updated decision proposal which states when satellite data products are expected to become available to the operator at which time(s).

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	• User receives a decision proposal, e.g. as an email, with the satellite data acquisition options for the next few hours/days. • Data coming from in-situ sensors, installed near the area of interest, exhibit a fast increase of the water level. • Activate first responder rescue teams and provide the first information • Flood/person detection services are used to verify the phenomenon and search for people in danger. • Through geospatial retrieval, detected flood is localised on the constructed digital twin or geo-visual map. • Interaction between the field and the sat. operation rooms • First responder create a plan of action for the rescue operations and they brief the teams • Satellite images are used to detect flooded areas, permanent water, as well as secondary products such as flood duration based on multi-source, AI-based remote sensing data processing for spatio-temporal detection/assessment of flood events, and automated alerting. • Drone planning will generate aerial robots plans & trajectories for image and data acquisition. • Drones will survey the area taking images for their processing and segmentation. • Information fusion module will gather results of processing of satellite images, drone images and in-situ sensors to provide the near real-time status of the flood. • If available: High-res satellite and drone images are used to detect objects of interest such as vehicles and buildings (TBD). • Video analysis tools detect people, re-identify them and detect the actions they are performing. • A first situational awareness map is generated after hours followed by more and more accurate versions once additional remote sensing data is acquired over time. • The analysis of social media texts is used to gain a better understanding of the natural disaster extent, and for cross validating the results of detection and segmentation technologies. Remarks: A permanent exchange between sat- providers and the PPDR in the field After the event • Drones survey the area of interest searching for people and providing the size of the affected area. • Drones are equipped with sensors to enable geolocalization of objects/people.

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6.2 RAS Fires

Use Case 2	
Description	A historical scenario will be played out in real time for TEMA validation. A widespread forest fire started due to undefined causes provoking serious damages at Montiferru (central Sardinia). The fire lasted several days, with several re-ignitions affecting an area of thousands of hectares.
Goal	The TEMA platform will be used to build fire propagation models, to generate alerts and visualise information of the affected area and to analyse gathered information to gain a better understanding of the natural disaster extent, and for cross validating the results of detection and segmentation technologies. The TEMA platform will also be used for examining the conditions of post-event territory, with particular regard to the implications for geomorphological risk.
Area	Montiferru, central Sardinia
Technologies tested	• Digital Enabler • Satellite-based forest fire detection and assessment • Fire/smoke/person detection • Fire/background segmentation • Geospatial information retrieval • Sentiment analysis for short texts (e.g., tweets) • Privacy preservation during visual analysis • DNN Robustness • Federated Learning • Extended Reality-based interactive visualisation system • Information fusion • Drone-based image and data acquisition • Response planning & recommendations • Concept discovery for latent space interpretability of deep neural networks • Human-comprehensible presentation of concept-based explanations

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	• Person re-identification tool • Contrastive image-language models • Data scarcity, synthetic data generation pipeline • Geo-social media analysis • Smartdesk • Explainable and robust analytics, Novel trustworthy AI algorithms • Real-time semantic visual analysis and remote sensing, Novel semantic visual analysis and remote sensing AI algorithms • Precise phenomenon prediction o Wildfire Analyst. FireSim • Precise Digital Twin • Geovisual analytics • Augmented Reality and rapid visualisation • Visualisation of AI prediction explanations • 3D smoke modelling and fire detection
End-Users involved	RAS
Technical Partners involved	AUTH, DLR, ENG, ATOS, USE, TSYL, ND, NS, PLUS, FHHI, UNIME, KAMK

Data sources and Data used	• Image, video from UAV
	• Satellite images:
	    o Sentinel-3 OLCI
	    o Aqua/Terra MODIS
	    o Sentinel-2 MSI
	• In-situ sensors, including wind and smoke concentration measurements
	• Topographical data
	• Fuel model data (type and structure of vegetation)
	• Meteorological data
	• Geosocial media data (text, image and videos)
	• Geomorphological data

Scenario Flow	Prior to the event

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	• Set-up and calibration of the fire model for the area of interest based on information retrieved from historic fire events, including a wide range of multimodal data. • Digital Enabler collects data coming from devices installed near the area of interest, analyse and visualise them. • Meteorological data provide information for days with high risk of fire (e.g., high temperatures). During the event • Data coming from in-situ sensors, installed near the area of interest, provide a fire alert. • Smoke and hot spot detection offer prompt and efficient response to the forthcoming fire. • Smoke and wildfire behaviour outputs (arrival time, rate of spread, fire line intensity, flame length or fire paths through Wildfire Analyst API) are provided as well as monitoring of fire evolution through simulations. • Social media are investigated to find related information posted from citizens. • Through geospatial retrieval, detected fire is localised on the constructed digital twin or geo-visual map. • Fire/person detection services are used to verify the phenomenon and search for people in danger. • Satellite images are used to detect active fires, burnt area and burn severity products in near-real time based on multi-source, AI-based remote sensing data processing for spatio-temporal detection/assessment of forest fire events. • Drone planning will generate aerial robots plans & trajectories for image and data acquisition. • Drones will survey the area taking images for their processing and segmentation, as well as smoke and wind data. • Information fusion module will gather results of processing of satellite images, drone images and in-situ sensors to provide the near real-time status of the wildfire. • Near-real time burnt area is monitored with Sentinel-3 and MODIS, and fire evolution over time is provided. • Monitoring of fire fronts evolution via hotspots is provided as these enter the Wildfire Analyst API (VIIRS, 2-3 hours delay).

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	• Video analysis tools detect people, re-identify them and detect the actions they are performing. • A first situational awareness map is generated after hours followed by more and more accurate versions once additional remote sensing data is acquired over time. After the event • Drones survey the area of interest searching for people and providing the size of the affected area. • Drones are equipped with sensors to enable geolocalization of objects/people. • The analysis of social media texts is used to gain a better understanding of the natural disaster extent, and for cross validating the results of detection and segmentation technologies.

6.3 D. MALLIAN Floods

Use Case 3	
Description	A mega fire of August 2021 took place at the municipality of Mantoudi - Limni - Agia Anna in Greece. The geomorphology, the land cover and the hydrometeorological regime of the area contribute to extreme flash floods events.
Goal	TEMA solution will be used to warn D. MALIAN early, to provide information about the accessibility of the affected region (regarding roads, bridges, etc.) and to estimate the damages after the event leading to improved NDM.
Area	D. MALIAN, Greece
Technologies tested	• Digital Enabler platform • Explainable and robust analytics, Novel trustworthy AI algorithms • Real-time semantic visual analysis and remote sensing, Novel semantic visual analysis and remote sensing AI algorithms • Social media and text semantic analysis, Novel semantic analysis algorithms for geosocial media/news

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	• Real-time federated analytics • Precise phenomenon prediction • Study AI model adaptability to extreme data conditions • Response planning and recommendations • Information fusion • Atos Smart Vision • Precise Digital Twin • Geovisual analytics • Augmented Reality and rapid visualization • Visualization of AI prediction explanations • Satellite-based flood detection and assessment • flood/person detection • Fire/flood/background segmentation • Geospatial information retrieval • Sentiment analysis for short texts (e.g., tweets) • Privacy preservation during visual analysis • DNN Robustness • Federated Learning • Extended Reality-based interactive visualization system • Drone-based image and data acquisition • Concept discovery for latent space interpretability of deep neural networks • Human-comprehensible presentation of concept-based explanations • Person re-identification tool • Flood and background segmentation • Contrastive image-language models • Data scarcity, synthetic data generation pipeline • Geo-social media analysis • Smartdesk
End-Users involved	D. MALLIAN
Technical Partners involved	AUTH, DLR, ENG, ATOS, USE, ND, NS, PLUS, FHHI, UNIME, KAMK
Data sources and Data used	• Image, video from UAV • Satellite images

This project has received funding from the European Union – European Commission under grant agreement No 101093003

	○ Sentinel-1 Ground Range Detected (GRD) and Sentinel-2 MSI ○ High-res on-demand satellite VHR optical ● Geo-social media data ● In-situ sensors, ● Topographical data ● Geosocial media data (text, image and videos) ● Geomorphological data ● 3D terrain
Scenario Flow	Prior to the event Set-up and calibration of the flood model for the area of interest based on information retrieved from historic fires that will cause flash floods, including a wide range of multimodal data. Digital Enabler collects data coming from devices installed near the area of interest, analyse and visualise them. During the event Meteorological data provide an alert for an imminent flood. Data coming from in-situ sensors, installed near the area of interest, exhibit a fast increase of the water level. Flood/person detection services are used to verify the phenomenon and search for people in danger. Through geospatial retrieval, detected flood is localised on the constructed digital twin or geo-visual map. Satellite images are used to detect flooded areas, permanent water, as well as secondary products such as flood duration based on multi-source, AI-based remote sensing data processing for spatio-temporal detection/assessment of flood events, and automated alerting. If available: High-res satellite and drone images are used to detect objects of interest such as vehicles and buildings (TBD). Video analysis tools detect people, re-identify them and detect the actions they are performing. A first situational awareness map is generated after hours followed by more and more accurate versions once additional remote sensing data is acquired over time. The analysis of social media texts is used to gain a better understanding of the natural disaster extent, and for cross validating the results of detection and segmentation technologies. Drones will be commanded to gather visual images, which will be processed and segmented, and will provide valuable flood information.

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	The information fusion module will integrate results of processing of drone images, satellite images, contextual information and in-situ sensors to obtain the georeferenced status of the flood. After the event Drones survey the affected area searching for people and providing the size of the affected area. Drones are equipped with sensors to enable geolocalisation of objects/people.

6.4 KAHY Fires

Use Case 4	
Description	Kainuu is an area that is sparsely populated and up to 95% covered by forests. The long dry periods in the last decades, combining the historical data of fires, have increased the possibility of forest fires.
Goal	TEMA solutions will be used to examine and improve procedures for managing disasters and for decision making support to provide information about the accessibility of the affected region (regarding roads, bridges, etc.) and to estimate the damages after the event leading to improved NDM.
Area	Kainuu, Finland
Technologies tested	• Digital Enabler platform • Explainable and robust analytics, Novel trustworthy AI algorithms • Real-time semantic visual analysis and remote sensing, Novel semantic visual analysis and remote sensing AI algorithms • Social media and text semantic analysis, Novel semantic analysis algorithms for geosocial media/news • Real-time federated analytics • Precise phenomenon prediction ○ Wildfire Analyst. FireSim

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	• Study AI model adaptability to extreme data conditions • Response planning and recommendations • Information fusion • Atos Smart Vision • Precise Digital Twin • Geovisual analytics • Augmented Reality and rapid visualisation • Visualisation of AI prediction explanations • Satellite-based forest fire detection and assessment • Fire/smoke/person detection • Fire background segmentation • Geospatial information retrieval • Sentiment analysis for short texts (e.g., tweets) • Privacy preservation during visual analysis • DNN Robustness • Federated Learning • Extended Reality-based interactive visualisation system • Drone-based image and data acquisition • Concept discovery for latent space interpretability of deep neural networks • Human-comprehensible presentation of concept-based explanations • Person re-identification tool • Contrastive image-language models • Data scarcity, synthetic data generation pipeline • Geo-social media analysis • Smartdesk • 3D smoke modelling and fire detection
End-Users involved	KAHY
Technical Partners involved	AUTH, DLR, ENG, ATOS, USE, TSYL, ND, NS, PLUS, FHHI, UNIME, KAMK
Data sources and Data used	-Image, video from UAV -Satellite images: • Sentinel-3 OLCI

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	● Aqua/Terra MODIS ● Sentinel-2 MSI - In-situ sensors, In-situ sensors, including wind and smoke concentration measurements - Topographical data - Fuel model data (type and structure of vegetation) - Meteorological data -Geosocial media data -Public disaster alerts - Satellite acquisition data (if real event is trialled in real-time then this will be available from online data source; otherwise, prepared historic data if available) -smart sensors
Scenario Flow	Prior to the event Set-up and calibration of the fire model for the area of interest based on information retrieved from historic fires, including a wide range of multimodal data. Digital Enabler collects data coming from devices installed near the area of interest, analyse and visualise them. In case of real event in real time: After constantly monitoring public disaster alerts (GDACS + KAHY) Decision Support Service for Remote Sensing automatically detects an early warning for the crisis area, identifies the affected AOIs, retrieves satellite position and acquisition data, provides information on when and which remote sensing data will be available for the AOIs. Otherwise, decision proposals will be prepared for showcasing. During the event Meteorological data provide an alert for high possibility of fire. Decision Support Service for Remote Sensing provides for the meteorological alert an updated decision proposal which states when satellite data products are expected to become available to the operator at which time(s) (real or prepared). User receives a decision proposal, e.g. as an email, with the satellite data acquisition options for the next few hours/days. Fire/smoke/person detection services are used to verify the phenomenon and search for people in danger. Wildfire behaviour outputs (arrival time, rate of spread, fire line intensity, flame length or fire paths through Wildfire Analyst API) are provided as well as monitoring of fire evolution through simulations.

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	Through geospatial retrieval, detected fire is localised on the constructed digital twin or geo-visual map. Satellite images are used to detect active fires, burnt areas as well as burn severity based on multi-source, AI-based remote sensing data processing for spatio-temporal detection/assessment of forest fire events. Video analysis tools detect people, re-identify them, and detect the actions they are performing. A first situational awareness map is generated after hours followed by more and more accurate versions once additional remote sensing data is acquired over time. The analysis of social media texts is used to gain a better understanding of the natural disaster extent, and for cross validating the results of detection and segmentation technologies. Drone planning will generate aerial robots' plans & trajectories for image and data acquisition. Drones will be commanded to gather infrared and visual images of the wildfire. The information fusion module will integrate results of processing of drone images, satellite images, contextual information, and in-situ sensors to obtain the georeferenced status of the wildfire. TEMA platform will help decision-making support. After the event Drones survey the affected area searching for people and providing the size of the affected area. Drones are equipped with sensors to enable geolocalisation of objects/people. A tool for the estimation of the damages will be provided.

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6 Conclusions

The elicitation of the end users' requirements is of particular importance and instrumental to the development of usable, useful, and applicable tools for emergency response. In this deliverable, the end user requirements regarding Natural Disaster Management and especially in Floods and Fires were defined. The user requirements gathered from five sources: a) Literature review, b) Grant Agreement, c) Story Telling, from consortium end users regarding an NM event that they have experienced, d) Questionnaire and e) The continuous collaboration with end users of the consortium.

The User requirements gathered are twenty-three (23) and categorised into Functional and Non-Functional Requirements. Following the user requirements, the technical solutions were defined and will be implemented in the TEMA project.

The technologies in TEMA are categorised in Trustworthy Federated Analytics technologies, in Phenomenon prediction and decision-making technologies and data acquisition, Simulation and Visualization technologies, that are twenty-eight (28) in total. Therefore, the data requirements and TEMA technologies with the technical providers contribution resulted in a cross table that presents the requirements in accordance with the technologies. Finally, based on the above information a preliminary scope of the trial use cases was generated.

The End-User requirements presented in this document will give input to the next tasks of the project (T2.2) and will be a guidance for the technical specifications that lead to the design of the TEMA Open Architecture (D2.2).

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ANNEX I

INFORMED CONSENT FORM

Please tick (check) the following boxes to indicate whether you consent or not:

HAVING CAREFULLY READ AND UNDERSTOOD THE INFORMATION SHEET
INFORMATION_SHEET.pdf

* I consent to participate in the questionnaire as described in the Information Sheet.

☐ YES ☐ NO

* I consent to the processing of my personal data for the purposes described in the Information Sheet.

☐ YES ☐ NO

* I consent to be contacted to my e-mail address for future activities of interest. |

☐ YES ☐ NO

Previous Next

2 Profile

Name (optional, for additional exchanges only):

Organization:

Country:

Command level/rank (if applicable):

Position in the organisation:

Years of experience:

Contact Details

Email:

Tel:

Previous Next

3 Questionnaire

A.

1. What are the types of disasters that your organization deals with?

- ☐ Flood
- ☐ Fire
- ☐ Other: ____________________

2. Does your organization own drones?

at most 1 choice(s)

☐ Yes ☐ No

If yes, which type/model?

[ ]

3. Do you officially use drones during operations?

at most 1 choice(s)

☐ Yes ☐ No

If yes:

How many operations per year?

[ ]

Which kind of mission (SAR, Assessment, Hazard detection, other)?

[ ]

4. Do you use any technologies during operations?

at most 1 choice(s)

☐ Yes ☐ No

4.1 If yes, which new technologies do you use? Please specify.

Software :	[ ]
Hardware:	[ ]
Data:	[ ]

5. On a scale of 1 to 5, please indicate how confident you feel personally using the above technologies?

at most 1 choice(s)

- ☐ 1 - Not confident at all
- ☐ 2 - Not very confident
- ☐ 3 - Ok
- ☐ 4 - Confident
- ☐ 5 - Very Confident

6. At which stage of the disaster management cycle (prevention, preparedness, response, recovery) do you use the above technologies ? You may choose more than one option.

☐ Prevention ☐ Preparedness ☐ Response ☐ Recovery

7. Please rate the usefulness of the above mentioned technologies' utilization regarding each stage of the disaster management cycle, using scale 1 to 5, with 5 being the most useful:

	Technology 1	Technology 2	Technology 3	Technology 4	Technology 5
Prevention	○	○	○	○	○
Preparedness	○	○	○	○	○
Response	○	○	○	○	○
Recovery	○	○	○	○	○

B.

1. Do you agree that Artificial Intelligence (AI) technologies used in a Natural Disaster Management platform should be ethically adherent and lawful (meaning that should be compliant with EU and National legislation)?

at most 1 choice(s)

- ☐ Strongly agree
- ☐ Agree
- ☐ Neutral
- ☐ Disagree
- ☐ Strongly disagree

2. Would you be interested in using tools which provide explanations, evidence, and/or reasoning for each provided output, helping operators to understand the decisions or predictions made?

at most 1 choice(s)

- ☐ Extremely interested
- ☐ Very interested
- ☐ Moderately interested
- ☐ Slightly interested
- ☐ Not at all interested

Please elaborate

3. Would you be interested in tools for fire/smoke/flood detection, in order to be aware of your organization early?

at most 1 choice(s)

- ☐ Extremely interested
- ☐ Very interested
- ☐ Moderately interested
- ☐ Slightly interested
- ☐ Not at all interested

4. Please score which of the following technologies and/or data would be useful for your organization to have access in (1: Not at all important, 2: Slightly important, 3: Moderately important, 4: Very important, 5: Extremely important)

	1	2	3	4	5
Technologies	○	○	○	○	○
Fire Detection	○	○	○	○	○
Smoke Detection	○	○	○	○	○
Flood detection	○	○	○	○	○
Image/video recognition	○	○	○	○	○
3D Maps	○	○	○	○	○
3D Maps of smoke concentrations	○	○	○	○	○
Object Detection	○	○	○	○	○
Data	○	○	○	○	○
Satellite Data	○	○	○	○	○
Drone Data	○	○	○	○	○
Social Media Data	○	○	○	○	○

5. Would your Authority be interested in applications for detecting objects/people, (from aerial views or other image/video footage), in order to find people and vehicles that are not visible to the naked eye?

at most 1 choice(s)

- ☐ Extremely interested
- ☐ Very interested
- ☐ Moderately interested
- ☐ Slightly interested
- ☐ Not at all interested

6. Would your Authority be interested in technologies offering reliable early warnings for fire and flood prevention and preparedness?

at most 1 choice(s)

- ☐ Extremely interested
- ☐ Very interested
- ☐ Moderately interested
- ☐ Slightly interested
- ☐ Not at all interested

If you already use channels for early warning please specify these channels (e.g. National meteorological agency, Meteoalarm, GDACS, Copernicus EFFIS/EFAS, etc.)

7. Would your Authority be interested in technologies offering real-time, realistic 3D maps of smoke concentrations of a forest fire?

at most 1 choice(s)

- ☐ Extremely interested
- ☐ Very interested
- ☐ Moderately interested
- ☐ Slightly interested
- ☐ Not at all interested

8. Would your Authority be interested in technologies offering early warnings on fire and flood detection through social media?

at most 1 choice(s)

- ☐ Extremely interested
- ☐ Very interested
- ☐ Moderately interested
- ☐ Slightly interested
- ☐ Not at all interested

9. Would your Authority be interested in a Natural Disaster Management platform which would encompass GDPR (General Data Protection Regulation) provisions for the protection of personal data and the free movement of them?

at most 1 choice(s)

- ☐ Extremely interested
- ☐ Very interested
- ☐ Moderately interested
- ☐ Slightly interested
- ☐ Not at all interested

10. Do you agree that near-real-time processing is important for a Natural Disaster Management platform which aims to increase responsiveness?

at most 1 choice(s)

- ☐ Strongly agree
- ☐ Agree
- ☐ Neutral
- ☐ Disagree
- ☐ Strongly disagree

Regarding near-real-time processing, how fast would you need the output of a specific technology to be available, e.g. minutes, hours or days?

Please specify

11. Would you be interested in an Operational Forest Fire Simulator which provides highly accurate and near real-time wildfire models?

at most 1 choice(s)

- ☐ Extremely interested
- ☐ Very interested
- ☐ Moderately interested
- ☐ Slightly interested
- ☐ Not at all interested

12. Does your Authority already use such a simulation tool?

at most 1 choice(s)

- ☐ Yes
- ☐ No

Please name the specific tool(s) used

13. Would you be interested in a tool that provides estimation of the damages after the natural disaster?

at most 1 choice(s)

- ☐ Extremely interested
- ☐ Very interested
- ☐ Moderately interested
- ☐ Slightly interested
- ☐ Not at all interested

If yes, please check below the type of damage you are interested in (you can check more than one):

- ☐ Building Damage detection
- ☐ Burnt area estimation
- ☐ Mud detection
- ☐ Road network damage detection
- ☐ Collapsed bridges detection
- ☐ Other, Please specify

14. Would you be interested in a platform which integrates all proposed technical solutions or in a set of different tools?

at most 1 choice(s)

- ☐ Integrated platform
- ☐ Set of tools

15. Would you be interested in an innovative tool/platform that combines information from multiple sources in order to provide an enhanced situational awareness picture?

**Example: drone data, sensor measurements, meteorological data, satellite/SAR data, information derived by social media/news posts, geovisual analytics, etc.*

at most 1 choice(s)

- ☐ Extremely interested
- ☐ Very interested
- ☐ Moderately interested
- ☐ Slightly interested
- ☐ Not at all interested

16. How useful would it be for you to get information on possible and upcoming satellite data availability* for an area of interest?

**Example: type of satellite, radar or optical, low-resolution or high-resolution, free or commercial satellite data, etc.*

at most 1 choice(s)

- ☐ Extremely useful
- ☐ Very useful
- ☐ Moderately useful
- ☐ Slightly useful
- ☐ Not at all useful

17. In addition, how useful would it be for you to get information on the expected time (e.g. in hours/days) until you would be provided with the resulting satellite data products*?

**Example: spatial extent of affected area, map showing the extent and distribution of damage, map with destroyed/accessible bridges and roads, etc.*

at most 1 choice(s)

- ☐ Extremely useful
- ☐ Very useful
- ☐ Moderately useful
- ☐ Slightly useful
- ☐ Not at all useful

18. Would you be interested in receiving or being shown decision proposals about your options for your customized satellite-based product in a human-like way*?

**Examples:*

- *"Burnt area map product automatically derived from Sentinel-3 (OLCI) satellite imagery will be approx. available for your area of interest at 2023-03-23T09:18:18Z"*
- *"High-resolution commercial satellite xy may be tasked by 2023-03-23T09:18:18Z to receive the respective data products for your area of interest at approx. 2023-03-23T12:18:18Z"*
- *"Cloud coverage expected in the time range from 2023-03-23T09:18:18Z - 2023-03-23T12:18:18Z, no optical satellite data acquisitions available in this time frame" ?*

at most 1 choice(s)

- ☐ Extremely interested
- ☐ Very interested
- ☐ Moderately interested
- ☐ Slightly interested
- ☐ Not at all interested

19. Would you be interested in having access to a tool that will reflect the physical affected area into a virtual model in real-time?

at most 1 choice(s)

- ☐ Extremely interested
- ☐ Very interested
- ☐ Moderately interested
- ☐ Slightly interested
- ☐ Not at all interested

20. Would you be interested in training material in order to use the aforementioned technologies?

at most 1 choice(s)

- ☐ Extremely interested
- ☐ Very interested
- ☐ Moderately interested
- ☐ Slightly interested
- ☐ Not at all interested

21. Please provide any other comments you would like to share.

Previous Submit

ANNEX II

Functionality	Technology / Service	Partner	Use case
Natural Disaster Management Platform	Digital Enabler platform The "Digital Enabler Community Edition" is the Engineering's Ecosystem Platform powered by FIWARE, supporting the entire value chain of data, from the discovery to the analysis, harmonisation, and visualisation. The Digital Enabler includes tools to discover and interact with different and heterogeneous data sources (even IoT), to graphically correlate and normalise data in standard formats, to analyse and deduct new information, to visualise data, to apply rules and manage complex events.	ENG	☒ Fire ☒ Flood
AI Analytics;	Novel trustworthy AI algorithms for DNNs AI technology that is lawful, ethically adherent, and technically robust.	AUTH	☒ Fire ☒ Flood
	Explainable artificial intelligence (XAI) methods XAI will be used for the extreme data scenario, providing explanations for which modality contributed most to the final result.	FHHI, ATOS, UNIME	☒ Fire ☒ Flood
Visual analysis and remote sensing	Fire, smoke, flood detection/segmentation/recognition	AUTH	☒ Fire ☒ Flood
	3D realistic smoke reconstructions in real-time	DLR-KN	☒ Fire ☐ Flood
	Image/video instance segmentation and object detection	AUTH	☒ Fire ☒ Flood
	Satellite-based flood and forest fire detection and assessment Multi-source, AI-based remote sensing data processing for spatio-temporal detection/assessment of forest fire and flood events.	DLR-DFD	☒ Fire ☒ Flood
	UAV control and planning for image and data gathering Multi-UAV planning	USE	☒ Fire

			☒ Flood
	Information fusion AI and RBF-based methods for combining perceptions from individual sensors	USE	☒ Fire ☒ Flood
	Privacy preserving algorithms	AUTH	☒ Fire ☒ Flood
	Atos Smart Vision. Computer vision algorithms and tools to detect people, actions, objects, etc. optimised to run in some specific environment such as edge devices.	ATOS	☒ Fire ☒ Flood
	Geovisual analytics Geovisual analytics for rapid retrieval of large-scale geospatial data (Content-based geospatial information retrieval algorithms, Semantic annotation) and a detailed geospatial map which will be on-the-fly semantically annotated based on the outcome of extreme data analytics, so that it can be exploited both by the TEMA phenomenon modelling engines and the XR-based interactive visualisation module. Semantically annotated 3D area map.	LAT40, AUTH, ENG, TSYL, NS, DLR-KN	☒ Fire ☒ Flood
	Real-time federated analytics An edge-to-cloud continuum computational infrastructure, with dynamical distribution of AI/DNN inference workload for a large, afflicted area under the federated computing paradigm aiming to promote collaborative analysis of data collected by different entities, without the sharing of collected data themselves, and help in rapid execution of all analysis algorithms with a minimal latency.	UNIME, ENG	☒ Fire ☒ Flood
	Study AI model adaptability to extreme data conditions Novel approaches for handling visual data scarcity in DNN-based learning.	ATOS, AUTH, FHHI	☒ Fire ☒ Flood
Social media and text analysis	Social media and text semantic analysis Novel semantic analysis algorithms for geosocial media/news posts and textual content will be developed. • Identification, multilingually handling and post relevance classification/assessment • Sentiment analysis for short texts (social media posts)	PLUS, AUTH, DLR-DFD, ATOS, ATOS SP, FHHI	☒ Fire ☒ Flood

	• Novel uses of the CLIP methodology for combining images with text snippets		
Information fusion	Information fusion Innovative information fusion mechanism for optimally merging the analytics information into a coherent, unified outcome.	USE, DLR-KN, PLUS, NS, TSYL, LAT40	☒ Fire ☒ Flood
	Data-fusion-based decision support and process triggering Innovative data-fusion-based decision support service for early remote sensing data acquisition and processing using geographical areas of interest (AOIs) computed and dynamically refined from open web data (e.g. official warnings) as well as flood and wild fire modelling tools; Modelling tools also provide context to the collected satellite information (e.g., historical inundation frequency maps); Input to "Augmented Reality and rapid visualisation"	DLR-DFD, NS, TSYL, KAMK	☒ Fire ☒ Flood
Augmented reality / Virtual reality	Augmented Reality and rapid visualisation A novel, real-time XR-based interactive visualisation prototype	ND, DLR-KN, LC, NS, TSYL, FHHI, KAMK	☒ Fire ☒ Flood
	Smartdesk Smartdesk is a solution for collaboration in situation management with a user-friendly interface with touch controls.	KAMK	☒ Fire ☒ Flood
	Northdocks FirefighterVR® FirefighterVR provides capabilities to train firefighters in virtual reality making the training experience as realistic as possible, providing specific interface and interaction options.	ND	☒ Fire ☐ Flood
Phenomenon prediction	Flood modelling 3Di product for achieving near-real-time flood modelling.	NS	☐ Fire ☒ Flood
	Wildfire evolution, propagation Wildfire Analyst API The Wildfire Analyst API provides capabilities to integrate the full range of forest fire modelling capabilities and respective data input models into custom applications on any desired platform. The FireSim® application provides real-time on demand spread prediction capabilities. The software application includes as background proprietary forest fire progression simulation models and related data input models.	TSYL	☒ Fire

	Response planning and recommendations An automated response planning engine for optimal dynamic sensor placement.	USE, DLR-KN, KAHY, KEMEA, D.MALIAN, RAS, BRK	☒ Fire ☒ Flood
Digital Twins - 3D reconstruction	Precise Digital Twin Novel photogrammetry solutions for generating precise Digital Twins of the afflicted areas in real-time.	ND, ENG, ATOS	☒ Fire ☒ Flood