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

ResponDrone

D.10.1

“Requirement Analysis Report”

Project Deliverable Report

Deliverable Number: D 10.1
Deliverable Title: Requirement Analysis
Author(s): HCFDC
Work Package Number: WP 10
Work Package Title: Large Training Programs

This project is funded by the European Union’s H2020 Research and Innovation Programme and the Korean Government under Grant Agreement No. 833717
https://respondroneproject.com/

RESPONDRONE Project Information	
Project full title	Novel Integrated Solution of Operating a Fleet of Drones with Multiple Synchronized Missions for Disaster Responses
Project acronym	RESPONDRONE
Grant agreement number	833717
Project coordinator	Max Friedrich, DLR
Project start date and duration	1st May 2019, 36 months
Project website	https://respondroneproject.com/

Deliverable Information	
Work package number	WP 10
Work package title	Large Training Programs
Deliverable number	D.10.1
Deliverable title	Requirement Analysis Report
Description	This report covers the first phase of the training work package for the project and the requirements of the involved First Responders involved as well as the analysis about which tools would be best to use in order to achieve the results sought.
Lead beneficiary	HCFDC
Lead Author(s)	Christian Sommade, Patric Botey
Contributor(s)	DLR; IAI; ALPHA; CEA

This project is funded by the European Union's H2020 Research and Innovation Programme and the Korean Government under Grant Agreement No. 833717
https://respondroneproject.com/

Revision number	1.0
Revision Date	15-06-2021
Status (Final (F), Draft (D), Revised Draft (RV))	F
Dissemination level (Public (PU), Restricted to other program participants (PP), Restricted to a group specified by the consortium (RE), Confidential for consortium members only (CO))	PU

Document History			
Revision	**Date**	**Modification**	**Author**
0.1	10/03/2021	Initial draft	P.Botey, C.Sommade
0.2	30/03/2021	Revised version	P.Botey C. Sommade
0.3	05/05/2021	Revised version	P. Botey
0.4	03/06/2021	Revised version	R. van Oorschot
1.0	15/06/2021	Final revision	Max Friedrich

Approvals				
	Name	**Organisation**	**Date**	**Signature (initials)**
Coordinator	Max Friedrich	DLR	15/06/2021	MF
WP Leaders	Christian Sommade	HCFDC	15/06/2021	CS

This project is funded by the European Union's H2020 Research and Innovation Programme and the Korean Government under Grant Agreement No. 833717
https://respondroneproject.com/

Disclaimer

Copyright message

This project is funded by the European Union's H2020 Research and Innovation Programme and the Korean Government under Grant Agreement No. 833717
https://respondroneproject.com/

Table of Contents

This project is funded by the European Union's H2020 Research and Innovation Programme and the Korean Government under Grant Agreement No. 833717
https://respondroneproject.com/

This project is funded by the European Union's H2020 Research and Innovation Programme and the Korean Government under Grant Agreement No. 833717
https://respondroneproject.com/

This project is funded by the European Union's H2020 Research and Innovation Programme and the Korean Government under Grant Agreement No. 833717
https://respondroneproject.com/

Table of figures

This project is funded by the European Union's H2020 Research and Innovation Programme and the Korean Government under Grant Agreement No. 833717
https://respondroneproject.com/

1. Executive Summary

This deliverable covers the first phase of work package (WP) 10, which is the training work package for the ResponDrone project. It covers the study of the requirements of the First Responders involved in ResponDrone, as well as the analysis about which tools would be best to use in order to achieve the required results. Additionally, it includes an extensive case study that was developed when the option of using Virtual Reality (VR) based training (cf. Annex B) was considered before the formal start of the work package.

As a first step, a case study was conducted in order to explore the possibilities VR offers for training end-users on the ResponDrone platform. The study revealed that VR offers a great deal of possibilities for training exercises. However, it also became evident that before the platform can be integrated into a training exercise with specific scenarios (such as forest fires, floods or earthquakes), the users need to be trained how to safely and efficiently use and operate the system itself. It was concluded that for the training in the use of the ResponDrone platform, including its concept of operation and functionalities as well as training related to the safe operation of drones, an interactive web-based learning management system (LMS) would be more suitable than the application of a VR training framework. Nevertheless, VR may be used in a later stage of development to simulate the ResponDrone platform and integrate it into simulated VR-exercises to train specific scenarios.

For the development of the web-based LMS, it was important to well understand the expectations and needs of end-users in order to ensure that the training of the ResponDrone platform will be effective. As a start, we focused on the outcomes of the work done in WP 15 and WP 9 to initially identify the needs and expectations. In order to deepen the understanding of the end-user's needs a number of questionnaires were developed and sent out to the end-user partners, targeting expectations and requirements for a training platform.

This deliverable presents the methods and results of the questionnaires and the training concept for the web-based learning platform. The results of the initial case study into the use of VR can be found as an annex (cf. Annex B) to this deliverable.

This project is funded by the European Union's H2020 Research and Innovation Programme and the Korean Government under Grant Agreement No. 833717
https://respondroneproject.com/

2. Introduction

For identifying the requirements towards the training platform, it was important to understand the expectations and needs of the end-user partners. The results of the WPs 9 and 15 were very helpful for identifying expectations and needs. In order to deepen the understanding of the end-user's needs two questionnaires were developed and sent out to the end-user partners, targeting expectations and requirements for a training platform.
Contrary to the intial assumptions that VR would be an effective tool for training, the results of the questionnaire suggested otherwise. It became evident that for the training of the ResponDrone platform, including its concept of operation and functionalities as well as training related to the safe operation of drones, an interactive web-based training would be more suitable. Since the objective of the WP is to develop a training course for operating the ResponDrone platform, it was agreed to focus the work on the development of a web-based training platform.

The ResponDrone system is designed to facilitate the conduct of civil protection operations by First responders and to improve the situation awareness of the officers in charge of commanding these operations. Therefore, it is particularly important to adapt this system to the expectations of the different members of first response organizations.
To do this, it was necessary to well understand all the procedures used and to know how to best integrate the ResponDrone tool into existing operational systems.

In order to fully understand the expectations and constraints of the end-users in terms of the implementation of the drone system, two specific questionnaires were developed with the topics:

- The operational implementation
- The training program

As far as the operational implementation is concerned, we thought it was necessary to know, first of all, the different national systems of organization of civil protection during an emergency/crisis management situation. As a second step, it was necessary to know the procedures, the decision-making trees and the chain of command of each end-user structure.

Regarding the training program, we wanted to question the users to know their expectations both in terms of required training levels with ascending difficulty and the time that could be dedicated to the training by stratum of command and specialization to be able to use, as well as possible, the ResponDrone system (time of training, type, virtual, web based, practical, etc.).

The answers to these questionnaires and their analysis are decisive elements for the continuation of the work in WP10.

This project is funded by the European Union's H2020 Research and Innovation Programme and the Korean Government under Grant Agreement No. 833717
https://respondroneproject.com/

2.1 Questionnaires to derive training objectives

In order to better target the expectations of first responders, two online questionnaires were launched. These had a twofold objective:

1. Know the type and mode of organization for each entity during an emergency/crisis management situation and know their expectations in terms of training in the use of the ResponDrone platform.

2. What they expected in terms of training to understand and be able to use the ResponDrone system (time of training, type, virtual, web based, practical, etc.).

The questionnaires were completed by all end-user partners of the ResponDrone consortium and can be found in Annex A.

3. Results of the questionnaires

What emerges from these questionnaires is that first responders prefer more traditional, non-VR teaching methods, which seems to them more affordable and less complex with an interest in practical face-to-face training after a first part of e-learning.

The analysis of the collected data demonstrates and validates that globally end-users use three real levels of decision or command of the operations in which the ResponDrone system is going to be used (strategic, operational and tactical). Consequently, three levels of training should be offered in the e-learning solution.

It also appears from the collection of responses to the questionnaires that operational use of the ResponDrone system will take place in different locations such as national or regional command and control rooms, field command posts or directly by the incident commander closer to the field.

As a result, it will also be necessary to offer courses aimed at different target audiences that allow each learner to validate different training modules that cover the different aspects of use. This is essential so that, for each level of accreditation (or qualification), the operators who have received their qualification or accreditation are fully aware of the environment, the constraints, and above all the added value of using the ResponDrone system for emergency management and/or complex rescue operations.

This project is funded by the European Union's H2020 Research and Innovation Programme and the Korean Government under Grant Agreement No. 833717
https://respondroneproject.com/

4. Creating the training

As seen in the previous paragraph, the results from the questionnaires point strongly towards a basic need to first learn how the ResponDrone platform works, how it can and should be used, and when and where to implement it. There was a strong preference for online learning, strengthened by face-to-face sessions where possible. The recent global pandemic also points towards using a ‘remote-first’ approach in setting up a learning system. This makes the training platform also more resilient in case of a future crisis.

The basis for the ResponDrone training therefore will be a series of modules, divided in separate subjects and at different difficulty levels. The courses will be designed by the different partners in the project, under the supervision of a pedagogical expert.

The content of each module will again be split up into smaller units of approximately 5 minutes each, and will consist of enriched content, including but not limited to:

- Drawings
- Video speech or interviews
- Video taken from 3D simulation software to present tactical or operational situation
- Tutorial materials
- 3D animations
- Interactive supports
- Multiple choice questions

4.1 Training objectives

To be effective, an operationally oriented training program must meet two main types of objectives:

- The levels and qualification expectations of the learners:
  - What objective must each learner achieve at the end of his or her training?
  - What type of qualification or accreditation must each learner obtain after validation of his or her level of training?

- The operational target after training:
  - What role will each operator who has validated his or her specific level of training play in their professional structure?

As explained above, the training must aim to obtain the different levels of qualification by validating several modules per level. Together with the partners, we have developed a structure

This project is funded by the European Union’s H2020 Research and Innovation Programme and the Korean Government under Grant Agreement No. 833717
https://respondroneproject.com/

and a number of different modules, matching the different subjects, roles and levels (see chapter 4.2). The next steps will be to further refine this structure, and to develop the training material.

The objectives of these training courses are to enable learners from the various end-user partners and later companies or administrations outside the project to acquire the technical and operational skills necessary to handle the ResponDrone system and its interface.

In the operation of a system of systems there are a large number of different "professional" learnings and interactions coming from different environments (public-private- first responders, elected officials, UAV pilot, etc.). Only a complete mastery of the ResponDrone environment enables the acquisition of the situation awareness necessary for decision support. This mastery should be diversified throughout the organizations.

Therefore, after defining the levels, modules and the pedagogical content (see chapter), it will be necessary to specify the training course as a whole. This training path should be marked out by situational exercises during tests that will highlight the learner's possible lack of knowledge and the planned corrective measures. This is a learning technique using a skills-based approach mixed with a traditional method of knowledge transmission.

This technique allows for a virtual situation through the learner's progress and allows to measure their progress until the validation of the modules and then of the different levels.

4.2 Training architecture and structure

, The following structure based on three categories of knowledge has been selected as a base for the training of ResponDrone system:

1. Regulation & Concept of Operations;
2. Using the ResponDrone Platform (e.g. for mission planning, fly and return, incident management, post mission actions);
3. UAV flight training.

This training structure has been further elaborated into 9 different modules, with different (partially overlapping) target audiences. The complete program will prepare all the necessary roles to be trained sufficiently to use and operate the ResponDrone platform responsibly and correctly. Table 1 depicts the developed training structure . The content will be developed further based on this structure. To ensure the highest quality, each category, as they have been listed above, has a separate leader who will keep an overview of the entire objective, and how it is spread over the different difficulty levels. This ensures consistency over each subject.

This project is funded by the European Union's H2020 Research and Innovation Programme and the Korean Government under Grant Agreement No. 833717
https://respondroneproject.com/

Table 1. Training architecture and content.

Training Objectives		1 - Basic	2 - Advanced	3 - Expert
A - Regulation & Concept of Operations **Leader:** DLR **Participants:** Timelex, HCFDC	**Target Audience**	Commanders/ Management, UAV pilots, other interested parties	Commanders/ Management, UAV pilots, other interested parties	Commanders/ Management, UAV pilots, other interested parties
	Content	Overview of EU regulations for drone use	How to define a concept of operations	Guide to define a concept of operations for specific mission scenarios
B - Using the ResponDrone Platform **Leader:** IAI/SIMPLEX **Participants:** Thales, INESC TEC, Alpha, DLR, CEA, HCFDC, AUA	**Target Audience**	All First Responders	On-Site Commander	System Administrator
	Content	Overview of the platform's functionalities and user interfaces, incl. but not limited to • how to request a mission, • what mission is used where and when, • how to send messages and file reports	In-depth training on the platform's functionalities, incl. but not limited to • managing the missions using the platform, • approve/ reject missions, • keep overview of the mission status and resources, • payload control and management	Training for a system administrator, incl. but not limited to • system setup anO maintenance, • user creation and management, • troubleshooting, • update management, • networking, • payload management
C - UAV Flights **Leader:** Alpha **Participants:** Thales, INESC TEC	**Target Audience**	UAV Pilots	UAV Pilots	UAV Pilots
	Content	• Introduction and basic knowledge: UAVs, dynamics, systems overview • Allowing connections to TMM: API Interface.	• Vector AP • Visionair Flight Control Software • Operational Procedures and Maintenance	• Practice (Simulator) • Flight Practice (we still need to see if we can offer this in Respondrone timeframe)

This project is funded by the European Union's H2020 Research and Innovation Programme and the Korean Government under Grant Agreement No. 833717
https://respondroneproject.com/

Over the next months, the structure will be further refined, where each module will again be split into different sub-modules. Each sub-module will be aimed to be a sort of 'mini' subject and should take approx. 5 minutes of the student's time. This way, by stacking shorter subjects, the student will more easily retain focus, and learning can be done in a more natural way.

One of the next steps is to develop the modules and sub-modules by the partners. As discussed earlier, we will use different types of learning (e.g. text, video, imagery, interviews, etc.) to ensure we cover each subject appropriately.

4.3 Pedagogical approach

The pedagogical approach selected, based on the results of the questionnaires, is based on a e-learning system as a core of the training. This training will be completed by a face-to-face practical training where possible. After training and delivery of the platform, this will be combined with real flight missions as soon as the system will be given for service into first responders entities.

The concept of e-learning offers a pedagogical approach which is selective by trainee as well as adapted to the right level of knowledge requested regarding the first response mission usually conducted and the person learning the provided material.

When studying the potential different methods of remote learning, the use of a Learning Management System (LMS) presented itself quickly. It is a much more flexible way of offering a structured training, including testing of knowledge absorption, rather than for instance a classical linear website or a series of videos. An LMS allows for better time management by both the student and the supervisor, and improves the pedagogical process.

Furthermore, it became evident that we needed to be able to sequence the training in different levels regarding the needs in accordance with the roles of each user of the ResponDrone system. We have ended up with three levels of knowledge: Basic, advanced and Expert. Combined with the three subjects, this makes a total of nine modules of learning regarding the categories of knowledge which have been designed (cf. Table 1).

The e-learning will be able to be organized through a selection of those modules regarding the level of knowledge required to accomplish a specific mission, and the role(s) the student will play. The technical partners will define the missions and the level of knowledge needed as well as the detailed program needed to each training module.

In summary, the use of an LMS offers the following advantages with regard to the derived pedagogical process:

This project is funded by the European Union's H2020 Research and Innovation Programme and the Korean Government under Grant Agreement No. 833717
https://respondroneproject.com/

1. Use of a secure learning SaaS platform LMS with personalized access control (login and password) and trainer supervision.
2. Pedagogical progress with three levels of knowledge (Basic, Advanced, Expert)
3. Sequencing of the pedagogical action into tnine learning modules.
4. Validation of the modules by QMC and exercise test to be able to access to the next level.

4.4 Benchmarking different LMS system available on the market

A benchmark analysis of the different LMS systems available on the market was conducted in order to find a platform provider that best serves the identified needs of the training of the ResponDrone platform. Based in this analysis, the RISE UP LMS SaaS Solution has been chosen to create the nine e-learning modules for the training of the Respondrone platform. Table 2 presents the results of the benchmark analysis.

TABLE 2. Benchmark for LMS training tool

Benchmark	Pro	Con
Creation of customed HTML website	Easy - use of site framework possible like Wordpress or other: Wix etc.. – low initial cost for hosting	Not flexible - must be simple otherwise complex – does not fillfull all the requirements of a training process - not so cheap at the end - difficult maintenance
Moodle-Training platform	Low cost (almost free) - very powerful	Complex to use - need specialist for implementation - follow up version complex
360 Learning	Minimal cost - professional - flexible - not need to be a specialist for the trainer and for the designer of the training session -	You need to subscribe and pay a fee per trainee Need to be train on the platform
Rise Up	Minimal cost - professional - flexible - not need to be a specialist for the trainer and for the designer of the training session - follow up in the time by Rise up no hidden cost and hosting included - low cost by trainee - Already in used in HCFRN	You need to subscribe and pay a fee by trainee -
Crise	VR Air simulator - interesting for concept of use training - existing in SDIS 2B training program – useful to create scenario video	Not designed for training on the use of the system -

This project is funded by the European Union's H2020 Research and Innovation Programme and the Korean Government under Grant Agreement No. 833717
https://respondroneproject.com/

5. Conclusion

In the first months of the project, a lot of effort was put into conducting a case study for using VR for training the ResponDrone platform. The priority within the project however, as confirmed through end-user studies, is the actual training of the different users on how to use the Respondrone platform as it's being developed. This has drawn the focus towards developing a content based learning program, using an on-line LMS. The work done on the VR case study however is not lost and can be continued after the initial training program has been finished. This should be on the roadmap for the development of the ResponDrone platform and the processes around successful implementation of the platform. Especially table top exercises can be made more realistic and engaging using VR techniques.

For now, this work package will further continue on the path taken here, in developing a viable training package for the ResponDrone platform. The next steps within this work package will focus on:

- Determining the precise content of each module with the different partners involved.
- Creating the educational resources necessary to create the modules on the LMS platform.
- Developing and recording the necessary photographic and video material (for instance during the project's demonstrations and dry runs).
- Setting up and testing a robust method of evaluating the developed material.

This project is funded by the European Union's H2020 Research and Innovation Programme and the Korean Government under Grant Agreement No. 833717
https://respondroneproject.com/

ANNEX A END USER QUESTIONNAIRES

In the process of gathering input from ResponDrone's end-users, a number of questionnaires were used. This Annex presents these questionnaires in full.

Questionnaire on Civil Protection National Organisation

Define the authorities (Organization/Legal Entity/Government Body) that define and coordinate the inter-agency cooperations/collaborations (Civil protection Police - EMS response..) in your country and its applications to the different levels of operations *Please make sure the hierarchical structure of the entities is reflected.*	

2. Operational Decision makers			
Authorities	**National** ** Name of the Organization/Legal Entity/Government Body (Legal Name, Address)* ** Contact person: (FullName, Email, Phone, Position/Tille)*	**Regional (sub national if relevant)** ** Name of the Organization/Legal Entity/Government Body (Legal Name, Address)* ** Contact person: (FullName, Email, Phone, Position/Tille)*	**Local (if relevant)** ** Name of the Organization/Legal Entity/Government Body (Legal Name, Address)* ** Contact person: (FullName, Email, Phone, Position/Tille)*
Police			
Fire			
EMS (Emergency Management Service)			
Investigations - Police/Justice			
Support of Population			
Medical & Hospitals			

This project is funded by the European Union's H2020 Research and Innovation Programme and the Korean Government under Grant Agreement No. 833717
https://respondroneproject.com/

Please define the authorities (Organization/Legal Entity/Government Body) that are in charge of the operational response in the following cases:
Please make sure the hierarchical structure of the entities is reflected.

3. First Responders		
Type of disaster	**Regional**	**Local**
Fires : *Urban and industrial*		
Fires: *Forest* *Bush, Wildfires*		
EMS (Emergency Management Service): *Emergencies relief to the population*		
Anthropogenic: *All kinds of accidents*		
Search & Rescue: *At sea, mountain, perilous environment like Urban Collapse or other*		
Climatic: *Floods, landslide, storms, weather events*		
HAZ-MAT / C.B.R.N.E.		
Terrorist attack		
<Please add other Disaster Types if not listed above>		

This project is funded by the European Union's H2020 Research and Innovation Programme and the Korean Government under Grant Agreement No. 833717
https://respondroneproject.com/

Please define the authorities (Organization/Legal Entity/Government Body) that are in charge of the operational response in the following cases:					
4. Operational Organization Des					
Type of disaster	**4,1**	**4,2**	**4,3**	**4,4**	**4,5**
Fires : *Urban and industrial*					
Fires: *Forest* *Bush, Wildfires*					
EMS (Emergency Management Service): *Emergencies relief to the population*					
Anthropogenic: *All kinds of accidents*					
Search & Rescue: *At sea, mountain, perilous environment like Urban Collapse or other*					
Climatic: *Floods, landslide, storms,* *weather events*					
HAZ-MAT / C.B.R.N.E.					
Terrorist attack					
<Please add other Disaster Types if not listed above>					

This project is funded by the European Union's H2020 Research and Innovation Programme and the Korean Government under Grant Agreement No. 833717 https://respondroneproject.com/

5. Technical Questions			
Technical Questions	**No** *Please comment*	**Yes** *Please comment*	**Notes**
Is Internet usually accessible in the common disaster areas? *What type of Internet connection is available (if at all): cellular, fixed, or mobile wi-fi stations.*			
Is there available data regarding topography and critical infrastructure of the disaster area? *What format is the geographical data available and can it be accessed/used by Respondrone.*			
Does your organization have drones that can be used and/or integrated into the RESPONDRONE system?			
Do first responders use mobile terminals currently? *It is important for INESC TEC to know what terminals will be used so that the network is compatible with them.*			
Are there any existing software/hardware solutions that you will need to integrate into the RESPONDRONE system?			
Are there any software/hardware licensing requirements/restrictions you would like the technical teams to consider?			

This project is funded by the European Union's H2020 Research and Innovation Programme and the Korean Government under Grant Agreement No. 833717 https://respondroneproject.com/

Timestamp	End-User Name	Describe the different levels of your organization's chain of command, from the highest to the tactical level.	In your organization, who decides on the use of UAVs? Or at what level this decision is taken?	Describe the decision-making process from the request to use the UAV to the decision to use it. If possible, give the decision flowchart	In your country :- Who controls civil airspace? From which administration?- In a disaster zone, who controls local airspace? From which administration?- During a disaster, is air command integrated into the land chain of command?How is air coordination conducted during operations? From which administration?If several actors interact :- Who are they?- How do they cooperate? - Describe the interactions	How many people compose a tactical team?	For a UAV system, how many tactical teams do you plan to train per UAV system (24/7 use, other)?

This project is funded by the European Union's H2020 Research and Innovation Programme and the Korean Government under Grant Agreement No. 833717 https://respondroneproject.com/

QUESTIONNAIRE 1

Questionnaire on Designing the Training Agenda for ResponDrone End-Users in WP10

The aim of the questionnaire is design a targeted training for End Users that would serve all levels and all types of needs to adopt ResponDrone solution in the full cycle first response operations.

Questions

Q1. What level of training does your organization require on the ResponDrone solution?
Tick all that apply.

☐ user training (how to use the system, instructions to using the software and hardware interfaces, how to integrate in the firt response operations)
☐ administrator training (how to administer the system in each country at each end user, manage access permissions, workflows, metadata, make sure it remains compliant with user needs and addresses them in full)
☐ system maintenance training (how to install the system, maintain integrity and security of hardware and software, regularly update it, evaluate the performance in critical situations, implement backup plans, address risks of failure, measure uptime/downtime, track log activity)

Q2. How many hours can you devote to the training courses per week? Indicate a value in numbers (*sample answer: 20 hours per week)*.

Q3. What is the ideal span of the training? Indicate the number of weeks for the entire duration of the training (*sample answer: 4 weeks*).

Q4. How would you like the training sessions designed? Indicate the desired duration of each session in hours, ideal number of the participants (*sample answer: not more than 5 people in one training group*).

Q5. What is the ideal proportion of methodological vs. practical material in the course for you? *(sample answer: 40% methodology, 60 % hands-on practice).*

Q6. Would you be willing/able to read training manuals before the actual training? Specify X, the number of maximum pages if answering Yes.

☐ Yes, not more than X pages
☐ No

Q7. How would you like the training materials to be shared with you after the training?
Tick all that apply.

This project is funded by the European Union's H2020 Research and Innovation Programme and the Korean Government under Grant Agreement No. 833717
https://respondroneproject.com/

☐ PDF documents /PPT presentations (passive reading)
☐ Interactive HTML materials
☐ Videos, including the recordings of each training session
☐ All of the above

This project is funded by the European Union's H2020 Research and Innovation Programme and the Korean Government under Grant Agreement No. 833717
https://respondroneproject.com/

QUESTIONNAIRE 2

WP 10 end-users questionnaire

The aim of this questionnaire is to understand how the use of UAV's is determined in the chain of command in order to understand who should be targeted by the training exercise and how the ResponDrone system should be integrated into the chain of command during disasters.

Integration of the UAV's system on a global scale during an event
1. Describe the different levels of your organization's chain of command, from the highest to the tactical level.
2. In your organization, who decides on the use of UAVs? Or at what level this decision is taken?
3. Describe the decision-making process from the request to use the UAV to the decision to use it. If possible, give the decision flowchart
4. In your country : - Who controls civil airspace? From which administration? - In a disaster zone, who controls local airspace? From which administration? - During a disaster, is air command integrated into the land chain of command? How is air coordination conducted during operations? From which administration? If several actors interact : - Who are they? - How do they cooperate? - Describe the interactions
5. When two levels of command have to use UAVs, what is the priority level? Is it the one closest to the field or the one with the highest level of hierarchy? Who makes the decision?
6. When several UAV systems are available in the operational field, at which hierarchical level is the framework of employment defined?

This project is funded by the European Union's H2020 Research and Innovation Programme and the Korean Government under Grant Agreement No. 833717
https://respondroneproject.com/

Use of the UAV's system on an operational scale
7. How many people compose a tactical team?
For a UAV system, how many tactical teams do you plan to train per UAV system (24/7 use, other)?
8. In your organisation, should the person/team who technically deploys the ResponDrone system (getting out of the storage box, starting the engine, technical checks, starting the monitoring console) be the person/team who controls the system in the operational use phase?
9. Are the pilot and the operator in charge of storage, transport and preparation of the UAV system? Maintenance? Are they also responsible for the use of the UAV system and the mission? If not, is there a team dedicated to piloting and another to preparing the job?
10. To which level in the chain of command does the UAV mission leader (pilot, operator) report? By what means?
11. Do the different tabs offered in the Respondrone interface have to be used and looked after by the same person? If so, what is the position of this person in the operational chain of command?
12. Who manages the risk of collision between UAVs and aircraft (helicopter, water bomber, other aircraft) and how is it managed? Is there an air coordinator? If so, to which administration does it belong? How is he positioned in the chain of command? What is his or her level of responsibility in decision-making?
13. In your operational organization, who manages the "prioritization" of UAV missions?
14. Do you think that the same person can manage all the tabs offered by ResponDrone on complex operations?
15. Describe the organization of communications enabling the UAVs to be made available to different operators in the field. Is this availability by voice, telephone or radio network? If you are not currently using drones, what do you think this organization would be?

This project is funded by the European Union's H2020 Research and Innovation Programme and the Korean Government under Grant Agreement No. 833717
https://respondroneproject.com/

16. When using the radio network, determine whether the contact frequency is the command's operational frequency or a particular frequency.
17. In the context of a major operation (e.g. a forest fire covering more than 500 ha), give the position of the UAV controller/pilot in the chain of command, as well as his integration in the radio network.
Regulatory and operational framework
18. Depending on the legal constraints in your country, do you see the ResponDrone system fitting easily into your regulatory framework?
19. In your country, is it conceivable that the UAV system could be operated by a private company for the benefit of rescue operators?
20. What about exclusion zones above cities, airport exclusion zones, military exclusion zones?
Context: Images and information collected by ResponDrone are accessible in the Cloud.
21. Describe the levels of access and the entities that can connect to this information.
22. Is there a specific regulation in your State on the authorization to pilot UAVs in an operational context?
23. Who must ensure that data storage is compatible with the rules laid down by the country and the European Union?
24. Who and how should privacy be managed when flying over populated areas and people?

NOTE

This project is funded by the European Union's H2020 Research and Innovation Programme and the Korean Government under Grant Agreement No. 833717
https://respondroneproject.com/

ANNEX B Methodology and Results of the VR Case Study

Introduction

In preparation for the start of WP10 we started with a study into the use of Virtual Reality (VR) in First Responder training. This Annex will describe the steps taken in this study.

Analysis of ResponDrone consortium's "first responder" entities

In order to successfully study the application of VR in training in a variety of operational arrangements of the different entities, it was important to better understand the different levels of decision-making in first responder organizations. This knowledge also enables the training and exercise architectures that could be developed to be developed in the best possible way. The results of this exercise will be described below.

Classification by hierarchical and decisional level in crisis management

A study of the decision-making level of First Responder organizations involved in the RESPONDRONE Project reveals two categories of organizations:

(1) First responders from emergency and rescue services

They are made up of the fire and rescue services of different countries. There are 3 of them:

1. SIS2B (Corsica France)

The Fire and Rescue Department of North Corsica (SIS2B) is responsible for preventing, protecting and fighting fires

2. VRH LAHAYE (Netherlands)

The regional fire department and the organization for medical assistance (GHOR) have combined forces in an agency: the 'Safety Region The Hague county' (SRH).

3. SFRS LATVIA

SFRS of Latvia implements state policy in the field of fire safety, fire-fighting and civil protection, coordinates and supervises disaster management measures and civil protection system

(2) First responders from regional and national crisis management and coordination centers.

1. NEMA

The National Emergency Management Authority (NEMA) was established in December 2007 and is responsible for national emergency preparedness,

This project is funded by the European Union's H2020 Research and Innovation Programme and the Korean Government under Grant Agreement No. 833717
https://respondroneproject.com/

including leading ministries and coordinating military and civil action in emergencies.

2. MES

The Ministry of Emergency Situations of the Republic of Armenia, which develops, implements and coordinates the policy of the Republic of Armenia in the field of civil protection and protection of the population in case of emergencies.

3. RWM

RWM is the Emergency coordination center for the Region of Western Macedonia in Greece

4. MRC

MRC is the Emergency coordination center for the Region of Central Macedonia in Greece

5. RAV

RAV is the Emergency coordination center for Varna Region in Bulgaria

Entities in this category generally do not conduct operations with their own resources on the field. Their role in times of crisis focuses on supervision, mobilization and coordination of all the actors (forces of the various ministries, private structures, associations, external reinforcements, etc.) that can be mobilized. They are working at a strategic or operational level.

Classification by geographical location

First responders can also be differentiated by geographic location with different typology of natural hazards.

(1) Southern country or region

- SIS2B Corsica (France)

An island extremely exposed to the risk of wildfires, with a few tens of thousands of hectares burnt each year.

- MRC and RWN (Regional authorities in Greece)

This project is funded by the European Union's H2020 Research and Innovation Programme and the Korean Government under Grant Agreement No. 833717
https://respondroneproject.com/

Two regions very much exposed to the risk of forest fires, with several tens of thousands of hectares burnt each year.

- NEMA (Israel)

The small size of the country's forests and high population density requires a strong response capable of reacting quickly to avoid destruction of properties.

- MES (Armenia)

Droughts are more and more frequent in Armenia, which with 350,000 hectares of forest (a small area compared to other countries) cannot afford an increase in the number of fires, at the risk of seeing this ecological capital rapidly disappear.

- RAV (Bulgaria)

Bulgaria has more than 3 million hectares of forest of which more than 30% is coniferous, a variety which is very sensitive to forest fires. Moreover,Bulgaria is exposed to extreme weather phenomena linked to climate change such as strong winds and drought.

(2) Northern countries or regions

- VRH (Netherlands)
- SFRS (Latvia)

The climate is harsher, but these countries could be affected in a few years by global warming and be subject to more intense droughts that could affect, for example, the more than 15,000 km2 of coniferous forests in Latvia.

Classification by risk exposure

A classification by exposure to natural hazards is frequent in risk management. It should be noted that the southern countries are the most exposed. They are subject to the risk of forest fires in a very significant way, to flash floods generated by episodes of intense rainfall and, in recent years, to violent storms called “Medicanes”(sub-tropical Mediterranean storm) .

These major risks with rapid kinetics require a large amount of information to respond in an efficient and coordinated manner. In this context, the solution proposed by ResponDrone can be a pertinent asset for reconnaissance and management of such crisis.

This project is funded by the European Union’s H2020 Research and Innovation Programme and the Korean Government under Grant Agreement No. 833717
https://respondroneproject.com/

VR (Virtual Reality) in Vocational Training

The use of VR and simulation in vocational training is common in emergency services, particularly in those on which large scale or specialized responses depends.

There are several companies on the market that offer VR solutions for training first responders in tactics, traditional risks (urban fires, first aid), Hazmat risks (Radiological - chemical risks) and even large-scale risks (forest fires, earthquakes etc.).

Why Virtual Reality?

VR allows, at a reduced cost, to multiply training sequences and thus allow learners to be subjected to a set of operational situations that would be impossible to reproduce in reality. The use of VR allows the trainee to repeat the exercises as many times as necessary until he or she has mastered them.

Strengths and Weaknesses of VR

The strength of VR is the ability to duplicate the exercises over and over again and to offer a tailor-made gradation of difficulty levels. VR also makes it possible to create major crises over several hundred square kilometers without having to mobilize very large resources.

This system also has weaknesses. Like any modern pedagogical system, it is difficult to be accepted by people who are not familiar with the system and who have difficulties to manage the system or understanding its advantages.
It also requires significant investment and a significant allocation of human resources. It should be noted that there are rental solutions on the market that can then be used for training periods.

Solutions available on the market

There are currently several dozen VR solutions on the market. Their use is widespread, especially in fire departments, which realized some twenty years ago the benefits they could get from this type of training solution.

But are they compatible with tactical and strategic level operational organizations as we have defined them?

Tactical level

The contents for the tactical level are much more explicit and the trainees are really immersed in the heart of the response. Their movements in a 3D world are made in real time and the actions

This project is funded by the European Union's H2020 Research and Innovation Programme and the Korean Government under Grant Agreement No. 833717
https://respondroneproject.com/

they undertake have direct effects on the evolution of the situation. Several sub-levels, corresponding to the trainee's layer of responsibilities, can be played and thus increase the number of interactions between the different layers of the operational organization.

Strategic level

As far as simulation at the strategic level is concerned, it is more a question of a solution that integrates the sending of computer inputs (feedback information from tactical level first responders, local authorities, traditional media or social media monitoring). With the exception of a few very specific solutions, VR, as it is currently proposed on the market, is not very well adapted to this type of training at the strategic level. Indeed, very few entities at this level (if any) have their own or shared means to receive video streams and data in real time.

Since VR is essentially based on the simulation of situations using images, the process is not very effective.

ResponDrone's particular constraints for VR application

Before implementing the process of integrating ResponDrone into VR we need to assess the constraints of its protocols and functionalities.

The bi-component land and air

The airborne component requires the VR support software to have a flight simulation engine, enabling it to be parameterized with data specific to the UAVs used. Moreover, the fight against forest fires requires many airborne means (reconnaissance or C2 aircrafts and helicopters as well as fire-fighting water bombers) and many “stakeholders” on the ground.
VR software must be capable of simultaneously managing ground and air components in the same “reality” in consequent number (about ten aerial means and about thirty ground means) is required at minimum.

The extent of the geographical area to be covered

To enhance the quality of the training program, the UAV's evolutionary environment must be commensurate with its real capacity. Starting from a logic of multiple UAVs with a radius of at least 5 km around the take-off and landing zone, a virtual world of more than 75 square kilometers needs to be designed.
At this level the number of software capable of generating such maps is limited to two or three.

This project is funded by the European Union’s H2020 Research and Innovation Programme and the Korean Government under Grant Agreement No. 833717
https://respondroneproject.com/

Kinetics of observable phenomena

One of the unique features of ResponDrone is its ability to provide video and data streams on a large scale. As the platform is meant for tactical and strategic levels, the simulation platform needs to be able to handle this. It is therefore necessary that the simulated events are evolutionary in time and space.
As far as forest fire is concerned, it must be able to spread over several hundred hectares (or more) for a level of strategic coordination to be effectively activated.

The multiplicity of sensors

The selected VR software must have the ability to integrate concepts and functionality specific to the ResponDrone program, including the ability to automatically process data and video of fire or ground information and to provide real-time analysis. There is a need for an open software into which the development of new technology of sensors and data treatment (AI) can be integrated.

A Fair cost regarding the program

Finally, the selected solution must be compatible with the budget envelope allocated in the ResponDrone program, in terms of Person months and other direct costs.

Selection of the solution

After an initial study, three software packages integrate three of the required characteristics
Bi air-terrestrial component, extent of the geographical area, kinetics of the phenomena (forest fire).

- SEILAF (Spain)
- XVR (Netherlands)
- CRISE (France)

XVR was rejected because the software was not selected by the French Civil Security Application School (ECASC) which evaluated it as not efficient enough for forest fire training (full evaluation done).

SEILAF is intended rather for education and training of aerial means. The ground components such as autonomous vehicles, etc. is only slightly developed.

This project is funded by the European Union's H2020 Research and Innovation Programme and the Korean Government under Grant Agreement No. 833717
https://respondroneproject.com/

The CRISE software is currently one of the most popular in forest fire education and training and has a flooding simulation component developed a year ago with SIS2B.

Through a partnership between the HCFDC and SIS 2B, we have access to the basis of the system of CRISE, which covers parts of the needs we had previously defined. This is why we have used this platform to start building the virtual environment of this case study.

Integration issues and architecture

To enable the integration of the ResponDrone solution in a VR world in this case study, we have listed all the protocols and functionalities requiring adaptation

Protocols and functionalities synthesis

Controls and flight plans

To be able to make the VR simulation as realistic as possible. The objective was to be able to reproduce the flight profiles (speed, handling, flight envelopes) of the UAV used in ResponDrone in the simulation so that the participants could perceive all the possibilities that the platform can bring. This integration was partially completed by vectoring the image of the UAV, enabling the aircraft to be viewed in exact proportions.
Apart from the 3D vectorization, which was just a "simple" adaptation of the 3D envelope used by the computer-aided design software when designing the Alpha UAV, further work would need to be done in the engine of the flight software that manages the air assets in the VR solution to capture the full functionalities.

The video stream

For the video stream, we focused on simulating the use of a virtual camera, having the same characteristics (angle, focal length, magnification...) as the camera on board the UAV and to send the video stream in the same format as the one used for reality.
For the infra-red image, the solution chosen was to transform the black and white video signal into reverse polarity, thus giving the visual impression of an infra-red image. The point of ignition, for example, would have been found by integrating an invisible vector marker (hidden marker) in the simulated space associated with a routine highlighting the hidden geo-referenced data each time the camera passes (in infrared mode).

Hidden marker

A hidden marker is an alpha-numeric object that is embedded in the VR reference matrix but does not have an associated image file or pixel. It is therefore invisible. However, it is geo-referenced. It can be associated with action routines (sound emission, data sending…) and

This project is funded by the European Union's H2020 Research and Innovation Programme and the Korean Government under Grant Agreement No. 833717
https://respondroneproject.com/

become active when, for example, the field of a virtual camera covers the surface in which it is inserted.

Sensor data

For sensors, other than video, the problem was more complex and would require more details on the full capabilities of the sensors and missions. As a placeholder we decided to use the same principle as for the point of ignition of the infrared image, namely a hidden vectoral marker.

Artificial Intelligence

The ResponDrone platform performs automated AI data processing on the recorded images. Simulating this on the VR platform would be quite complex. In parallel with the project's development, we decided to focus on 5 forms of recognition:

- Fire - flames
- Smoke
- People
- Vehicles
- Buildings

Two solutions were proposed:

- Implementing the AI engine onto the VR platform. This AI engine would then need to be trained on a lot of synthetic images of the virtual world of these 5 forms, so that the AI engine can recognize them automatically. The AI would "learn" based on computer-generated images and not on real images. In simulation, the AI would then have played its role automatically,
- Alternatively, the workings of the AI engine could be scripted by integrating hidden geo-referenced marks associated with action routines.

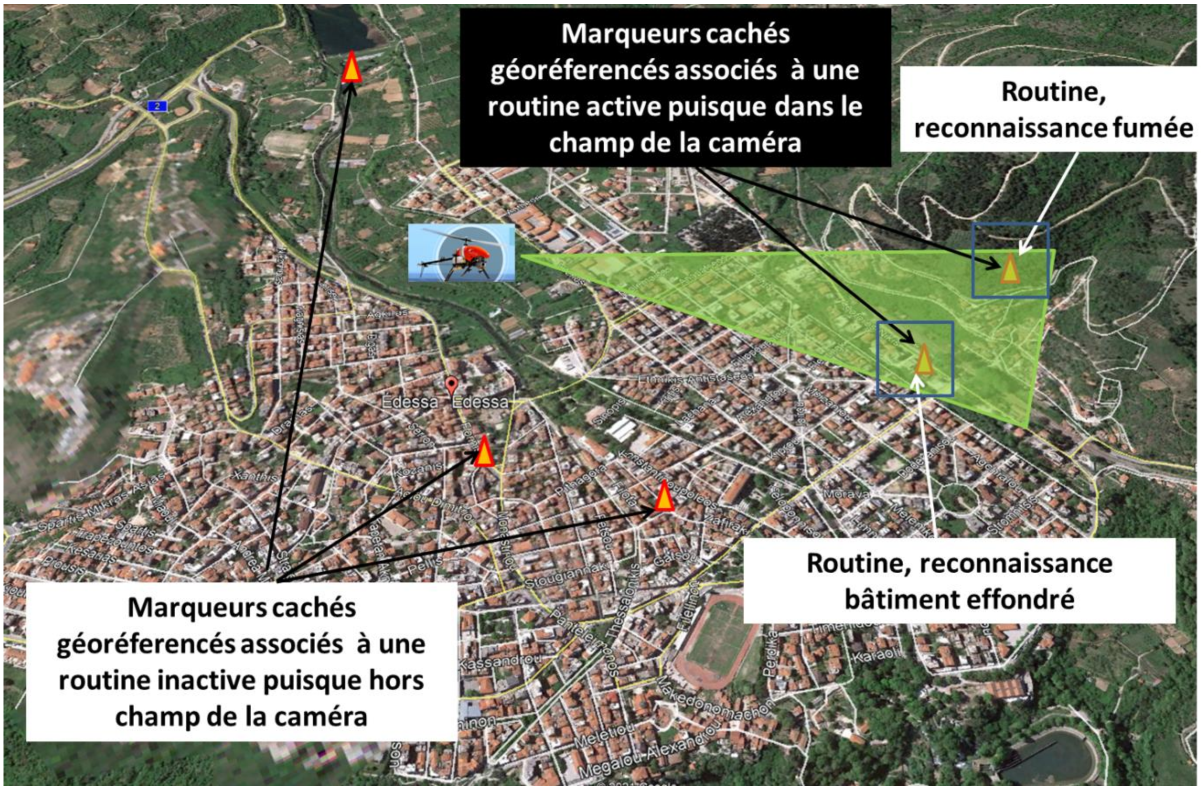

Figure 1: General process of hidden geo-referenced markers associated with a routine

Geolocation

The geo localization of people and events in the virtual world does not pose any particular problem because the cartography is based on a self-standardized grid according to an international geo referencing system (Lambert 93 for France).

Using smartphone

The use of the ResponDrone smartphone interface for First Responders in the field raises a more complex problem. The VR interface is not built for simulating smartphone interfaces. The location of the smartphone on the CCSO map is still a problem to solve, it will still require further thought and research. The transmission of information and communication of the CCSO is done simply by recreating a WIFI transmission bubble similar to that encountered in a real theater of operation.

Vector scans designed for ResponDrone VR Simulation

Choice of scenarios and writing of injects

To make the scenario more complex and allow several entities at different levels of the chain of command to be active at the same time, we propose creating two crisis VR map areas to play simultaneously.

This project is funded by the European Union's H2020 Research and Innovation Programme and the Korean Government under Grant Agreement No. 833717
https://respondroneproject.com/

- The first map corresponds to the forest fire hazard with, of course, a certain number of domino effects to be managed, roads and highways cut off with blocked vehicles surrounded by fire, camping and residential areas threatened, industrial areas affected by incandescent projections.
- On the second map an earthquake is simulated with cascading effects. Dam failure, flooding, collapsed buildings, roads cut off, chemical risk, pollution, loss of electricity networks.

The main part of our work has been to create the virtual cartography, and the inputs that will be injected during the exercises.

The cost for digitizing can be quite high, since each road, each building, each scenario location must be positioned and vectorized. This is a costly process; the digitization of a small town represents several hundred hours of work and can cost upwards of 40,000 euros, depending on the level of detail. Future work on this could be done in more generic areas, or regions that have already been digitized.

Selecting and starting the digitization of the map of Greece (Region of Central Macedonia (RCM))

We have researched a simulation exercise to be organized by the RCM in Thessaloniki (Greece). This exercise would play at 2 levels: C2-3 (Command Control and Communication) by a regional entity (here RCM) and on the ground simulated by CRISE software with the involvement of Fire response units and ResponDrone assets.

The exercise program would be based on real, dynamic and real-time operational simulations. This program and scenario have been discussed with the local ResponDrone partner.

To give realism and to make two tactical levels and one strategic level work together, we opted for two remote scenarios, to be played simultaneously.

The different levels of coordination and operational command (referring to the hierarchical levels of intervention of "first responders").

First Scenario: Edessa

In order to fit perfectly with the reality of the terrain, we had chosen that one of the exercises would be located in the city of Edessa in Greece. This average city of 25,000 inhabitants has the advantage of concentrating many risks on a relatively small area of 9 km2.
It includes:

- An important network of roads and tracks
- A river
- Very high housing density
- A dam overhanging the city

This project is funded by the European Union’s H2020 Research and Innovation Programme and the Korean Government under Grant Agreement No. 833717
https://respondroneproject.com/

- A high-voltage line
- Some industries where the level of risk can be increased by the addition of a hydrocarbon deposit or a small refining unity
- Forest all around the town

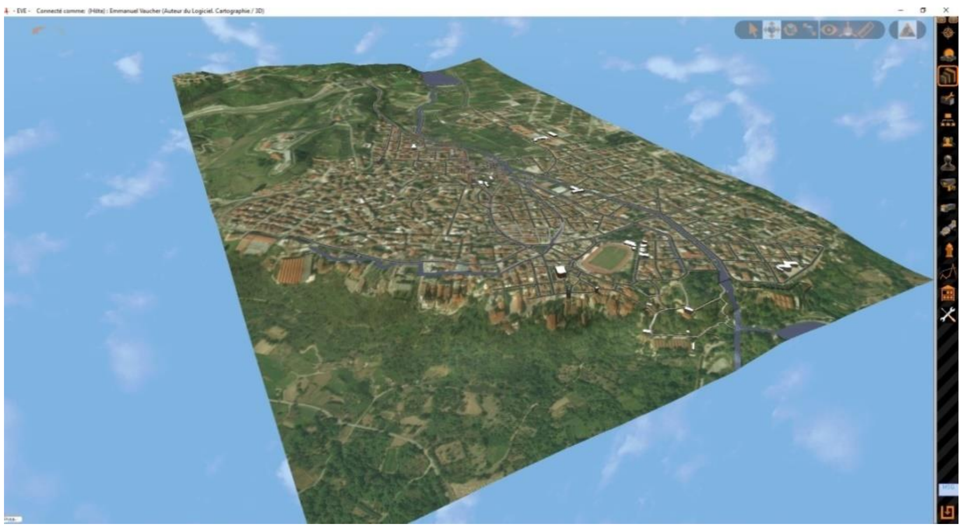

Figure 2: Edessa 3D scanning base with road and buildings

Figure 3: Downtown Edessa 1

This project is funded by the European Union's H2020 Research and Innovation Programme and the Korean Government under Grant Agreement No. 833717
https://respondroneproject.com/

There were significant difficulties in setting the local Edessa map in the Crise software. Crise uses the Lambert 93 French geo-referencing system. There is no map of Edessa in Lambert 93. The latitude_ longitude references contained in the 3D orthophoto of the globe do not allow a direct integration in the VR world. The transformations are long and complex if one does not want to see badly wedged roads for example (roads crossing the relief, road on slopes) or the company and the installation of buildings not perpendicular to the plan. In future scenario development this should be taken into account

Digitization of "risk" hazards

In order to make our exercises dynamic with real-time evolution of hazards, we have started to digitize the building blocks of our scenarios.

A - Earthquake

This project is funded by the European Union's H2020 Research and Innovation Programme and the Korean Government under Grant Agreement No. 833717
https://respondroneproject.com/

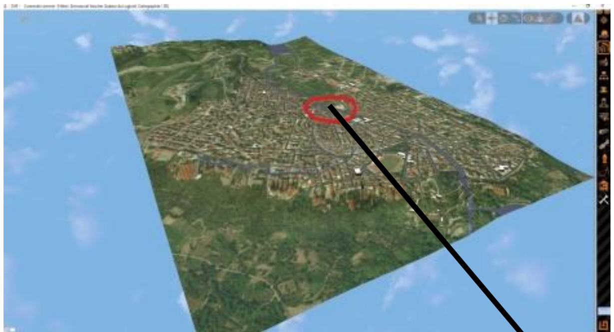

Figure 4: Downtown Edessa 2

Figure 5: Collapsed building in the city of Edessa

Note that each building must be vectorized twice. Once integrated, once demolished.

B - Flooded areas

The dam failure caused flooding of part of the city of Edessa.

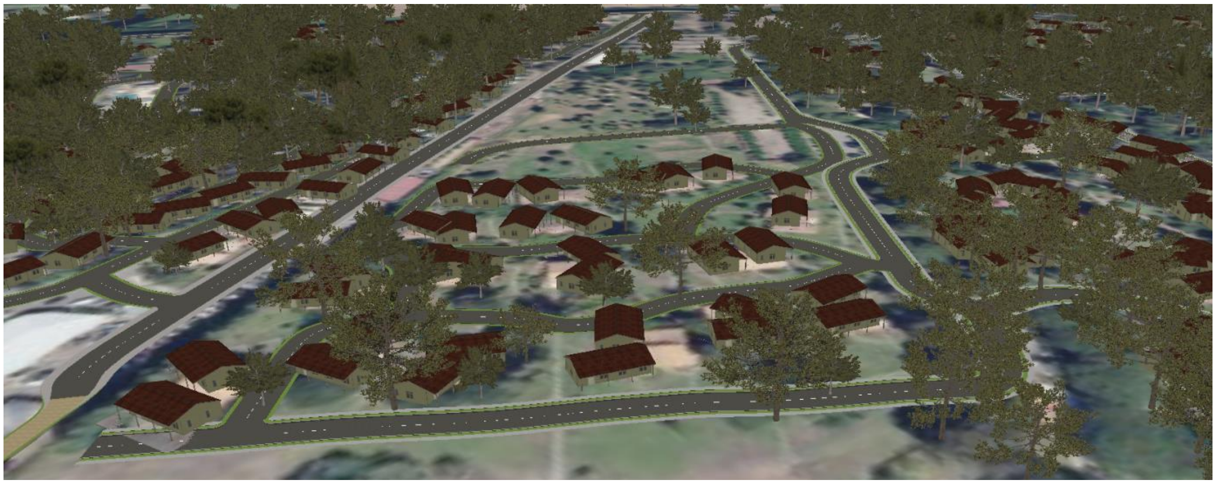

Figure 6: Peripheral district of Edessa before dam failure

Figure 7: Peripheral district of Edessa after dam failure

C- Loss of power system

The scenario also included the management of the loss of the electricity network and all the induced consequences (local hospital center impacted, loss of pressure on the fire network, etc.).

This project is funded by the European Union's H2020 Research and Innovation Programme and the Korean Government under Grant Agreement No. 833717
https://respondroneproject.com/

	
Figure 8: Edessa electric substation before dam failure	*Figure 9: Edessa electric substation after dam failure*

D-Pollution

One item was also to the management of the pollution generated by a leak on the wastewater treatment plant caused by the earthquake.

E- Building fires

Ruptured gas lines also caused many building fires.

Figure 10: Building in Edessa before the earthquake and after with the fire starting

This project is funded by the European Union's H2020 Research and Innovation Programme and the Korean Government under Grant Agreement No. 833717
https://respondroneproject.com/

F) Mass casualties

Obviously, such a disaster caused many casualties to be managed for rescue services.

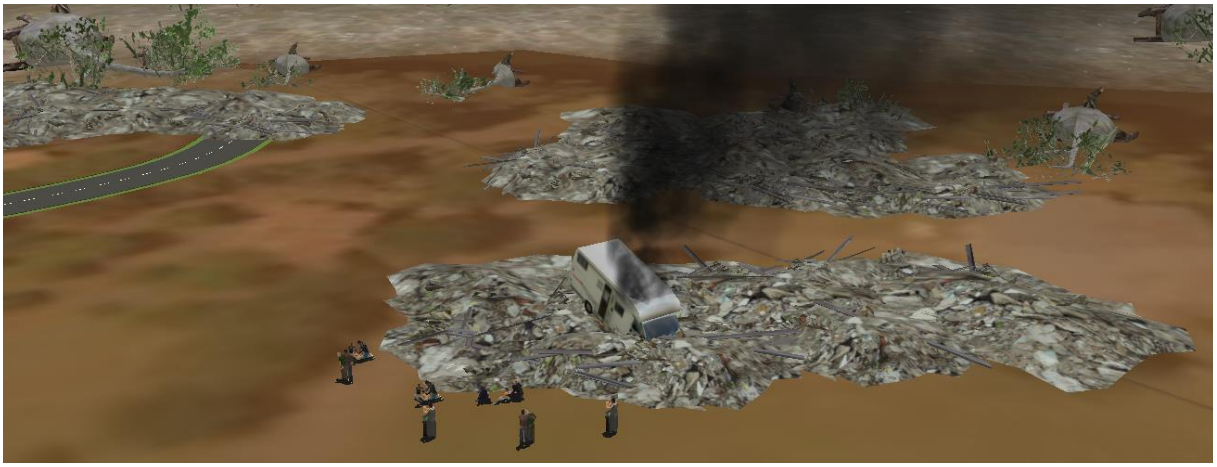

Figure 11: Victims in Edessa neighbourhoods

G- Chemical risk

The scenario also included a chemical accident at the Edessa processing plant.

Figure 12: Chemical plant

H) Dynamic water wave

This project is funded by the European Union's H2020 Research and Innovation Programme and the Korean Government under Grant Agreement No. 833717
https://respondroneproject.com/

To be more realistic, we created a dynamic water wave generated by the rupture of the dam under the effects of the earthquake. In this scenario, the wave would unleash a storm that would hit the city of Edessa.

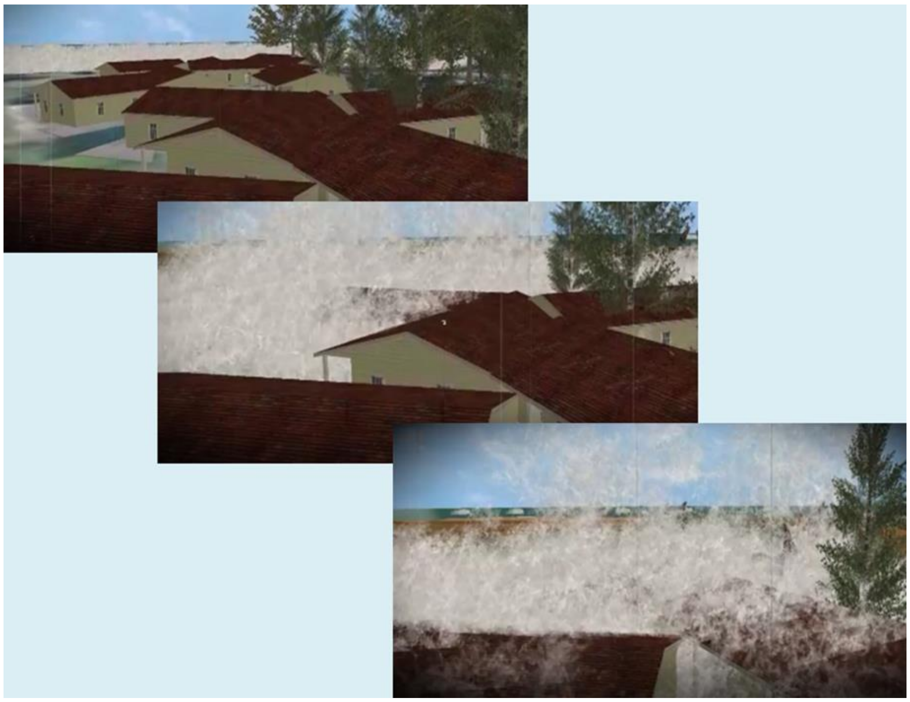

Figure 13: Dynamic wave

Second Scenario: Wildfire

At the same time as the first scenario, a violent forest fire broke out in the region of Thessaloniki and quickly threatened infrastructures and people.

The dynamic simulation of the forest fire allows the situation to evolve in real time. The first scenario was based on a slow evolution of the crisis, the second on a rapid evolution obliging the tactical and strategic levels to bring different responses.

Figure 14: Forest fire

In this very touristic region, fire trapped people and vehicles on highway n°2, forcing the authorities to mobilize their means to quickly extract them from the threat.

Figure 15: Trapped person on highway n°2

An early approach

In view of the challenges to be met, it was necessary to start the work on this study and its preparation well before the proposed start of WP 10.

This project is funded by the European Union's H2020 Research and Innovation Programme and the Korean Government under Grant Agreement No. 833717
https://respondroneproject.com/

The digitization of a map and the creation of the inputs and their integration in the cartography takes several months. The amount of work is really considerable if you want a relevant and authentic virtual rendering.

Figure 16: Operational levels

This project is funded by the European Union's H2020 Research and Innovation Programme and the Korean Government under Grant Agreement No. 833717
https://respondroneproject.com/

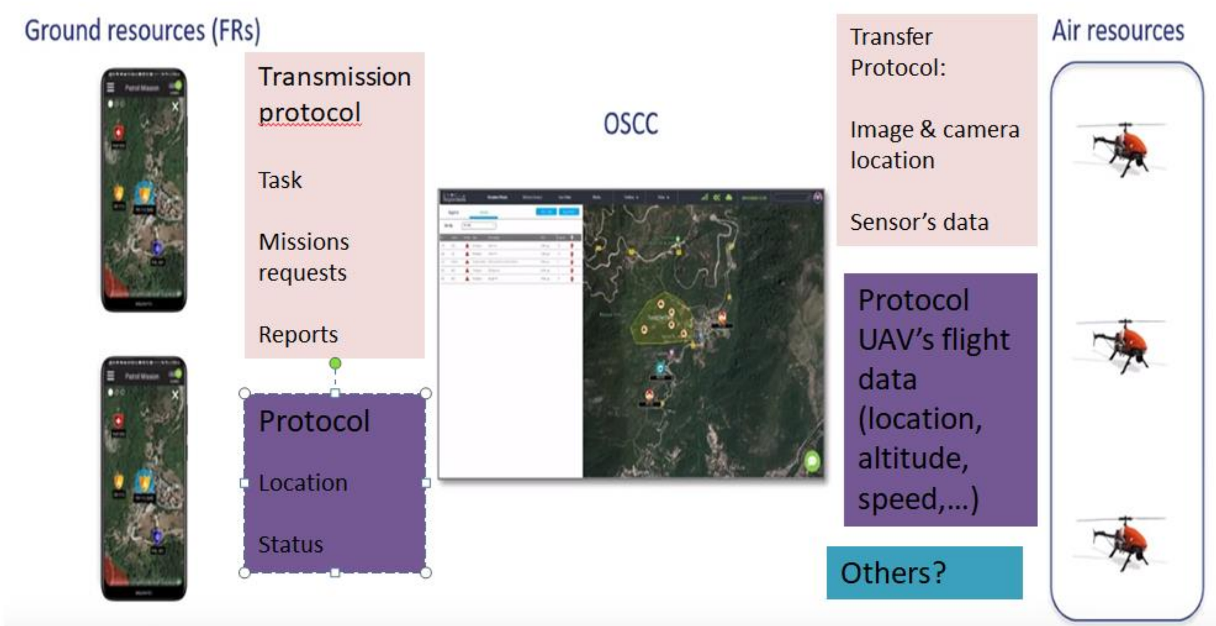

Figure 17: The different levels of coordination and operational command (refer to the hierarchical levels of intervention of "first responders")

This project is funded by the European Union's H2020 Research and Innovation Programme and the Korean Government under Grant Agreement No. 833717
https://respondroneproject.com/

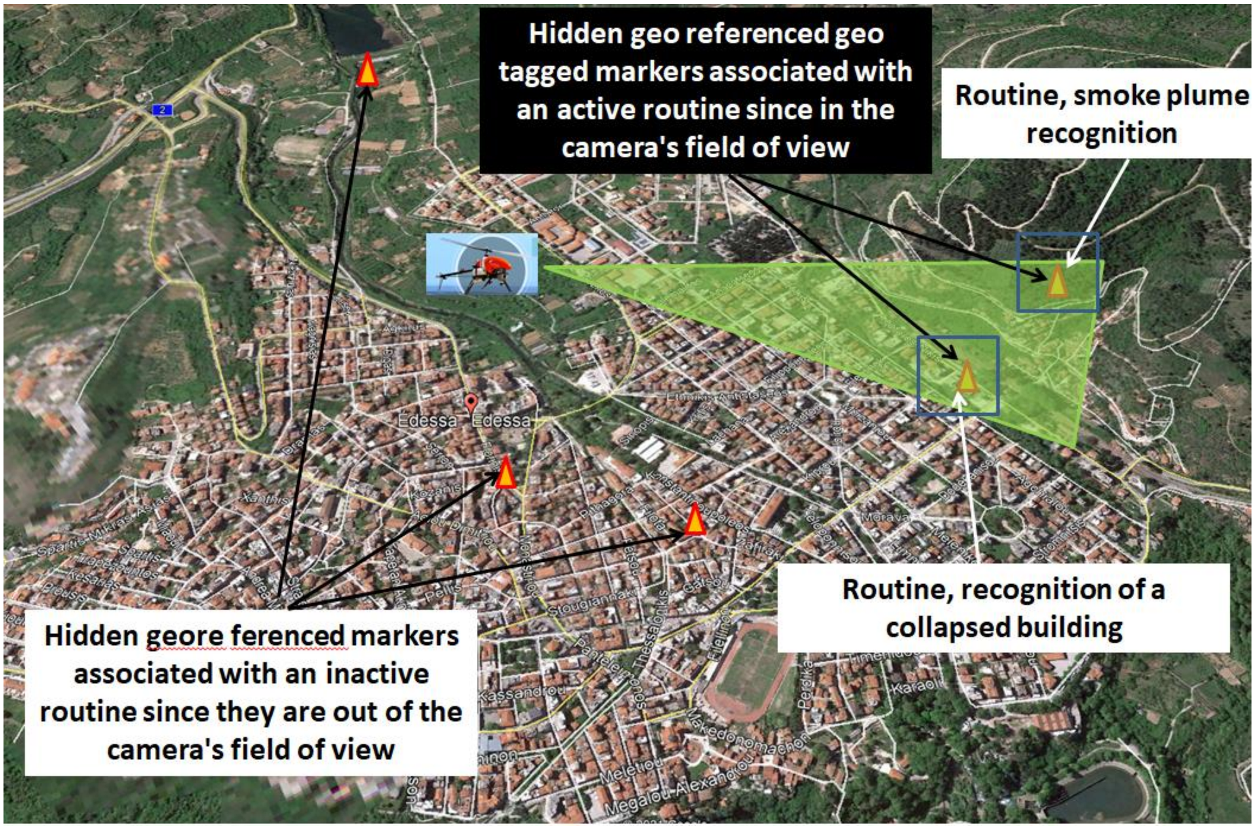

Figure 18: Different routines

Conclusions

As discussed earlier, VR simulation can create a richer scenario for Table Top Exercises (TTX). It would be very valuable to include a full simulation of the features of the ResponDrone platform inside an existing 3D VR platform (like Crise, as used here). This can be done, and we have shown the steps that need taking above. However, this requires a significant amount of resources. As shown above, rendering a new area convincingly in 3D is neither easy nor quick, and the addition of the specific ResponDrone mechanics and features, as well as the full integration with the platform are costly.

Seeing that results from the End-user studies in WP10 showed that the requirements of the End Users of the Respondrone project first have prioritized training on the use of the actual platform. This has led us to focus completely on developing a training package first. The work on the VR platform can be used at a later stage in the development of the ResponDrone platform, as a beneficial tool for training First Responders that have already been trained on using the platform.

This project is funded by the European Union's H2020 Research and Innovation Programme and the Korean Government under Grant Agreement No. 833717
https://respondroneproject.com/