Emergency Response in Recent Urban/Suburban Disaster Events in Attica: Technology Gaps, Limitations and Lessons Learned

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ABSTRACT

Emergency response operations in large-scale urban/suburban disaster events is often addressed by the standard protocols and international guidelines for collapsed buildings, heavy debris, etc. However, a wide range of First Responder (FR) operations need to address various other contexts, work environments and hazards. In this paper, two real disaster events are explored as use cases for such urban/suburban FR operations, namely a flash flood and a wildfire, both in Attica, Greece (2017-2018). Based on our team's experience from these mobilizations and active participation in both these events as FR actor in the field, we present the challenges, the complexity of such multi-aspect disaster events, the limitations of emergency response, the technology gaps of the FR teams, as well as the lessons learned during these deployments. Finally, we make some notes on future prospects and possible advancements in tools and technologies that would greatly enhance the operational safety and readiness of the FR teams in such events.

Keywords

First Responders, Search and Rescue, Flash Flood, Urban Wildfire, Urban Operations.

INTRODUCTION

Today's emergency response operations need to address a very wide range of missions, from localized accidents with very few victims to large-scale disaster events with hundreds of known and unknown victims. The context of such operations also ranges wildly in terms of working environment (open/closed spaces), hazards, weather conditions, time constraints, medical emergencies, evacuation routes, etc. It is imperative that the First Responder (FR) teams and the Communication & Coordination Center (C3) have the necessary resources to operate with safety,

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Figure 1. Mandra: Areas affected by the flood (source: Copernicus)

reliable information, concise operational view for the FRs and detailed Common Operational Picture (COP) for the team commanders.

In urban and suburban environments there are several considerations and challenges that increase the complexity of large-scale disaster events, as well as the emergency response plan and the mobilisation of the FR teams.

This paper provides an overview of such issues regarding the challenges, the complexity of disaster events, the limitations of emergency response, the technology gaps of the FR teams, as well as the lessons learned from two recent large-scale events in Attica, Greece. Specifically, a case of flash flood in the western region (2017) [**1**] and a case of wildfire in the eastern region (2018) [**2**] are the baseline for describing these aspects of emergency response and FR teams, with special focus on technological resources used or in-need for such operations. Our team was mobilized and operationally involved in both these cases, as part of the Civil Protection, the agency in charge (Fire Department) and the regional authorities that were activated.

BACKGROUND

In the following sections the two disaster events in Attica, i.e., flash flood in Mandra (2017) and wildfire in Mati (2018), are briefly described as use cases. The general context in both events is Urban Search and Rescue (USAR), since it is focused on urban/suburban environment and the emergency response of FR teams from time zero (main USAR) up to a few days after the event (mostly search for missing/fatalities).

Mandra: Flash flood

On November 15th 2017, a low-pressure front over the north-western region of Attica produced extreme rainfall for several hours. Measurements showed that the overall precipitation was of a return period higher than 150-200 years for that region. As a result, a flash flood was created and swept through the main roads of the urban grid, devastating neighbourhoods in Mandra and claiming 23 fatalities in the process.

For several days after the main event, many areas inside and around Mandra were covered with thick layers of mudslide, which was partially enforced by the fact that in July, only a few months earlier that summer, large wildfires have swept the eastern side of mount Pateras, directly above the affected area, causing the heavy rainfall to create unobstructed floods and mudslide downhill.

Mati: Urban wildfire

On July 23rd 2018, at approximately 13:00' local (EET), a wildfire started at the western Attica region near Kineta, attracting the attention and fire-fighting resources there. A few hours later, probably around 17:30', another wildfire front broke out at mount Penteli at the eastern region of Attica. Due to the very high wind speed and gusts, measured up to 124 km/h or 12 Beaufort, the fire front moved rapidly downhill on the eastern side, burning open fields and rural areas, while at the same time the front at Kineta was endangering houses and urban grid. Hence, most of the fire-fighting forces, including aircrafts and helicopters, continued their work on the western front until late in the afternoon.

Figure 2. Mandra: City center during the flood (source: local media)

As the eastern front reached the first houses at Neos Voutzas, it was too late to divert forces there. Fortunately, an entire summer camp of 620 children was pre-emptively and safely evacuated from that area. The fire swept rapidly through the open field and reached Marathonos avenue within about 1.5-2 hours from its start, a few km uphill. The fire front jumped from one side of the avenue to the other without any delay, probably due to the very high flames and temperature reached by that time. From there on, within 20-25 minutes the fire front entered the main urban grid in Mati and Kokkino Limanaki (just north of Rafina port), swept through the entire area of roughly 2x2 km2 and stopped at the sea front, which is mostly rocky and cliff coastline with only few narrow passages down to the sea.

Post-event analysis revealed that the local weather conditions, specifically the very high winds, low humidity (19%) and high temperature (30C) due to summer, created a very unique localized 'micro-climate' that enabled the fire to grow and move rapidly across the plain. Inside the urban areas of Mati and Kokkino Limanaki the flames were so intense that people got trapped inside their houses within seconds. The area was covered mostly by dense pine trees, so exploding pines and burning animals trying to escape the front contributed to the spreading of the fire towards the sea front within few minutes. The intensity and speed of the fire was very evident in the aftermath, where on several spots the houses were charred at the first floor and above with glass items melted inside from the extreme temperature, while some ground floors were only smoked and relatively undamaged from flames.

Many people trying to escape by car were trapped in congestion near the shore inside the very few escape routes. As a result, many of them were intoxicated by smoke and burned inside their cars, most of which were found charred in one particular street stuck in a deadly traffic jam 150-200m long. First-witness reports and telecommunications logs revealed that, even as the flames were inside those urban areas and cars were being jammed in the path of the fire front, lack of communication and coordination between the authorities continued to direct some of the traffic from Marathonos avenue away from the immediate front in the north but unknowingly into harm's way inside the sweeping fire in Mati and Kokkino Limanaki.

The result of the wildfire at the eastern front resulted in 102 fatalities and hundreds of severe injuries, including smoke intoxications, direct burns from flames and secondary complications from extensive skin injuries.

CHALLENGES FOR FIRST RESPONDERS

Operational assessment

In both these events of the flash flood in Mandra (2017) and the wildfire in Mati (2018) our team was mobilized and tasked according to the national plan of the Civil Protection, under the direct guidance of the Fire Department HQ which is the agency in charge of such large-scale disaster response operations. We assisted with several Urban Search & Rescue (USAR) elements in the field for several days in both events, mostly operating alongside or under the direct guidance of the Special Disaster Response Unit ('EMAK') of the Fire Department.

One of the most important factors identified during the operations in these events was the availability of prompt, reliable and continuously updated information. The main mobilization plan of our team often includes the rapid deployment of a first 'scout' team inside the affected area to gather information and up-to-date status reports on

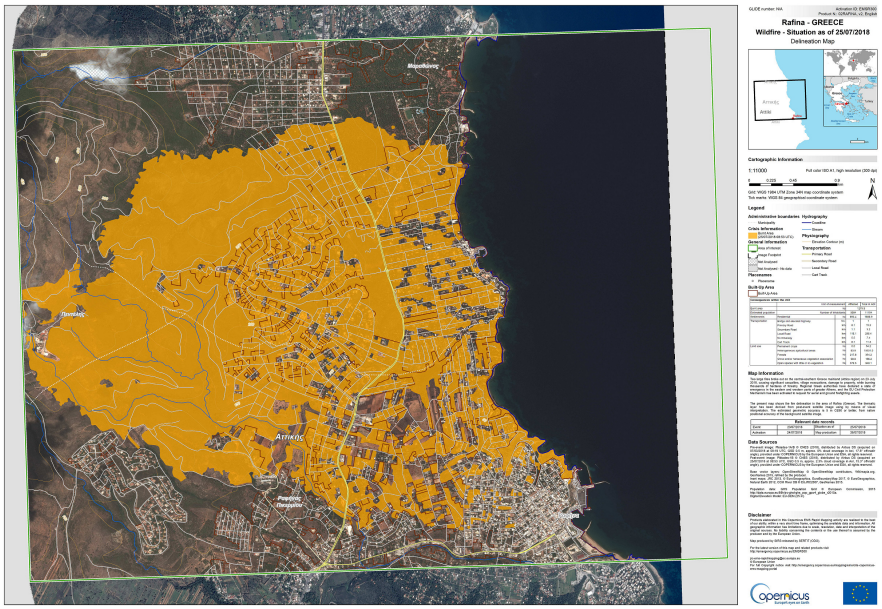

Figure 3. Mati: Areas affected by the fire (source: Copernicus).

Figure 4. Mati: People reaching the sea waiting to be evacuated (source: Greek media).

Figure 5. Mati: Main traffic jam near the city center (source: Greek media).

access routes, number of victims, expected emergencies, identification of liaison contacts, etc, while our main resources are prepared for deployment. As a result, during the first few hours of the wildfires in Mati our team was able to assess the severity of the situation, provide organizational assistance in the local authorities and identify areas where the USAR resources should be immediately deployed. Our rapid deployment element was inside the hotzone in Mati were people were gathering at the coastline or inside the shallow waters for protection and assisted in their fast and safe evacuation by boats, including our own inflatable boat stationed near the Rafina port.

In summary, the main operational issues can be viewed under the standard four-phase operational plan:

1. **Preparedness:** High level of readiness in both equipment and personnel; prior arrangements and contacts with local/regional/national authorities w.r.t. emergency response; well-tested organizational and communication procedures.
2. **Deployment:** Proper training and field experience of the team elements selected to go into the hotzone, especially for the 'scout' rapid deployment; prompt, reliable and up-to-date information about the situation, access routes, severity of the event, expected emergencies; alternative and overlapping means of deployment, e.g. cars and boats, in order to ensure quick and safe access into the hotzone.
3. **Mission:** Continuous updates to the C3 of the team; integration of multiple sources for better COP; reliable communications and contacts with the authorities; strict operational protocols for safety and effectiveness in stressful and hazardous environments.
4. **Disengagement:** Proper debriefing of all the personnel involved; provision of Psychological First Aid if required; extensive follow-up work with the logs, documentation, recorded material for post-mission analysis and data protection.

Technology gaps

In most cases, our team had provisioned all the necessary equipment and tools for the field operations. These included a wide range of things, from hand-held electronic devices like smartphones to simple paper-and-pencil notes as backups. For the most part, everyday technologies and open-access services were the elements most heavily used and exploited by our team during the USAR operations.

Regarding communications, cellular phones were marginally available near and inside the affected areas as the main events were evolving. When available, voice calls and data transfers (images, videos) to and from the deployed teams were extremely important for up-to-date information sharing in both directions. Specifically in the case of wildfires in Mati, lightweight data exchange via Internet access (e.g. messaging applications, social media posts, but not regular SMS/MMS) were proven as relatively reliable and resilient tool during the hours of network saturation. Additionally, simple means of information exchange was extremely valuable in the field, as for example the numerous hand-written notes posted at the door of burned houses stating that the particular family has already been evacuated and they are all safe.

Another important aspect of the operations in both cases was geolocation and online mapping services, available on-site and open-access, with small handheld devices and typical smartphones (e.g. Google Maps). As long as the team had prepared such devices beforehand, downloading all the necessary maps for offline use, geolocation via standard GPS sensors and geo-mapping in the field of operations was readily available to all USAR elements.The exact location of the USAR element down to specific street numbers, the planning of search patterns in open fields, as well as the tracking of area coverage during the search operations, were crucial to the reliability of the findings or the lack of those (clear of any victims). One additional aspect of geolocation capabilities in the field is when marking possible findings for further investigation, e.g. bone fragments, to be conducted by a follow-up team of experts later on.

Limitations in operations

As described above, during the deployment in these two disaster events our team had the chance to identify and evaluate several operational aspects that are inadequately addressed or missed altogether by today's standards and guidelines for emergency response.

In brief, these can be summarized as follows:

- **Safety:** FR teams were often required to assess possible hazards, entry points and search plans on a per-house basis. When no other information was provided and no visual clues were available, the team had to plan, enter and search the houses one by one for possible missing persons/victims.

- **Communications:** Bad propagation conditions and channel saturation were often a problem in R/F communications. Cellular phones and mobile Internet access provides some complementary functionality, but mostly in post-event conditions.
- **Situational Awareness & Logistics:** The evolution of the disaster event as it is happening, as well as the changes in the situation, severity, emergencies and most-prominent search locations are issues that severely affect the level of situational awareness of both the FR teams and the on-site C3 of the team. Lack of communication and coordination between the authorities and the FR resources is a crucial factor.
- **Missing persons/victims:** In many cases the FR teams were required to assess the validity of findings at a level outside their normal scope and expertise, e.g. if some bone fragments are from a human or an animal. This is a very difficult task to formulate into a well-defined procedure, since on one hand some findings are inherently difficult to classify (e.g. end parts of collar bone, ulna, radius, isolated finger bones, etc) and on the other any false negative characterization translates into a real victim not being detected and identified.

FUTURE PROSPECTS

Based on the operational aspects of these two disaster events and the experience of our team's deployment in both cases, several issues have been identified for possible improvements with the introduction of new technologies, tools and practices.

In Safety, 'smart' wearables, handheld and portable devices should enable the FR teams to operate autonomously, safely and with increased situational awareness. This includes possible on-the-spot searching for victims remotely, mapping of access routes and possible hazards (e.g. gas leaks), extensive documentation of scenes and assistance from the C3 (e.g. medical emergencies), etc. A very important aspect of FR safety is the use of biometric sensors, especially in relation to important vital signs (e.g. heart rate fluctuations, sweating, respiration) and other modalities providing hints of excessive physical effort and fatigue (e.g. total weight, accelerations).

In Communications, there is a clear need for resilient, high-capacity, cross-platform compatible and energy-efficient mobile technologies for the FR teams, especially for use inside closed spaces or under debris. The devices should be designed for personal safety, inter- and intra-team (C3) information exchange via voice or data (e.g. images, streaming video), as well as easy integration into information fusion platforms for enhancing COP. Some of these technologies are emerging or available as a first-generation set, but not yet fully certified and ready for most real-world SAR deployments.

The Situational Awareness factor also includes the easy and extensive use of geolocation and on-site mapping services, which should be open-access and available also for offline use (no Internet connection). The geolocation tools should be enhanced with tracking area coverage, waypoint/route planning, search patterns planning, automatic reporting to the on-site C3, tagging of digital material captured in the field (images, videos, voice notes).

Finally, Missing person/victim identification and registration should be enabled as an on-field technology, especially for forensic findings (e.g. bone identification) after a large-scale disaster event where the number, possible location and identity of victims is unknown for several days or even weeks. This is an issue that directly affects the planning of the SAR operations, as well as the support to the families and the affected population.

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