Article citation info:
Mazur M, Loks F, Gładysz P, Borucka A. Diagnosis of crisis situations using UAVs. Diagnostyka. 2026;27(2):2026214.
https://doi.org/10.29354/diag/225191.

DIAGNOSTYKA, 2016, Vol. 27, No. 2

e-ISSN 2449-5220
DOI: 10.29354/diag/225191

DIAGNOSIS OF CRISIS SITUATIONS USING UAVS

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Abstract

This article analyses the use of unmanned aerial vehicles (UAVs) in the process of crisis situation diagnostics. In dynamic situations, such as large-scale fires or floods, the rapid acquisition of reliable operational information is of critical importance. The study adopts an approach based on the analysis of selected real-world cases, focusing on the role of UAVs as a diagnostic tool in the identification, monitoring, and assessment of the operational situation. It was demonstrated that the use of UAVs enables a reduction in the time required to obtain information, an increase in the accuracy of situational diagnosis and an improvement in the quality of data used in the decision-making process. At the same time, limitations resulting from technical, environmental, and organizational-legal conditions were identified. The results of the analysis confirm that UAVs constitute an important element of the situational diagnostics system and information logistics in crisis management.

Keywords: unmanned aerial vehicles; UAVs; crisis management; situational diagnostics; disaster response

List of Symbols/Acronyms

BBPN - Biebrza National Park - Biebrza NP;
CBK PAN - Space Research Centre of the Polish Academy of Sciences;
EMS - Emergency Management Service;
GOPR - Mountain Volunteer Search and Rescue;
IMGW - Institute of Meteorology and Water Management;
SAR - Search and Rescue;
UAV - Unmanned Aerial Vehicle.

1. INTRODUCTION

Effective crisis management increasingly depends on the quality and timeliness of operational information. In the context of dynamic events, such as large-scale fires, floods, or infrastructure disasters, rapid and reliable situational diagnostics, understood as the process of identifying threats, evaluating their scale and consequences, and monitoring changes over time, is of critical importance. The limitations of traditional reconnaissance methods, which involve ground teams or the use of manned aircraft, mean that obtaining a complete picture of the situation is often delayed or incomplete.

In this context, unmanned aerial vehicles (UAVs) are gaining increasing importance as tools that enable the rapid acquisition of data from areas affected by an incident. Thanks to the use of visible-light and thermal imaging sensors, UAVs enable reconnaissance to be conducted in near real time, regardless of terrain conditions and with limited risk to personnel. Their use forms part of the situational diagnostics process, encompassing both the initial threat identification phase and the ongoing monitoring of its development.

The use of UAVs affects not only the method of information gathering but also the entire decision-making process. Real-time imagery enables faster and more precise prioritization of actions, thereby increasing the effectiveness of the deployment of forces and resources. UAVs thus support the flow of up-to-date data between the incident site and the crisis management command center.

Despite the growing availability of UAV technology, their use in the crisis situation diagnostics process is also associated with certain limitations. These include, among others, technical constraints such as flight time and range, environmental factors such as weather conditions, and organizational and legal constraints, which may affect the effectiveness of operations.

An important factor determining the operational usefulness of UAVs in crisis situation diagnostics is their flight endurance and range. These parameters directly affect the ability to cover large areas,

Received 2026-05-12; Accepted 2026-06-29; Available online 2026-06-29

maintain observation over time, and provide data with sufficient temporal resolution for decision-making purposes. This is particularly important in dynamic crisis events, where the diagnostic value of UAVs also depends on the ability to maintain flight in changing operational and environmental conditions. As shown by Kucharski et al. [1], UAV flight capability may vary significantly depending on environmental conditions and the geographical area of operation, which should be considered when planning the use of unmanned platforms in crisis assessment.

It should also be noted that the use of UAVs in operational environments is connected with broader research on their technical, structural, and material properties. Studies concerning UAV composite structures, including methods based on finite element modelling and dynamic response analysis, indicate that the design and material characteristics of UAV platforms remain an important area of research [2]. This confirms that the effectiveness of UAV-based diagnostics depends not only on the adopted operational procedures but also on the technical maturity and reliability of the platforms themselves.

The aim of this article is to analyse and evaluate the implementation potential of UAVs in the situational assessment process, considering their functionality, limitations, and cognitive and operational value, based on a study of selected real-world crisis events. Particular attention is given to the role of UAVs in threat identification, monitoring the course of events, and supporting the decision-making process. The research algorithm adopted in the article is presented in Fig. 1.

Fig. 1. Diagram of the situational diagnostics process using UAVs

The main analytical contribution of this article is the interpretation of UAVs not only as tools for aerial observation, but as components of a situational diagnostics system that reduces information uncertainty and supports operational decision-making. The paper proposes a comparative perspective in which the diagnostic role of UAVs is analysed in relation to the type of crisis situation: zone-oriented diagnostics in fires, area and infrastructure-oriented diagnostics in floods, and target-oriented diagnostics in search and rescue operations.

2. LITERATURE REVIEW

Research on crisis management increasingly emphasizes the importance of information as a resource that determines the accuracy of situation assessment and the effectiveness of operational actions. In this context, situational diagnostics involves continuously updating the situational picture based on data obtained from various sources [3,4]. The literature on crisis management emphasizes that unmanned systems are used, among other things, for reconnaissance, mapping the effects and scale of events, monitoring their progression, and supporting rescue operations [5-7].

The development of UAV technology has significantly changed the way data is collected in operational environments, enabling the observation of areas that are difficult to access, dangerous, or dynamically changing [6, 8]. Literature reviews indicate that the key advantages of UAVs include the speed of information acquisition, the ability to operate in near real time, and the use of advanced sensors, including visible-light and thermal imaging systems [5, 7, 9]. As a result, UAVs are used not only for observation but also for assessing the extent of damage, identifying hazards, and supporting the coordination of operations [6, 7]. The capabilities of UAVs as diagnostic tools also include measurement applications, such as studies using unmanned platforms with integrated equipment for spatiotemporal analysis of pollutant distribution, demonstrating their usefulness in acquiring high-resolution environmental data [10].

An important area of research is the integration of data obtained from UAVs with other information sources. The authors emphasize that the mere availability of imagery does not determine the effectiveness of the response if the data is not properly processed and utilized in the decision-making process [4]. In this context, UAVs can be viewed as an element of information logistics, supporting the flow of data between the incident site and command centers [3].

At the same time, the literature points to limitations in the use of UAVs in crisis situations. These primarily concern the technical parameters of the platforms, such as flight time and range, as well as the impact of environmental conditions and formal and legal constraints [8, 9, 11]. Consequently, the effectiveness of UAVs should be analysed in conjunction with the organization of operations and the degree of integration with the crisis management system [4, 11]. These conclusions are also confirmed by studies on UAV reliability, which show that the time to failure varies depending on its cause, with power-related failures and adverse weather conditions being of particular significance [12].

In light of existing research, it is reasonable to view UAVs primarily as tools for situational diagnostics. This perspective allows for an analysis of their significance not only in a technological context but also in terms of the quality of operational diagnosis and the utility of information in the decision-making process [5, 7].

3. MATERIALS AND METHODS

The main research method used in this article was a case study, involving an analysis of selected examples of the use of unmanned aerial vehicles in crisis management systems. This method allowed for a detailed examination of how drones are used in specific operational situations, with particular emphasis on their role in terrain reconnaissance, threat monitoring, supporting the decision-making process, and coordinating the activities of emergency response services. Complementarily, a comparative analysis was conducted to compare the studied cases in terms of the scope of drone use, the type of data collected, the effectiveness of operational support, and the limitations resulting from environmental, organizational, and technical conditions. This research approach enabled not only the description of individual cases but also the identification of common mechanisms, differences, and potential best practices regarding the use of drones in crisis management systems.

The research material covers selected cases of crisis events in which UAVs were used for reconnaissance, monitoring, and situational diagnostics. The selection of cases considered the diversity of threat types and the availability of sources allowing for the reconstruction of the course of operations and the manner of using unmanned systems.

The cases were selected purposefully rather than randomly. The selection criterion was the documented use of UAVs in crisis situations in which rapid situational assessment was necessary for operational decision-making. The selected cases represent three different types of crisis events: a large-scale fire, a flood, and a search and rescue operation. This diversity made it possible to assess whether the diagnostic function of UAVs changes depending on the type of threat and the information needs of the entities responsible for crisis response.

The cases are not directly comparable in terms of the physical nature of the threat, spatial scale, or duration of operations. However, they are analytically comparable because each of them involves the same diagnostic problem: the need to reduce information uncertainty under time pressure. For this reason, the comparison was based on common analytical criteria: the main diagnostic problem, the type of data obtained using UAVs, the role of UAVs in updating the situational picture, the impact of UAV-derived information on operational decision-making, and the limitations affecting their use. This approach made it possible to identify both case-specific differences and common mechanisms of UAV-supported situational diagnostics.

The analysis was based on secondary sources, in particular reports and communications issued by public institutions, materials documenting the course of operations, and scientific studies related to the use of UAVs in crisis management. The material collected was analysed in terms of three key issues:

- methods and conditions for data acquisition using unmanned aerial vehicles;
- the usefulness of the acquired data in the process of assessing the operational situation;
- the impact of information obtained from UAVs on the course and quality of the decision-making process.

The adopted research perspective allows UAVs to be treated as a component of the system for acquiring, processing, and distributing information, supporting the operational assessment of a crisis situation from an operational standpoint. Consequently, the analysis focuses on the diagnostic function of UAVs, understood as the ability to identify threats, monitor changes, and support the ongoing updating of the situational picture. The characteristics of the analysed cases are presented in Table 1.

Table 1. Characteristics of the analysed cases

CASE	YEAR	TYPE OF CRISIS	MAIN DIAGNOSTIC PROBLEM	ROLE OF UAV
Fire in Biebrza NP	2020	Large-scale fire	Identification of active danger zones and fire dynamics	Aerial reconnaissance, thermal imaging, monitoring of changes
Flood in Poland	2024	Flood	Assessment of local flood impacts and infrastructure condition	Inspection of levees, terrain mapping, imagery for the command center
SAR in the Beskid Niski	2021	Search for a missing person	Narrowing the search area and locating the person	Imaging, target identification, support for ground teams

4. RESEARCH RESULTS

4.1. Fire in Biebrza National Park

The fire in Biebrza National Park in April 2020 serves as an example of the use of unmanned aerial vehicles to diagnose a dynamic threat in an area with very limited accessibility. The initial Copernicus EMS imagery already indicated that the fire was spreading rapidly in several directions, engulfing hard-to-reach peatland. One of the first estimates indicated that approximately 3,800 ha were affected by the fire, with the peatland area itself, which posed the greatest operational challenge, estimated at around 1,200 ha [13]. Images of the fire-affected area, obtained in part through Copernicus EMS, are shown in Fig. 2.

Under such conditions, traditional ground-based reconnaissance, due to its limitations, provided a more delayed and fragmented picture, as it required physically reaching the marshy terrain, which was difficult to penetrate and dangerous for rescuers. For this reason, it can be concluded that without UAVs, the assessment of the situation would have been slower, less precise, and subject to greater uncertainty.

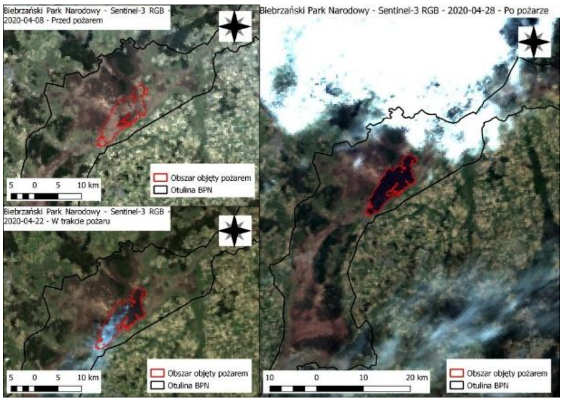

Fig. 2. Reports generated using Copernicus EMS for the BBPN fire

However, the significance of UAVs was not limited solely to providing an aerial view. Official operational reports on the course of operations also indicate the use of thermal imaging from drones to identify locations where fire hotspots might be present [14, 15]. An example of an image obtained through such an operation is shown in Fig. 3.

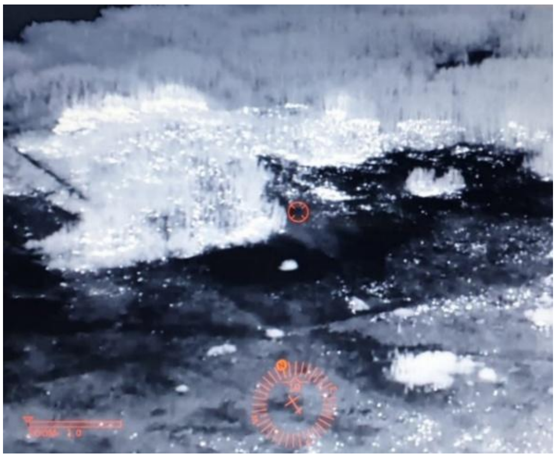

Fig. 3. Thermal image captured by a drone

This finding is important from the perspective of situational assessment because it shows that unmanned systems were primarily used to identify active danger zones, including areas that were invisible or difficult to detect from ground level. In practice, this allowed for a quicker distinction between sections requiring urgent intervention and those that could be monitored or addressed later.

This highlights the difference between operations using UAVs and those without their support. If reconnaissance relied solely on reports from ground patrols and ground-level observations, directing operations in such a specific environment would have been more dependent on incomplete, local observations and a less targeted reconnaissance of a large area. UAVs reduced this uncertainty because they allowed for a faster reconstruction of the spatial layout of the threat, captured its dynamics, and supported better adaptation of the deployment of forces and resources to the current situation. The diagnostic value of the data obtained from drones thus stemmed from their direct utility for directing rescue and firefighting operations.

The case study also shows that the use of drones in Biebrza National Park was not a one-time operational support effort. According to the park's data, the total area affected by the fire was 5,526 ha, and after the operation concluded, further monitoring of the burned area was necessary, for which UAV systems were also utilized. Subsequent scientific studies further indicate that the experiences from the 2020 fire served as an impetus for modernizing the park's fire protection system and developing solutions based on open remote sensing data and GIS [16]. This means that the significance of this case extends beyond the firefighting operation itself, and the fire revealed the practical value of remote data sources in assessing major threats, particularly in hard-to-reach areas.

An important conclusion from this situation is that UAVs significantly enhanced the ability to assess the operational situation in real time. They enabled faster identification of active hazard areas, supported monitoring of changes over time, and provided data useful for the selective deployment of forces and resources. Without their use, the picture of the situation would not only have been less up to date but also less suited to the needs of command and coordination of operations.

4.2. Flood in Poland (2024)

The September 2024 flood in southwestern Poland serves as an example of a crisis in which situational diagnostics had to simultaneously account for the phenomenon's high dynamics, extensive spatial reach, and rapid changes in infrastructure availability. According to the IMGW bulletin, following heavy rainfall in mid-September, numerous rapid rises in water levels were recorded in the Odra River basin, with the highest number of alarm-level exceedances (81) recorded on September 16. Concurrently, a report by Wody Polskie indicates that the scale of the event required multi-source analysis, encompassing hydrological, meteorological, and satellite data, as well as information obtained from drone flights [17, 18]. a map of the event's extent is presented in Fig. 4.

In the analysed case, the combination of data at various levels of detail was of great importance. The Wody Polskie report indicates that the indicative flood extent was developed, among other sources, based on analyses conducted by the Crisis Information Center (CBK PAN) in cooperation with ICEYE, data from the Copernicus Emergency Management Service, reports from flood protection operations centers, and data obtained from drone flights. Meanwhile, Copernicus EMS was launched for Poland on September 13, 2024, and as of September 25, the activation of EMSR756 covered

20 areas of interest and 32 cartographic products. This means that the assessment of the situation was built in layers: satellite data was used to evaluate the extent of the phenomenon, while UAVs supplemented this picture at the local level [17, 19, 20].

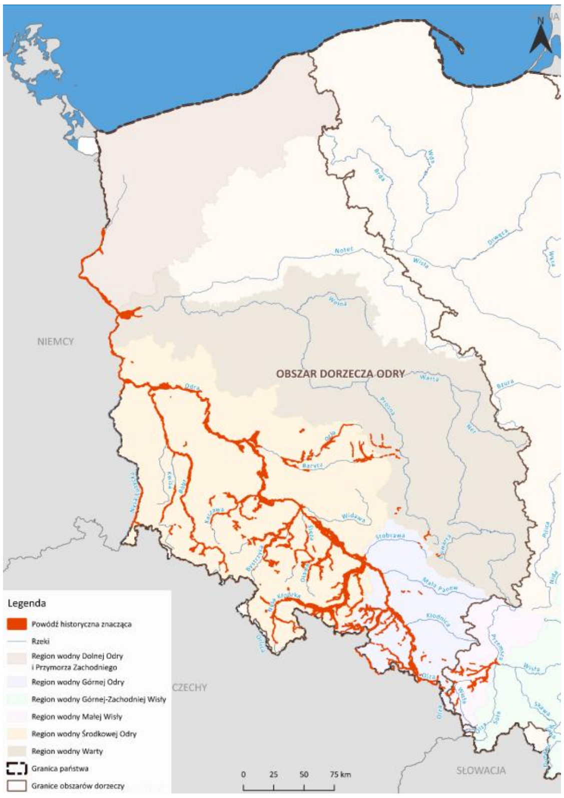

Fig. 4. Map of the flood extent in Poland in 2024

Drones were also used, among other things, to monitor levees for damage, inspect flooded areas to identify people in need of assistance, map the terrain, and transmit live video to the command center. An example of a situational awareness tool in the form of a 3D model created based on drone imagery is shown in Fig. 5.

Fig. 5. 3D model created using drone imagery

This scope of use indicates that drones were not used solely to document the course of operations, but served as an element of current situational diagnostics, providing information necessary for decision-making. The role of drones consisted in clarifying the local consequences of the event and supporting ongoing response measures. This function aligns well with the definition of situational diagnostics as the process of updating the picture of an event for the purposes of ongoing rescue operation management [18, 21].

The analysed case also shows that the effectiveness of UAVs was greatest when they were integrated into a broader reconnaissance system. Hydrological and meteorological data enabled tracking of the phenomenon's development, Copernicus system products were used to assess its spatial scale, while UAVs provided highly up-to-date and useful information at the local level. This indicates that UAVs served as a diagnostic tool supporting the ongoing analysis of the situation, especially where a rapid assessment of the state of infrastructure and operational conditions was needed.

4.3. Search and Rescue Operations for a Missing Person (2021)

In search and rescue operations, the fundamental diagnostic problem is of a different nature than in the case of a fire or flood. It primarily concerns reducing the area of uncertainty as quickly as possible, identifying sectors with the highest probability of finding the missing person, and pinpointing locations requiring direct verification on the ground. In this context, UAVs become an element of the diagnostic process supporting target localization and guiding the actions of ground teams. In the literature, this use of UAVs is primarily associated with increasing search selectivity, reducing detection time, and improving the usability of data for coordinating SAR operations.

A good example of such an application is the operation conducted on June 29, 2021, by the Bieszczady Group of the Mountain Volunteer Search and Rescue (GOPR) in the vicinity of the village of Cergowa in the Beskid Niski. According to the description provided by Niedzielski et al. in [22], the SARUAV system was deployed nearly 24 hours after a 65-year-old man left his home [23]. The missing man suffered from Alzheimer's disease and had experienced a stroke the previous day, which further increased the time pressure on the operation. The Police, Volunteer Fire Brigade, and other organizations also participated in the operation, while an important component of the reconnaissance was the use of a drone and software enabling the automatic detection of people in aerial photographs. a diagram of the system's operation is shown in Fig. 6.

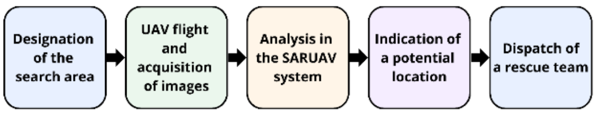

Fig. 6. Operational diagram of the SARUAV system

In the analysed case, the value of the UAV did not stem solely from its ability to observe the terrain from the air. The SARUAV software processed 782 images taken during four photogrammetric flights, and 4 hours and 31 minutes after the system was deployed in the field, it pinpointed the missing person's location; the stage involving the upload of 121 images from the flight over the area where the missing person was found, as well as their processing and verification, took 5 minutes and 48 seconds [22]. This means that the UAV, together with the analytical system, enabled a transition from a vast search area to a specific operational location requiring immediate verification by rescuers. The diagnostic function of the system thus consisted in reducing information uncertainty through automatic target identification, rather than merely providing an additional aerial image. Table 2 presents the key parameters characterizing this SAR case.

Table 2. Key SAR parameters

PARAMETER	VALUE	OPERATIONAL SIGNIFICANCE
Number of photogrammetric flights	4	Coverage of the search area
Number of processed images	782	Improved analytical accuracy
Time from system deployment to location identification	4 h 31 min.	Reduced time required to narrow the search area
Time to process the final set of images	5 min. 48 s	High operational utility

This case also clearly demonstrates that the use of UAVs allows for increased selectivity in the ground search process. In the traditional operational model, based on foot patrols, road searches, sector-based operations, and successive field reports, narrowing the search area is more time-consuming and more heavily dependent on terrain conditions. In the analysed SARUAV operation, the UAV did not replace ground teams but provided them with information of high operational value, indicated the likely location of the person, and thereby guided the further actions of the services. For this reason, the system should be interpreted as a tool supporting the decision to prioritize subsequent search steps [24]. This conclusion is consistent with both the case description itself and subsequent materials from the University of Wrocław, which describe the operation in the Beskid Niski as the world's first automatic detection of a missing person in aerial imagery captured by a drone, resulting in a life-saving rescue [25].

Unlike in the case of a fire, where UAVs supported the identification of active danger zones, and in the case of a flood, where their role primarily involved assessing the local spatial consequences of the phenomenon, in SAR their main value lies in accelerating target detection. While in the two previous cases UAVs supported the assessment of the hazard situation, here they supported the assessment of the location of the person being searched for. This indicates that the SARUAV case in the Beskid Niski serves as an example of the use of UAVs as a location-oriented diagnostic tool, particularly useful where a rapid transition from a broad area of uncertainty to a precisely identified point of action is crucial.

4.4. Comparative Synthesis

The analysis conducted indicates that the diagnostic function of UAVs takes different forms depending on the nature of the emergency. In the case of the fire in Biebrza National Park, the identification of active danger zones and the monitoring of fire dynamics in hard-to-reach terrain, including marshy and peatland areas, were of critical importance. During the September 2024 floods, however, the primary diagnostic challenge was assessing the local consequences of the flood's spatial spread, specifically including the condition of levees, terrain accessibility, the passability of access routes, and the distribution of locations requiring intervention. In search and rescue operations using the SARUAV system, the primary value of UAVs was demonstrated in narrowing the search area and aiding in the location of a missing person.

Despite the differences between the analysed cases, a common element remains the reduction of information uncertainty. In all three situations, UAVs provided highly up-to-date and operationally useful data, supporting the construction of a situational picture for the purposes of real-time decision-making. This means that their significance should be considered in terms of a tool for situational diagnostics, whose role changes depending on the type of threat: from identifying zones of active impact of the phenomenon, through assessing its local spatial consequences, to locating a specific search target.

By comparison, it can therefore be concluded that UAVs are most useful in situations where traditional ground-based reconnaissance provides data too slowly, too sporadically, or involves excessive operational burden and risk. During fires, their advantage lies primarily in the selective reconnaissance in hard-to-reach areas; during floods, in rapid local assessment of infrastructure and operational conditions; and in SAR operations, in reducing the time required to move from a broad area of uncertainty to a precisely indicated point of action. This perspective allows UAVs to be treated as an element of a decision-support system, rather than merely as a technical extension of aerial observation. a comparison of the diagnostic role of UAVs in the three cases is also presented in Figure 7.

4.5. Limitations of UAV-Based Situational Diagnostics

Despite their significant operational value, UAVs should not be treated as an unlimited or fully autonomous source of diagnostic information. Their effectiveness in crisis situations depends on a set of technical, environmental, organizational, and legal conditions that may directly affect the quality, continuity, and usefulness of the data obtained. Therefore, the diagnostic value of UAVs results not only from their ability to acquire aerial imagery but also from the conditions under which this imagery can be collected, processed, and used in the decision-making process.

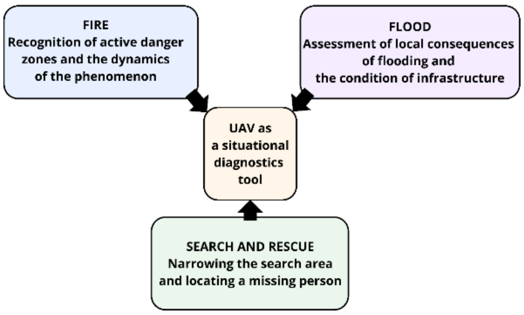

Fig. 7. Comparison of the analysed cases

The first group of limitations concerns technical parameters. Flight time, range, battery capacity, payload, sensor quality, and communication stability determine whether UAVs can effectively support operations conducted over large or difficult-to-access areas. In long-lasting or spatially extensive events, such as floods or large-scale fires, limited endurance may require frequent battery replacement, multiple flights, or the use of several platforms. This can interrupt data continuity and reduce the ability to monitor the development of the situation in real time. Moreover, limitations in data transmission may affect the possibility of providing live imagery to command centres, especially in areas with damaged or overloaded communication infrastructure.

The second group of constraints is related to environmental conditions. Strong wind, heavy rainfall, low temperature, fog, smoke, dust, and limited visibility may restrict UAV flights or reduce the quality of the acquired data. In fire operations, smoke and high temperature may limit visibility and complicate the interpretation of thermal imagery. In flood situations, rainfall, wind, and difficult access to safe take-off and landing locations may reduce the operational availability of UAVs. In search and rescue operations, dense vegetation, terrain obstacles, insufficient thermal contrast, and the time of day may influence the probability of detecting a missing person. As a result, UAV-based diagnostics may still require verification by ground teams and should be treated as decision support rather than a substitute for all other reconnaissance methods.

The third group of limitations includes organizational and legal factors. The use of UAVs in crisis management requires trained operators, clear procedures, coordination with other services, and safe integration with manned aviation and other rescue activities. In complex operations involving many entities, the lack of standardized data exchange procedures may reduce the usefulness of UAV-derived information. In addition, the availability of imagery alone does not guarantee better decisions if the data is not properly interpreted and integrated into the command process. This means that UAVs achieve their highest diagnostic value when they are incorporated into a broader information system that includes satellite data, field reports, hydrological and meteorological data, and operational information from rescue services.

The analysed cases show that these limitations affect UAV use in different ways depending on the type of crisis. During the fire in Biebrza National Park, the main constraints were related to smoke, wind, difficult terrain, and the need to identify active fire zones in a large and inaccessible area. During the 2024 flood in Poland, the usefulness of UAVs depended on their ability to provide local information on levees, flooded areas, and infrastructure, but their operation could be constrained by weather conditions, access to launch sites, and communication requirements. In SAR operations, the diagnostic value of UAVs was strongly connected with image quality, terrain coverage, and the effectiveness of automatic detection. These limitations do not undermine the usefulness of UAVs, but they indicate that their operational value depends on proper mission planning, integration with other data sources, and the ability to interpret UAV-derived data in the context of the whole crisis situation.

5. CONCLUSIONS

The study indicates that unmanned aerial vehicles constitute a significant component of crisis situation diagnostics, particularly under conditions of limited information availability, high event dynamics, and the necessity of making decisions under time pressure. Their importance stems not only from the ability to obtain aerial imagery, but primarily from the provision of information that is up-to-date, selective, spatially targeted, and directly useful for the ongoing management of operations. In this context, UAVs should be viewed as a tool that enhances operational reconnaissance, increases situational awareness, and reduces information uncertainty in the decision-making process.

The analysed cases indicate that the diagnostic function of drones is strongly dependent on the nature of the crisis, the type of threat, and the information needs of the entities responsible for the response. In the case of fires, UAVs can assist in locating active fire zones or hotspots and assessing the directions of its spread; in flood situations, they enable observation of the extent of flooding and identification of particularly vulnerable areas; and in search operations, they can accelerate the narrowing of the search area. Despite the diversity of applications, a common element in all analysed cases remains the increased utility of situational imagery for decision-making. UAVs enable faster assessment of operational conditions, more accurate allocation of forces and resources, and precise targeting of interventions. Their role thus extends beyond the function of technical support for operations and should be viewed as a permanent component of the situational diagnostics system.

At the same time, the results of the analysis indicate that the effectiveness of UAV use does not depend solely on their technical parameters, such as range, flight time, sensor quality, or the ability to capture thermal imagery. The key factor is the degree of their integration into a broader system of information acquisition, processing, and interpretation. Drones achieve their highest operational value when they function as part of an integrated reconnaissance system encompassing hydrological, meteorological, and satellite data, field reports, information from rescue services, and command structures responsible for data analysis and utilization. This means that UAVs should not be treated as an autonomous source of information about an incident, but rather as one element of a multi-source system for building situational awareness.

Consequently, UAVs should be recognized as an important tool supporting modern crisis management, especially in situations where traditional ground-based reconnaissance proves insufficient in terms of time, range, safety, or accuracy. Their use enhances the ability of crisis management entities to assess the operational situation in real time, enables faster detection of changes during a threat, and strengthens the basis for rational decision-making. From the perspective of crisis management practice, this implies the need for further institutionalization of UAV use, encompassing not only technological development but also operational procedures, data exchange standards, personnel training, and the integration of drones into existing planning and response structures. The findings also indicate that the operational value of UAVs is conditional and depends on the ability to manage technical, environmental, organizational, and legal limitations during real crisis operations. Ultimately, UAVs should be viewed not as a temporary support tool, but as a permanent component of the crisis management system's information infrastructure, whose importance is likely to increase as modern threats become more complex, dynamic, and unpredictable.

Source of funding: *This research received no external funding.*

Author contributions: *Research concept and design, M.M., F.L., P.G., A.B.; Collection and/or assembly of data, M.M., F.L., P.G., A.B.; Data analysis and interpretation, M.M., F.L., P.G., A.B.; Writing the article, M.M., F.L., P.G., A.B.; Critical revision of the article M.M., F.L., P.G., A.B.; final approval of the article, M.M., F.L., P.G., A.B.*

Declaration of competing interest: *The authors declares no conflict of interest.*

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