"NOVEL INTEGRATED SOLUTION OF OPERATING A FLEET OF DRONES WITH MULTIPLE SYNCHRONIZED MISSIONS FOR DISASTER RESPONSES"

ResponDrone

D15.3 Set of scenarios and simulation data

Project Deliverable Report

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Glossary of terms and abbreviations used	
Abbreviation / Term	**Description**
AHRS	Attitude and Heading Reference System
AUA	American University of Armenia
CBRN	Chemical, biological, radiological and nuclear hazards
CRISE	Crisis Simulation Engineering software
DLR	German Aerospace Center
DoA	Description of the Action
End User	RESPONDRONE partners that represent emergency response authorities
EU	European Union
FIET	Fortress Incident Evolution Tool
FSB	Fortress Scenario Builder
GIS	Geographical Information System
HCFDC	Haut Comité Français pour la Défense Civile
IMS	Information Management System
IMU	Inertial Navigation Systems
MES	Ministry of Emergency Situations of Armenia
NEMA	National Emergency Management Authority
RAV	Regional Administration of Varna
RCM	Region of Central Macedonia
RQ	Research Question

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RWM	Region of Western Macedonia
SFRS	State Fire and Rescue Service of Latvia
SGSP	Main School of Fire Service
SIS2B	Fire Fighter Department of Corsica
UAS	Unmanned Aerial Systems
UAV	Unmanned Aerial Vehicle
VRH	Netherlands - VRH - Safety Region Haaglanden
VULCAIN	Tactical Simulator Software
WP	Work Package

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1. Executive Summary

Our Report on *Set of scenarios and simulation data* describes a list of disaster/emergency scenarios derived from scientific literature, relevant EU projects, and interviews from the first responder organizations (End Users) involved in the RESPONDRONE project. During the end user interviews, several alternative scenarios and disaster types were discussed. Relevant data for simulation development was derived from routine operational norms as well as the threats and risks to which each first responder organization is exposed. For each studied first responder organization, a number of alternative scenarios were developed from how its personnel may handle and mitigate the above-mentioned threats and risks. Variables used for the scenarios are information flows among organizations, risk assessment methodologies, inter-operational measures, use of currently available technologies and the need for new technology.

The scenario information will be used for WP15, notably for the development of D15.4 (*RESPONDRONE concept/mock-up*), and D15.5 (*RESPONDRONE functional design document*) as well as for WP2 (*Risk Assessment & Risk Management*) and WP10 (*Large Training Programs*) activities.

In preparation for the upcoming WP10 activities, this deliverable report also defines the sources of simulation data.

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2. Introduction

This document provides information about the following RESPONDRONE DoA requirements:

Section 3: Scenarios derived from research done around D15.2: Report of Field Studies

RESPONDRONE relevant disaster scenarios have been derived from the following research activities:

- Existing EU Projects
- Scientific Literature Review
- End User Interviews

Section 4: Simulation Data

The section provides information about:

- The Simulation Software that is planned to be used in the testing/simulation phase of the RESPONDRONE project.
- The sources of the data to be used during the simulation

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3. Scenarios derived from D15.2 research: Report of Field Studies

3.1. Methodology

This section provides a set of scenarios that will be used for WP15 D15.4 and D15.5 and the trainings included in WP10. RESPONDRONE relevant disaster scenarios have been derived from the following research activities:

- Existing EU Projects
- Scientific Literature Review
- End User Interviews

Each of the research activities involved a Research Question (RQ) related to scenarios:

- RQ3-Scenarios
    - What examples (or case studies) can the activity retrieve to help in defining RESPONDRONE set of scenarios development?

Note: *The information derived from the other RQs (RQ1-Relevance, RQ2-SysReq, RQ4-Stakeholder Mapping, RQ5-Methodology) is included in WP15 D15.2.*

3.2. Scenarios from Literature

The complete list of the Literature/Articles identified as relevant for review is provided in the WP15 D15.2. Only the most relevant and the most valuable findings are included in the report. More research on the articles is included in WP15 D15.2.

Disaster Scenarios were identified in the following Articles:

Disaster Management Supported by Unmanned Aerial Systems (UAS) Focusing Especially on Natural Disasters (2017)
Three emergency examples were developed – flood, earthquake, and forest fire – based on international examples and experience. Disasters vary widely in scale and kinetics. The article then discusses how drones can be used in three separate phases of disaster management. During early detection and prevention, drones can be used to detect smoke or other visible signs of imminent disaster. During response, drones can be used to provide real time information for better decision making. Finally, during the transition to recovery, drones can be used in formal damage assessment. These mission parameters should be included in any scenarios developed. [4]

A Survey of Unmanned Aerial Vehicle (UAV) Usage for Imagery Collection in Disaster Research and Management (2011)
The article discusses how UAVs were used during 2005 Hurricanes Katrina, Wilma and Ike; Typhoon Morakot; and the 2009 L'Aquila, 2010 Haiti and 2011 Japan Earthquakes.
Their usage during these events can be classified in 3 tactical levels - Data Acquisition for Post-Disaster Assessment, Data Acquisition for Rapid Response, Data Acquisition for

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Management and Monitoring. This mirrors the previous paper regarding missions that should be included in scenarios. [1]

Unmanned Aerial Vehicles for Disaster Management (2019)
The authors (C. Luo et al., 2019) analyse several international examples. They study many natural disasters. They posit that drones can be used with diverse missions by supporting disaster management in different stages of emergency.
Missions that should be included in developed scenarios include pre-disaster coordination with other early warning systems, acquisition and analysis of real-time high-resolution imagery for both decisions making and mapping purposes. [15]

A Surveillance System Using Small Unmanned Aerial Vehicle (UAV) Related Technologies (2014)
The article suggests that in addition to previously identified uses, UAVs can also be used for regular monitoring of infrastructure (such as dams) and surveillance of various environments prone to disasters such as forests and mountains regions vulnerable to fire and landslides. [19]

Drone Applications for Supporting Disaster Management (2015)
The article includes five disaster scenarios: nuclear accidents, dangerous material releases, floods, earthquakes and forest fires. It then applies UAV capabilities to the proposed disasters to create use-case scenarios. These missions mirror those of earlier articles including pre-disaster activity for early detection, traditional response management roles, and damage assessment during recovery. [6]

Assessment of existing and potential landslide hazards resulting from the April 25, 2015 Gorkha, Nepal earthquake sequence (2015)
The article includes assessment of landslides and the risks they pose post-disaster (or in the case that they are the primary disaster) is an important and interesting test scenario. Several partner countries have significant earthquake and landslide risk. [3]

An integrated approach of ground and aerial observations in flash flood disaster investigations. The case of the 2017 Mandra flash flood in Greece. (2019)
The case studied by the article was a 500 year flood in an urban catchment area. Flash floods are difficult to predict in these cases and typically block not only traditional land based rescue equipment from the disaster area, but also boats and other flood response vehicles. Flash floods require aerial support to understand flood dynamics within the disaster area due to these access issues. In this case, the article highlights the ability of a UAV to provide an overview of the flood, importantly flood depth estimates, in a civil protection context. [2]

Help from the Sky: Leveraging UAVs for Disaster Management (2017)
Standard disaster type scenarios are discussed in the article along with the application feasibility of UAVs during those disaster types. For example, during a geophysical or hydrological (Type A) disaster, UAVs are operational while an existing wireless sensor network would not be. In the opposite respect, during extreme meteorological events, UAVs would not be available, while the wireless network would be. [9]

UAV-assisted disaster management: Applications and open issues (2016)
The article discusses issues with UAVs, citing specifically limited flight time. It is important to test network relay and decentralized correction of autonomous UAVs during testing to allow for mid-mission replacement of UAVs. [14]

Self-Organizing Aerial Mesh Networks for Emergency Communication (2014)
In the article, the authors (M. Di Felice et al., 2014) discussed how the 3D scenario was modelled using the Omnet++ tool. They analysed rectangular-shape buildings reflect on synthetic generated scenarios. It is stated that realistic scenarios can also be created by using XML maps that are provided by OpenStreetMap with building data. It is very difficult to model the wireless propagation effects in a 3D environment and the capability of any system to operate in such an environment will be important in use case scenarios. [20]

Earth Observation based Crisis Information – Emergency mapping services and recent operational developments (2017)
The article includes the techniques developed by DRIVER (the EU project on which the paper was based) simulated a flood event. Pre-acquired satellite data was combined with collected aerial imagery to simulate what information could be generated. This scenario for a flood in Germany is a valid test case that could be replicated on a different city with similar inputs as well as the inputs provided by the RESPONDRONE system. [7]

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3.3. Scenarios from Existing Related EU Projects

Disaster Scenarios have been identified in EU Projects. Some of them have Drone and/or other flights involved.

***Disclaimer**: The content of this section contains information that is, in part, a direct quote from the relevant project resources (websites, published documents etc.). References used by the corresponding project resources are given in the text and listed in the Bibliography section.*

DRIVER+
In terms of development of scenarios, under the first objective of the project it envisioned four Trials, each dedicated to a different crisis scenario: industrial accident, wildfire, flood and earthquake. These scenarios can be useful during scenario development.

As described in the trial catalogue: "The Test-Bed provides software components to:

- Connect Solutions for data and information exchange
- Connect Simulators to create a fictitious, but realistic, crisis
- Create and control the scenario's storylines
- Record and collect observations and logs" [5]

This approach and software can be of great use for RESPONDRONE testing.

1. Trial Poland took place at the Main School of Fire Service (SGSP) from 21-25 May 2018 in Warsaw.
Chemical Spill of toxic fluid. The trial tested how Common Operational Picture approach can contribute to crisis management. Digital scenarios and observation were developed and implemented with particular focus on how the new tools can assist first responders in the field to take quicker decisions in fast evolving emergency situation. The scenario is relevant to RESPONDRONE as a solution called "Drone Rapid Mapping" enabled an incident or a crisis area to be mapped quickly using cloud computing. [5]

More information and a video is available at: https://www.driver-project.eu/events/trials/trial-1/

2. Trial France took place at the Entente pour la forêt Méditerranéenne from 22-26 October 2018 in Aix-en-Provence.
As was designed in the scenario, a large forest fire occurred in a cross-border Mediterranean environment that threatens wildland urban interfaces. "The hazard develops rapidly and the resources of the departmental fire brigade are soon exceeded, requiring support from other fire brigades (with coordination at regional level) and national means' deployment of water bomber aeroplanes". Although no drones were used in this scenario, but the solutions on

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common platform for sharing information horizontally and vertically, is something RESPONDRONE will be looking at to integrate with. [5]

More information and a video are available at: https://www.driver-project.eu/events/trials/trial-france/

3. Trial Netherlands took place at 21-23 May 2019 at the premises of the Safety Region Haaglanden (SRH) in The Hague.
As described in the catalogue of the trial, flash flood scenario simulating a lock breach caused by severe weather conditions. Flooding of a large part of The Hague city Centre causing damage to infrastructure and threatening a large portion of the city's inhabitants. The trial also accounts for the Cascading effects, including power outage, flooded roads and railway infrastructure, affecting the population living in those areas. One of the solutions that was used to cope with the flood, which is relevant to RESPONDRONE is called "Airborne and Terrestrial Situational Awareness". As described in the trial catalogue, "Real-time aerial imaging could significantly support situational awareness during major and area wide disasters". DLR's solution "Airborne and Terrestrial Situational Awareness" comprises four parts first of which is the "Ground Control Station U-Fly operating the research aircraft D-CODE as a remotely piloted vehicle (RPV)". [5]

More information is available at: https://www.driver-project.eu/events/trials/netherlands-trial/

4. Trial Austria was held at the Austrian Red Cross from 12-15 September 2019 in Eisenerz/Austria.
The scenario described in the trial catalogue depicts the "The central area of Austria that has been struck by a heavy earthquake and subsequent heavy rains.
The local region of Eisenerz (in Styria, Austria) is one of the most affected with missing persons, casualties, collapsed buildings, blocked roads, and endangered industries working with hazardous substances". Here, too, the "Airborne and Terrestrial Situational Awareness" solution was used, with module responsible for collecting imagery by flying drones. [5]

More information on Trial is here: https://www.driver-project.eu/trial-austria-2/

COOLPOL
The COOLPOL project developed 3 scenarios:

Scenario 1: Site recognition
Site recognition (visual, mapping) is looked at prior to security forces' intervention to obtain ambient information on sites that are difficult to access (related to a threat or a risk) or present significant elongations. [21]

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Scenario 2: Surveillance of major events
Surveillance of major sporting and cultural events or planned gatherings is included in this scenario, in particular by detecting particular events (crowd movement of or violent events, multiple fire triggers, explosion, immobility of many individuals). [21]

Scenario 3: Emergency support for interventions
The last scenario models the emergency support during interventions to provide image information by providing real-time knowledge of the situation. For police forces, this would make it possible, through more precise elements, to detect and track people, vehicles or groups. For fire and rescue services, this would make it possible to anticipate the propagation or aggravation of perilous situations. [21]

All 3 scenario types would greatly benefit from Drone usage. [21]

HEIMDALL
The HEIDMALL platform creates decision-making products through modelling algorithms and data fusion for hazards or disasters during the response and recovery phases. These algorithms provide valuable insight which can be used along with decision support tools to provide improved situation assessment regarding risk and vulnerability.

The system achieves this by comparing the incoming data from the active disaster and comparing it to corresponding scenarios in the system catalogue, thus generating the most relevant best practices. It can also automatically reference existing plans or situational assessments for the active scenario.

Finally, this information can be shared with first responders in the field via a satellite-based communication system for first responders in the field. The two way nature of such a system will also allow data from first responders to be fed into the system to improve the generated outputs.

This systematic approach would allow the development of realistic scenarios via a rugged, tested approach applied to real case studies. It can be very useful for RESPONDRONE system of systems requirements definition. [8]
This systematic approach would allow the development of realistic scenarios via a rugged, tested approach applied to real case studies. It can be very useful for RESPONDRONE system of systems requirements definition. [8]

The following HEIMDALL deliverables contain the description of relevant study cases in Forest Fires, Landslide, Floods and Flash-floods hazards, focused on a cross-border scenario,

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in a multi-disciplinary event, “request for assistance” situations, inter-organisational cooperation and population awareness. [8]

D3.1 Case studies – Issue 1
Date of publishing: December 22, 2017
http://heimdall-h2020.eu/wp-content/uploads/2018/01/HEIMDALL_D3.1.PCF_.v1.0.F.pdf

D3.2 Case studies – Issue 2
Date of publishing: September 21, 2018
http://heimdall-h2020.eu/wp-content/uploads/2019/03/HEIMDALL_D3.2.PCF_.v1.0.F.pdf

IN-PREP
The IN-PREP project aims at creating a Mixed Reality Preparedness Platform and besides collaborative response planning and interagency training, includes also scenario building. It is recommended to consult the project completed deliverable for RESPONDRONE goals, since the scenario block of the IN-PREP project involves creation, editing, storage and execution of representative threat scenarios. [10]

The following deliverable, “Preparedness Platform and IN-PREP Layers for Response Planning and Scenario Editing (Iteration One)” available at https://www.in-prep.eu/wp-content/uploads/2019/05/Executive-Summary-3.5.docx, can later be examined in detail as it deals with the creation of realistic crisis scenarios, supported by modelling tools, to be implemented in training sessions. [10]

Useful contingencies in the completed scenarios included the simulation of land/sea emergencies as well as cross-border and multi-agency scenarios. Of importance will be testing the platforms ability to assist in such situations. As the development of scenarios continues, the possible input and suggestions of the IN- PREP team could be useful. [10]

DISASTER
In the DISASTER project, to understand what are the main challenges that emergency management stakeholders might have regarding the IT-based interoperability solution, two scenarios were selected for further analysis, in particular the “Air cargo scenario” and the “Moor fire scenario”. The first one imitated a plane carrying dangerous goods that has crashed at an international airport. Here the main challenge was to understand the response/mitigation actions in a challenging airport environment, where myriad of different business processes is going on and where, despite the advantage of the same language being used, establishing intra- and interoperability is a considerable issue to an IT-based solution. [16]

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The second scenario imitates a large wildfire on the border of two countries. Here the main problems are different languages, semantics, responsibilities, legislations and command structures that hinder the response operations of such an emergency. The translation and interpretation of tactical icons and symbols can dramatically enhance response/mitigation actions. Also, the connection of IT-based management systems and allowing for collaboration between stakeholders is the ultimate aim of this scenario. [16]

Both scenarios, worth considering for RESPONDRONE, are described in WP6 of DISASTER project.

SUNNY

The SUNNY project has developed a module of Automated Target Identification described in the project deliverable D4.2:
http://www.sunnyproject.eu/media/1012/sunny_d42_automated-target-identification_v9.pdf

The deliverable focuses on state-of-the-art target detection models and algorithms. These models use a single sensor, but a methodology for multi-sensor data could improve performance. The algorithms were then evaluated based on project datasets. The deliverable report finally provides details on how to reduce manual annotation via model learning. [13]

The results of this module could be helpful in developing data inputs for RESPONDRONE scenarios. [13]

SAY-SO

The document "D2.3 – Reference Scenarios" produced by SAY-SO project comprises a list of reference scenarios for five types of use cases, namely: natural hazards, technological hazards, security hazards (including CBRN), health hazards, and "socio-economic hazards", defining different types of scenarios to address.

Brief hypothetical scenarios are developed in the project deliverables and include relevant actions to be taken. These briefs were developed using real world incidents.

These inputs may be useful in RESPONDRONE scenario development and monitoring of the project's outcomes should be an ongoing task during scenario development. [17]

More information is available at: https://www.sayso-project.eu/modules/downloads/dlc.php?file=17&id=1564754306&sid=93

SESAR CORUS

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SESAR CORUS project reports, recommended for consulting, discuss scenarios and use cases related to take-off, fly and land where, in particular, there is no flight plan beyond visual line of sight flight and when an incident or an emergency happens during a flight. It tackles the issue of what services can be used to communicate about the emergency and initiate proper response/mitigation actions or scenarios. [12]

ACRIMAS

The ACRIMAS project provides relevant information by expanding the number of inputs into scenario development. These included a number of thematic areas, such as legislative frameworks, Situation awareness, Decision support, Deployment of resources, Communications, Training tools/methods, Restoration of basis services, Media involvement, and European coordination of Humanitarian operations which is beyond the scope of other projects reviewed. These bear consideration as a scenario input. Based on the ultimate selection of a general set of scenarios, a final report including a proposal for demonstration scenarios and confirmation parameters will be developed which could be useful to examine in the framework of RESPONDRONE. [18]

FORTRESS

Users collectively created the operational scenarios in the FORTRESS SCENARIO BUILDER (FSB) and exported them to the FORTRESS Incident Evolution Tool (FIET) for the trial. Three parallel trials at a smaller scale were conducted in Italy (Turin, November 2016), France (Paris, October 2016) and Germany (Berlin, December 2016), and focused primarily on a shorter demonstration and test approach to confirm and validate the FSB/FIET results. [22]

The project website reports that “two major field tests were conducted over the course of the project, in order to evaluate the applicability of FORTRESS tools to the preparation phase of a cross-border flooding event involving the Netherlands and Germany. ‘End users really appreciated the flexibility of the tools and the cooperative approach to modelling. The results of the tests show how important it is to use the tools in the preparation phase for providing reasons for crisis events and planning”.

There is no clear evidence of use of drones in the project, but RESPONDRONE team can greatly benefit from the approach adopted by Fortress during the test scenario development and the actual testing phase. [22]

EMSec. Real-time information services for Maritime Security

EMSec developed three scenarios in a maritime context – a highjacked ship, a man overboard rescue, and the use of popcorn to simulate a hazardous waste spill. The methodology and incorporation of alternative materials to simulate an actual event without environmental or property damage is a useful input for scenario development. [11]

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Hijack in the German Bight
EMSec project developed a demonstrator, where airborne radar and satellite images were employed to spot a hijacked ship. As the project website claims, the intelligent combination of all the data would make the operator's job in the Situation Centre easier and quicker. [11]

Rescuing a man overboard
Another scenario of EMSec project also runs through the possibility that people deliberately jump overboard during an accident or hijack. The airborne search for people in the water was tested with the EMSec demonstrator. The Do 228 was able to detect and locate people overboard and transmit to Situation Centre as well as shipping vessels in the area. This type of scenario is relevant to RESPONDRONE as during floods and other disasters detection of human beings and living organisms in water, forest is one of the capabilities the RESPONDRONE technical designers may want to consider for testing. [11]

Popcorn carpet as a hazardous substance
Another demonstrator provided by EMSec partner was aimed at detecting pollution caused by liquid of floating hazardous substances. This kind of testing of technological capability is relevant for RESPONDRONE as chemical disasters can also be greatly supported by drones. [11]

3.4. Scenarios from End User Interviews

Specific scenarios for various disaster types that have been discussed during the interviews with the end user partners are described below:

3.4.1. Armenia - MES - Ministry of Emergency Situations of Armenia

Airplane crash with difficulty locating the crash site

- Responders mentioned a case from 2018 in which a military aircraft crashed high in the mountains. As the crash was only known by air traffic control and the military due to loss of radar contact, reports of the crash did not come in through normal channels.
- In this scenario MES, asked for other agencies in Armenia for assistance in finding the aircraft. Initially, they did not know if the aircraft crashed or not, but when it was out of radar for 20 minutes, the flight operation center forwarded the case to decision makers at MES, who immediately launched a rescue group including flight troops to the disaster location. At the time, they did not know whether the pilots were alive or not, making it a rescue operation for all intents and purposes.

3.4.2. Bulgaria - RAV - Regional Administration of Varna

There was a flood in 2015 in which 17 people died in the center of Varna city as a result. Normally during a flood emergency, the governor, mayor and deputy mayor in charge of emergencies immediately dispatch and form a crisis cabinet. They are obliged to form a crisis cabinet within half an hour following the alert, and they call responsible parties from a predefined list. This generates information to analyse and to make decisions and provide directions to actions.

Information comes from different institutions and includes various maps and other data which is collected and recorded.

3.4.3. France - SIS2B - Fire Fighter Department of Corsica

The most important risks in Corsica are: forest fire, flash flood along coastal rivers, and winter snowfall.

- The transition from **rural to urban environments in Corsica is abrupt**, and so the ability test both urban and rural emergencies is equally important.

Commentary from first responders:

- “It’s very difficult to have good information, because cellular networks are not available, there is a lot of difficulty using the roads and sometimes it’s difficult to fly with helicopters“.

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3.4.4. France - HCFDC - Haut Comité Français pour la Défense Civile

Commentary from first responders:

- First responders stated during the interview that, due to the limited width of some roads in France, accessing some regions with large vehicles could be difficult or even impossible.

A scenario which includes access to such areas would be helpful in this case.

3.4.5. Greece - RCM - Region of Central Macedonia

Notable Events which can be studied for scenario development:

- Summer 2018 – Large-scale fire in Athens showed that the organizations are not very well trained and prepared to manage difficult situations.
- Summer 2019 - disasters in Halkidiki also showed the same issue: the region/country is not trained and prepared for the management of this type of emergency situations.
- Winter 2018 - An incident in the mountains were a couple has been lost with very bad weather situation. They used the European emergency number 112. Unfortunately, the couple died because of the rescue system not functioning properly.
- Meteorological information is disseminated every day. When there is a risk of emergency, a notification is issued. The emergency on Halkidiki for example was notified. Radio stations are also used to transfer information on time.

3.4.6. Greece - RWM - Region of Western Macedonia

Notable Events:

The events reported by the end user are describing the situation in Greece in general. Most of the events are not specific to RWM.

- Summer 2019 - 7 dead people due to extreme weather conditions caused by strong winds, 15 minutes rain only, near Thessaloniki and Halkidiki.
- Summer of 2018 - 100 dead people in forest fires in Attica in an extreme weather event.
- Accidents during a hike or a mountain climbing
- Flash flood is the main problem in the river Evros it is the river in the borders of Greece, Bulgaria and Turkey where in case of melt of snow and heavy rain during spring in Bulgaria and because there are big dams that release water. It may cause dangerous of floods but still there. It's a rural area, does not affect big cities, some villages maybe.
- The disaster in July 2019 in Northern Greece revealed a situation that was known but not publicised - The 112 emergency number is not operating in Greece. People are unable to report emergencies. They also do not receive direct alerts

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(SMS or other) in case of emergency. Early alerts via SMS could save some lives in Northern Greece.

3.4.7. Israel - NEMA - National Emergency Management Authority

Drone Usage scenario - In 2016 there was a large building collapse in Israel. A parking area collapsed and there were three people under it and there was no way to know what happened to the victims. Drones were able to locate cellular transmissions from one of the victims' cell phone. Through them they were able to locate the victims. After that, the drones were located on the discovered point to give the rescue team a direction where to go.

3.4.8. Latvia - SFRS - State Fire and Rescue Service of Latvia

Latvia deals mostly with floods and storm surges, which are seasonal. Forest fires are also common. Last year, Latvia experienced the largest forest fire in 100 years. Earthquakes, chemical or CBRN accidents are not usual, but the country has industrial sites, so it has to be prepared for emergencies (mostly chemical and oil, not radiological).

SFRS has previously been involved in the assessment for the regional and state communication during emergencies. The primary driver for such a disaster could be an emergency with the power grid or a destroyed communications tower after a storm. There is a committee on crisis emergency in charge of this kind of situations.

In case of an emergency, local telecommunication companies bring portable stations to reopen communications channels. It happened once during a forest fire when such portable tower was brought in since no communication worked (no mobile network, no radio).

3.4.9. Netherlands - VRH - Netherlands - VRH - Safety Region Haaglanden

Important for scenario development is understanding the transition from a level 1 to level 2 scenario. Typically, a level 2 scenario is declared when the third fire engine is dispatched. Understanding how the system will incorporate with the national emergency management system is important to this end user.

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4. Simulation Data

In this section we will describe:

- The software to be used for the simulations
- Sources of the data to be used during the simulation

4.1. Simulation Software - CRISE

The "CRISE" Crisis Simulation Engineering software will be used for disaster scenario simulation.

The company's website provides the following description of the software:

Per the CRISE company website (http://www.vr-crisis.com/?article255) - "CRISE delivers 3D simulation platforms aimed at teaching, training and qualifying response units for increased preparedness for risk and emergency handling. CRISE simulators are designed to address the training needs for individuals or teams, scaling the command ladder from first response operators to strategic command personnel.

CRISE offers a variety of solutions, custom made or ready-to-use, with a proven track record in delivering training modules and services to enhance organizations' pedagogy at a minimum cost."

Based on the initial plans 2 types of disasters will be simulated and tested:

- Flood
  - SIS2B will provide simulation software and data for Flood
- Wildfire
  - VULCAIN is a tactical simulator designed for teaching, training, assessing and validating forest firefighting in very large simulated environments.
  - http://www.vr-crisis.com/?article255

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4.2. End User Data

One of the key issues discussed during end user interviews was data captured during various stages of the Disaster Management cycle. The following were key data sources that respondents were asked about:

- Does the end user organization use an Information Management System (IMS, software) for capturing data on emergency reports?
- Is the data available to the first responders in the field?
- Is GIS available?

The following information was collected from respondents:

- Some end users have very sophisticated IMS Software with interagency integration and robust permission mechanisms and all data related to the disaster case is available electronically. However, in these cases, the **information is classified and cannot be shared publicly**, hence cannot be used for simulations.
- Some end users have IMS Software with limited functionality and typically accessible for only one agency. The Data in again classified and cannot be shared publicly.
- Some end users are not using any kind of IMS system and the data is kept in the form of official reports in document format (MS Word in most cases). The data in these cases is classified and is not well formatted or categorized.
- There are some cases when the official report is kept in paper document form.

To summarize, unless agreements can be made with end user organizations, data inputs from IMS software or manual inputs may be difficult to procure.

4.3. Scientific Data available in “CRISE” system

The information below is provided by HCFDC and SIS2B - The “CRISE” platform already includes all simulation, vehicle traffic and aircraft traffic software. There is a need to add tools for simulating accidents at industrial installations.

The following data must be integrated into the simulation platform:

- Modelled 3D map of the area of interest.
- The modelled shape of Alpha drones to provide a highly visible rendering during the simulation. Note: The scenario will include flying the drones along a pre-established route. It will be very useful to train users before the field demonstration.

4.4. Data provided from Drones

The information below is provided by Alpha - in Multi-UAV operations drones will have two different statuses: active or inactive, depending if the drone is selected to be commanded or not. On the other hand, while the drone is inactive, it will operate automatically, based on its flight plan.

The **Alpha-800** drone provides the operation software with different information depending on its status. While the UAV is inactive, it will provide only reduced telemetry which includes:

- Serial Number/ID
- Heartbeat
- Position (Including Altitude)
- Airspeed
- Toggled Mode
- Toggled Alarms

Additionally, for the active UAV: AHRS, Engine, Accelerometer, and IMU in addition to the reduced telemetry information. In order to simulate the physical behaviour of the Alpha-800, the following additional information will be needed:

- A 3D model of the UAV
- Trajectory simulation and physical parameters of the Alpha-800.

4.5. Data provided after video processing

3 main types of video analytics (on-board or on ground) are envisaged and must be confirmed/selected in accordance with the final scenarios.

- Object detection and tracking
- Image segmentation
- Objects classification on visible and thermal images (fire, smoke, shattered area, etc.)

Raw data that will be provided after the video processing are bounding boxes and type of objects. Provided that ground topology and drone telemetry data are available, real time position and speed of objects will be provided.

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5. Key Findings

5.1. Common scenarios

Each end user was asked to identify the types of disaster that is applicable to their country/region.

Common Scenario \ Relevant End User	NEMA	VRH	SFRS	VAR	MES	SIS2B/HC FDC	RCM	RWM
Earthquake	1				1	1	1	1
Fire / extreme heat	1				1	1		
Flood from the sea or rivers	1	1	1	1		1	1	1
Flood from dams								1
Collapsed building / search and rescue	1					1		1
Forest fire		1	1		1	1	1	1
Terrorist attack	1	1				1		
Storm, heavy rain, snow	1	1	1	1	1	1	1	1
Industrial accidents (oil & chemical spills, also in the sea)	1	1	1	1	1	1		
Landslides/Rockslides					1	1	1	1

5.2. UAV/Drone usage in scenarios

Each end user was asked to identify how the Drones are currently used in emergency situations.

Question/UAVs usage	MES	RAV	VRH	SFRS	NEMA	SIS2B/H CFDC	RCM	RWM
Operates/plans to operate drones in emergency response	1	1	1	1	1	1		
Purpose: Scale assessment			1	1	1	1		
Purpose: Kinetics and Dynamics of spread			1	1	1	1		
Purpose: Identify humans (dead or live) in the disaster area			1	1	1	1		

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Purpose: 3D modeling of disaster area			1	1	1	1		
Purpose: Is fleet of drones operated as communication channel				1	1			

Advantages of using Drones

- low-cost
- small size
- manoeuvrability

Technical issues when using Drones

- limited flight time
- network relay

Identified Missions for Drones

- early detection
- prevention
- real time monitoring
- information support for making better decisions
- damage assessment
- regular monitoring (dam facilities, surveillance of forest and coastal areas)
- surveillance of major events

Environments where Drone flights should be considered

- open space
- regular gridded obstacles
- random obstacles
- extreme meteorological events

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6. Conclusions & Next Steps

Based on the conducted research of EU projects, scientific articles, case studies, as well as the field studies conducted with the end user partners, we found that the majority of scenarios described in this document provide limited information, mostly about the common disaster types and typical operational structures.

However, some EU projects (e.g. DRIVER+) implemented sophisticated systems for scenario management. During the upcoming RESPONDRONE testing activities we might benefit from a closer cooperation with the teams of the above-mentioned relevant projects.

Extreme weather conditions, flood and wildfire are the most common disaster cases reported by the end users.

The end users that are currently using drones in first response operations report the usage of drones as very effective and useful. They find the limited number of trained pilots as the biggest challenge. RESPONDRONE offers a good solution to this challenge by allowing a single pilot and few observers to operate a fleet of drones.

The end users that do not have experience using drones in first response operations are also interested in testing and incorporating drones into their current operations.

All end users report the following advantages in using drones during the different stages of emergency management: low-cost, small size and manoeuvrability. The top 3 important drone missions in the first response operations are reported as: early detection, prevention and real time monitoring.

The content of the WP15 deliverable D15.3 will be used during the RESPONDRONE Design Thinking Workshop on November 12-13, 2019 in Thessaloniki.

The findings will also be used for the deliverables D15.4 - RESPONDRONE concept/mock-up and D15.5 - RESPONDRONE functional design document.

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