Grzegorz Matuszek, PhD
WSB University
e-mail: gmatuszek@wsb.edu.pl
ORCID: 0009-0002-3974-0949

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THE USE OF UNMANNED AERIAL VEHICLES IN CIVIL PROTECTION AND CIVIL DEFENCE

Abstract

The growing number and diversity of contemporary threats necessitate the development of new solutions that enable both effective prevention and efficient response to crisis situations. In addition to legislative and organizational measures, modern technologies play a crucial role in supporting operations conducted during natural disasters, technological accidents, and other hazardous events. One example of the application of advanced technologies in the fields of civil protection and civil defence is the use of Unmanned Aerial Vehicles (UAVs). The capabilities of UAVs make them particularly valuable for reconnaissance missions, environmental monitoring, and enhancing situational awareness. Equally important is their ability to transport various types of supplies to affected areas and to support evacuation operations. One of the most significant advantages of UAVs is their capacity to operate in hazardous environments without exposing operators to direct risk. However, these same capabilities may also be exploited for criminal or terrorist purposes. Therefore, it is essential to develop and implement appropriate legal regulations governing the use of UAVs while simultaneously addressing the potential risks associated with their deployment.

Keywords

Public safety and public order; civil protection and civil defence; modern technologies; unmanned aerial vehicles (UAVs).

Introduction

Contemporary threats related to civil protection and civil defence, including rapid climate change, pandemics, and armed conflicts, pose new challenges in terms of both prevention and response to their consequences. As a result, there is an increasing need to develop innovative legislative, organizational, and technological solutions that enable effective and efficient action in crisis situations.

Modern technologies, including information systems, mobile applications, unmanned systems, and other advanced technical solutions, play a crucial role in crisis management. Their application significantly enhances and accelerates decision-making processes while creating new opportunities for protecting human life and health. A key advantage of these solutions is their versatility. The same technologies can be employed in a wide range of scenarios and incidents requiring civil protection measures[1].

At the national level, the importance of modern solutions in civil protection and civil defence is reflected in ongoing legislative developments. Of particular significance in this regard is the enactment of the Act of 5 December 2024 on Civil Protection and Civil Defence[2]. Together with its implementing regulations, this Act constitutes the primary legal framework governing issues related to civil protection and civil defence in Poland.

Special attention should also be paid to the widespread use of Unmanned Aerial Vehicles (UAVs). These systems are employed, among other purposes, for threat monitoring, early warning activities, and support of search and rescue operations. Such solutions have been proposed within the framework of the SILVANUS project, which includes, inter alia, the development of UAVs (drones) designed to serve as airborne platforms for wildfire detection and monitoring[3].

Methodological Assumptions and Research Methods

The aim of this publication is to present the potential applications of modern technologies in the field of civil protection. Particular attention is devoted to Unmanned Aerial Vehicles (UAVs) as tools supporting threat monitoring and reconnaissance, as well as enhancing situational awareness, which consequently contributes to improved decision-making processes in crisis management. Furthermore, UAVs may serve as transport platforms operating in areas affected by hazards and emergencies. The adopted research objective led to the formulation of the following research question: What opportunities do Unmanned Aerial Vehicles create in the field of civil protection?

1 P. Gromek, *Nowe technologie w ochronie ludności w Polsce. Rozwiązania dotyczące projektu SILVANUS. Część 2 – Twarde technologie i rozwiązania służące angażowaniu społecznemu*. Zeszyty Naukowe Pro Publico Bono 2024, nr 1(1), p. 178-179.

2 Ustawa z dnia 5 grudnia 2024 r. *o ochronie ludności i obronie cywilnej* (Dz. U. z 2024 r. poz. 1907).

3 P. Gromek, *Nowe technologie w ochronie ludności*….. p. 190.

A qualitative analysis of the available literature constituted the core element of the research process. Particular emphasis was placed on international scholarly publications presenting experiences and solutions related to the use of UAVs in civil protection activities. The study employed the methods of synthesis, content analysis, and comparative analysis of various concepts and applications of Unmanned Aerial Vehicles.

Unmanned Aerial Vehicles – History and Characteristics

In recent years, the use of Unmanned Aerial Vehicles (UAVs) has increased significantly. One of the sectors experiencing particularly dynamic development in this field is the defence sector. Notably, military operations were the primary driving force behind the emergence of the first UAV designs. The literature indicates that the earliest unmanned aerial vehicles appeared as early as the Second World War. During this period, aircraft guided by simple inertial navigation systems were employed for the first time[4]. Examples of such solutions included flying bombs developed by Germany, the United States, and Japan. Particularly intensive research and development efforts on this type of technology were conducted in Nazi Germany[5].

When discussing the military origins of UAVs, it is also important to acknowledge the contribution of Nikola Tesla to the development of remote-control technologies[6]. Recognized as one of the pioneers in this field, Tesla established the theoretical and technical foundations of solutions that are currently applied in unmanned systems[7]. Following the end of the Second World War, UAV technology continued to evolve steadily, progressing from relatively simple reconnaissance platforms to advanced autonomous and combat systems[8].

An example of UAV application in the civilian sector can be found in experiences related to the COVID-19 pandemic. During this period, many countries employed unmanned aerial vehicles in public health and epidemic-response operations. One notable example was Australia's Vital Intelligence Project, which involved the use of autonomous UAVs equipped with artificial intelligence technologies to monitor public health conditions while minimizing direct human involvement. These drones were capable of monitoring selected physiological parameters, such as respiratory rate and heart rate[9].

4 Szerzej: A. Nowak, *Zdalnie sterowana oraz bezzałogowa broń III Rzeszy* [w:] *Wykorzystanie dronów i robotów w systemach bezpieczeństwa. Wybrane aspekty* red. R. Kamporowski, M. Skarżyński, Poznań 2019.

5 Ibidem.

6 Nikola Tesla (ur. 1856 r.) był wybitnym wynalazcą, inżynierem i pionierem technologii, znanym przede wszystkim za swoje wkłady w rozwój systemu prądu przemiennego oraz wielu innych innowacji w dziedzinie elektrotechniki. Tesla był zwolennikiem teorii elektromagnetyzmu i znacząco przyczynił się do zrozumienia pola elektrycznego oraz jego zastosowań w praktyce. Źródło: D. Świsulski, *Nikola Tesla i jego wynalazki.* Wiadomości Elektrotechniczne, 2020 1(1), 32–36. https://doi.org/10.15199/74.2020.1.6

7 W. Leśnikowski, *Drony w służbie ochrony infrastruktury krytycznej na wojnie z COVID-19,* Toruń 2021, p. 76.

8 P. Parczewski, M. Wojtaszek *Wybrane aspekty stosowania bezzałogowych statków powietrznych w systemie bezpieczeństwa,* Kultura Bezpieczeństwa 40,2021 (9–21), p. 11.

9 M. Watembroski, *Australia sięga po drony w walce z COVID-19. Będą monitorowały stan zdrowia ludzi*', https://fotoblogia.pl/15210,australia-siega-po-drony-w-walce-zcovid-19-beda-monitorowaly-stan-zdrowia-ludzi, (access:20.05.2026).

Experiences from the ongoing war in Ukraine since 2022 have demonstrated that drones have become one of the fundamental tools of the modern battlefield. They are extensively employed by both attacking and defending forces. Participants in the conflict utilize not only specialized military UAVs but also commercially available drones adapted for combat purposes[10].

In the contemporary world, UAVs are not limited to military applications. They are widely used by public administration bodies, law enforcement agencies, research institutions, private enterprises, and individual users. The growth dynamics of this sector are particularly evident in the Polish UAV market. While its value was estimated at PLN 150–450 million in 2018, forecasts indicate that it may reach approximately PLN 3.3 billion by 2026. Equally noteworthy is the increase in the number of UAV operators holding qualifications issued by the Polish Civil Aviation Authority. In 2014, approximately 300 individuals possessed such qualifications, whereas by 2019 their number had exceeded 15,000[11].

When analysing UAV applications, it is also necessary to consider the potential risks associated with their operation. On the one hand, UAVs may be exploited by transnational criminal networks and other organized criminal groups. On the other hand, they are increasingly utilized by terrorist organizations for a variety of operational purposes[12].

According to the method of flight control, the scientific and industry literature generally distinguishes three principal categories of UAVs:

– Autonomous UAVs – systems that perform tasks in accordance with pre-programmed procedures. Military literature further differentiates several levels of autonomy, including remote operation, real-time control, adaptation to flight conditions, autonomous route planning, coordinated group operations, and fully autonomous swarm systems[13];
– Remotely Piloted UAVs – systems controlled directly by a human operator. This category also includes model aircraft;
– Hybrid UAVs – systems combining the characteristics of autonomous and remotely piloted platforms, allowing operators to intervene during mission execution and modify flight plans when necessary[14].

Despite the broad spectrum of UAV applications, one common feature can be identified across most designs: the capability of remote operation. This characteristic determines many of their key advantages, including the ability to respond almost instantaneously to changing circumstances, access areas that are difficult to reach using conventional means of transport, and reduce direct human involvement

10 J. Meissner, *Aplikacje mobilne na froncie wojny rosyjsko-ukraińskiej,* Studia Bezpieczeństwa Narodowego Zeszyt 31 (2024), p. 109.

11 P. Kasprzyk, *Bezzałogowe statki powietrzne. Nowa era w prawie lotniczym. Rozwój regulacji prawnych dotyczących bezpieczeństwa lotnictwa bezzałogowego.* C.H. Beck, Warszawa 2021 p. 5.

12 Tamże s.12.

13 W. Leśnikowski, *Drony w służbie…* p. 44.

14 Tamże , p. 42.

in mission execution. Consequently, the level of risk to operators is significantly reduced, which constitutes one of the principal advantages of unmanned aerial vehicles over conventional solutions[15].

The Concept and Legal Framework for the Use of Unmanned Aerial Vehicles

The subject literature does not provide a single, universally accepted definition of an unmanned aerial system. Considerable terminological diversity can be observed both at the international level, where terms such as Unmanned Aerial Vehicle (UAV), Unmanned Aircraft System (UAS), Remotely Piloted Aircraft (RPA), and Unmanned Vehicle System (UVS) are employed, and at the national level. In Polish academic literature and legal acts, terms including Unmanned Aerial System (UAS), Unmanned Aerial Vehicle (UAV), and Unmanned Aircraft System are commonly used[16].

Initially, the term drone was met with criticism from representatives of the aviation community and regulatory authorities. Nevertheless, it has become the most widely used designation in everyday language. The etymology of the term derives from the characteristic sound produced by early unmanned aerial vehicles, resembling the buzzing of a drone[17].

The use of unmanned aerial vehicles has been regulated, among other instruments, by the Convention on International Civil Aviation, signed in Chicago on 7 December 1944[18]. However, the Convention does not contain a definition of the modern unmanned aerial vehicle, instead referring to an "aircraft capable of being flown without a pilot." At the same time, based on the method of flight operation, it distinguishes two principal categories of unmanned objects:

– those controlled by an operator (e.g., model aircraft, remotely piloted aircraft, and kites);
– those operating without direct operator control (e.g., autonomous aircraft and unmanned balloons) [19].

Within the Polish legal system, no statutory definition of the term drone exists. Instead, the legislator employs the term unmanned aircraft, as contained in the Aviation Law Act of 3 July 2002. To clarify this concept, the Act refers to the provisions of Regulation (EU) 2018/1139 of the European Parliament and of the Council of 4 July 2018 on common rules in the field of civil aviation and establishing the European Union Aviation Safety Agency (EASA) [20]. Pursuant to Article 3(30) of

15 W. Leśnikowski, *Drony w służbie…* p. 57.

16 A. Fellner, *Determinanty operacyjnego zastosowania RPAS (wybrane zagadnienia)* (w:) *Wykorzystanie bezzałogowych platform powietrznych w operacjach* [red:] M. Feltynowski, Józefów 2019, p. 76.

17 W. Leśnikowski, *Drony w służbie…* p. 41.

18 Konwencja o międzynarodowym lotnictwie cywilnym, podpisana w Chicago 7 grudnia 1944 r. – Konwencja chicagowska (Dz. U z 1959 r. Nr 35, poz. 212, z późn. zm).

19 W. Leśnikowski, *Drony w służbie ….* p. 48.

20 Ustawa z dnia 3 lipca 2002 r. *Prawo lotnicze* (Dz. U. z 2025 r. poz. 1431,1668 z 2026 – teks jednolity).

this Regulation, an unmanned aircraft is defined as an aircraft intended to operate autonomously or to be remotely piloted without a pilot on board[21]. As emphasized in the literature, the multiplicity of definitions and the absence of uniform classification criteria indicate the need for further harmonization of terminology relating to unmanned systems[22].

European regulations also define the concept of a remote pilot. A remote pilot is a natural person responsible for the safe conduct of a flight by manually controlling an unmanned aircraft or, in the case of automated operations, monitoring its performance and maintaining the ability to intervene and modify flight parameters at any time[23].

In addition to the aforementioned legal acts, UAV operations are regulated by[24]:

- Commission Implementing Regulation (EU) 2019/947 of 24 May 2019 on the rules and procedures for the operation of unmanned aircraft[25];
- Commission Delegated Regulation (EU) 2019/945 of 12 March 2019 on unmanned aircraft systems and on third-country operators of unmanned aircraft systems[26];
- the Act of 8 December 2006 on the Polish Air Navigation Services Agency (PANSA) [27].

Particular importance should be attributed to Commission Implementing Regulation (EU) 2019/947, which introduced a classification of UAV operations into three categories: open, specific, and certified[28]. The Regulation also defines an unmanned aircraft system (UAS) as an unmanned aircraft together with the equipment required for its remote operation[29]. The adoption of uniform European regulations was primarily motivated by the need to ensure aviation safety, protect privacy, and safeguard personal data. The literature identifies the introduction of mandatory

21 Regulation (EU) 2018/1139 of the European Parliament and of the Council of 4 July 2018 on common rules in the field of civil aviation and establishing a European Union Aviation Safety Agency, and amending Regulations (EC) No 2111/2005, (EC) No 1008/2008, (EU) No 996/2010, (EU) No 376/2014 and Directives 2014/30/EU and 2014/53/EU of the European Parliament and of the Council, and repealing Regulations (EC) No 552/2004 and (EC) No 216/2008 of the European Parliament and of the Council and Council Regulation (EEC) No 3922/91 (Text with EEA relevance.) https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32018R1139 (access: 23.03.2026).

22 W. Leśnikowski, *Drony w służbie…* p. 42.

23 Ibidem.

24 Wytyczne nr 7/2024 Prezesa Urzędu Lotnictwa Cywilnego z dnia 20 maja 2024 r. w sprawie sposobów wykonywania operacji przy użyciu systemów bezzałogowych statków powietrznych w związku z wejściem w życie przepisów rozporządzenia wykonawczego Komisji (UE) nr 2019/947 z dnia 24 maja 2019 r. w sprawie przepisów i procedur dotyczących eksploatacji bezzałogowych statków powietrznych, https://edziennik.ulc.gov.pl/legalact/2024/23/ (access:23.03.2026)

25 Commission Implementing Regulation (EU) 2019/947 of 24 May 2019 on the rules and procedures for the operation of unmanned aircraft (Text with EEA relevance.) https://eur-lex.europa.eu/eli/reg_impl/2019/947/oj?eliuri=eli%3Areg_impl%3A2019%3A947%3Aoj&locale=en (access:29.03.2026).

26 Commission Delegated Regulation (EU) 2019/945 of 12 March 2019 on unmanned aircraft systems and on third-country operators of unmanned aircraft systems, https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32019R0945 (access:29.03.2026).

27 Ustawa z dnia 8 grudnia 2006 r. *o Polskiej Agencji Żeglugi Powietrznej* (Dz. U. 2024, poz. 1272 – teks jednolity).

28 K. Kolasińska-Morawska, M. Opach, Ł. Sułkowski, J. Jończyk, R. Seliga, *Zarządzanie sytuacjami kryzysowymi w ratownictwie górskim z wykorzystaniem bezzałogowych statków powietrznych.* International Journal of New Economics and Social Sciences, 2023, 24(8), 61-76. https://doi.org/10.5604/01.3001.0054.5463, (access: 11.03.2026), s.68.

29 Commission Implementing Regulation (EU) 2019/947 of 24 May 2019 on the rules….

registration for operators using UAVs with a maximum take-off mass exceeding 250 g as one of the most significant regulatory changes[30].

Within the Polish legal framework, particular significance should be attributed to the amendment to the Aviation Law Act of 24 January 2025, which entered into force on 27 February 2025[31]. The amendment introduced Chapter VIa, entitled *"Unmanned Aircraft"*, and was primarily intended to align national legislation with European Union regulations.

The most important amendments included:

- Introduction of mandatory operator registration. The amendment established a registration procedure through the national platform *drony.gov.pl*. Registration is free of charge and applies to operators conducting operations in the open category using drones weighing at least 250 g or equipped with sensors capable of processing personal data, as well as to operators conducting operations in the specific category regardless of the drone's mass. Registration requires the operator to be at least 14 years of age. Operators are subject to registration if they have their place of residence or principal place of business in Poland. The amendment further stipulates that an operator may not be registered in more than one Member State, while operators from EU/EFTA countries may create training accounts using a foreign registration number.
- Definition of operational categories. The previous distinction between recreational/sport flights and commercial flights was replaced by the three operational categories established under EU law: open, specific, and certified.
- Revision of remote pilot qualification procedures. The minimum age for remote pilots operating in the open category was reduced from 16 to 14 years. In certain subcategories of the open category, completion of training and successful completion of an online examination became mandatory. Pilot qualifications remain valid for a period of five years.
- Establishment of geographical zones. The amendment granted the Polish Air Navigation Services Agency (PANSA) statutory authority to designate UAS geographical zones. These zones may be used both to restrict and to facilitate flight operations in areas requiring special protection or air traffic management measures.
- Introduction of third-party liability insurance requirements. Mandatory liability insurance was introduced for UAVs with a mass ranging from 0.25 kg to 20 kg.
- Modification of the sanctions system. The amendment replaced criminal penalties involving deprivation of liberty with administrative financial penalties imposed by the President of the Civil Aviation Authority. It also expanded the

30 A. Konert, *Bezzałogowe statki powietrzne. Nowa era w prawie lotniczym, zagadnienia cywilnoprawne,* Warszawa, C.H. Beck, 2020, p. 17.

31 Ustawa z dnia 24 stycznia 2025 r. *o zmianie ustawy – Prawo lotnicze oraz niektórych innych ustaw* (Dz. U. 2025 poz. 179).

catalogue of services authorized to inspect remote pilots and clarified procedures aimed at counteracting the unlawful use of drones[32].

Practical Applications of Unmanned Aerial Vehicles in Civil Protection

Unmanned Aerial Vehicles (UAVs) can effectively perform a wide range of tasks within the fields of civil protection and crisis management. Their principal areas of application include:

- threat monitoring for reconnaissance and early warning purposes;
- search and rescue (SAR) operations;
- assessment of the scale and consequences of natural disasters and industrial accidents;
- transportation of various supplies and materials necessary for life-saving and health-protection activities, including medical equipment, blood products, pharmaceuticals, and vaccines.

One of the primary functions performed by UAVs, regardless of their field of application, is broadly understood reconnaissance. This encompasses area patrolling, information gathering and transmission, environmental monitoring, and the identification of potential threats[33]. An example of the use of UAVs in threat monitoring is the concept developed within the SILVANUS project. The concept involves deploying drones to detect signs of fire through the identification of flames, smoke, and heat sources. To achieve this objective, UAVs must be equipped with appropriate detection sensors and communication systems enabling data transmission.

It should be emphasized that, depending on the type of aerial platform employed, operational requirements, and safety considerations, operators may control the system either from the immediate vicinity of the hazard zone or from a considerable distance. Equally important is the possibility of equipping unmanned platforms with a wide range of observation systems, including visible-light, infrared, ultraviolet, thermal imaging, night-vision, and multispectral cameras. The versatility of UAVs is further demonstrated by their ability to integrate various sensors, including fire detection, chemical, and radiation sensors. These capabilities confirm the broad potential of UAVs for civil protection purposes in response to fire, chemical, biological, radiological, military, and meteorological hazards[34].

An important factor influencing the effectiveness of UAV operations is the possibility of employing First Person View (FPV) technology. This solution enables operations to be conducted from a first-person perspective, allowing the operator to control the platform without maintaining direct visual contact with it. The UAV's

32 *Nowelizacja ustawy Prawo Lotnicze – zmiany dotyczące dronów.* https://ulc.gov.pl/aktualnosci/nowelizacja-ustawy-prawo-lotnicze-szczegoly-zmian-dotyczacych-dronow (access: 21.04.2026)

33 M. Adamski, J. Rajchel, *Bezzałogowe statki powietrzne. Część I: Charakterystyka i wykorzystanie*, Dęblin, Wyższa Szkoła Oficerska Sił Powietrznych, 2013, p. 49.

34 P. Gromek, *Nowe technologie…*. p. 184

position is determined on the basis of real-time imagery transmitted to the ground by onboard observation systems[35].

Another significant area of UAV application involves search and rescue operations. Such activities play a crucial role within civil protection systems during emergencies, and the use of drones substantially enhances their effectiveness, particularly in difficult-to-access areas. Platforms equipped with thermal imaging and visual observation systems enable the rapid detection of casualties, thereby reducing response times and increasing the efficiency of rescue operations[36].

Thermal imaging constitutes a particularly valuable solution, as it enables the identification of heat sources. This technology is especially useful in locating individuals trapped beneath collapsed structures or missing persons in remote mountainous terrain, where rescue operations are inherently challenging. It provides significant support to rescue teams by allowing efforts to be concentrated on areas with the highest probability of locating victims[37].

The use of optical imaging systems enables detailed monitoring of extensive areas within a relatively short period, significantly improving the effectiveness of search operations compared to traditional methods. Analysis of the collected data, supported by machine-learning algorithms, facilitates the automatic identification of locations requiring intervention, eliminating the need for time-consuming manual review by rescue personnel. The incorporation of artificial intelligence (AI) into video surveillance systems is becoming increasingly common, enabling more efficient and automated responses to emerging threats[38]. UAVs may also be equipped with infrared observation systems and illumination devices, allowing rescue operations to be conducted at night and significantly extending operational capabilities.

The ability to carry thermal imaging cameras represents one of the key factors justifying the use of UAVs in search operations. Other characteristics supporting their application include:

- compact dimensions and high manoeuvrability, enabling low-altitude flights (approximately 10 m above ground level) and monitoring of extensive areas;
- the possibility of employing Synthetic Aperture Radar (SAR), a coherent, active microwave remote-sensing system, as well as thermal imaging cameras;
- the use of multispectral sensors capable of recording electromagnetic energy reflected from objects on the Earth's surface across various wavelength ranges. Professional multispectral cameras capture imagery in several selected spectral

35 W. Leśnikowski, *Drony w służbie ochrony..*, p. 17

36 S.K. Abid, N. Sulaiman, S.W. Chan, U. Nazir, M. Abid, H. Han, A. Ariza-Montes, A. Vega-Muñoz, *Toward an Integrated Disaster Management Approach: How Artificial Intelligence Can Boost Disaster Management.* Sustainability, 2021, 13(22), 12560. https://doi.org/10.3390/su132212560 (access:10.03.2026)

37 Ibidem.

38 Szerzej: G. Matuszek, *Monitoring miejski jako narzędzie bezpieczeństwa i porządku publicznego,* Dąbrowa Górnicza, 2025.

bands, most commonly within the visible and near-infrared spectrum, making it possible to obtain information invisible to the human eye[39];
- the integration of Airborne Laser Scanning (ALS) and Light Detection and Ranging (LiDAR) systems, which utilize laser-scanning technology to acquire highly accurate spatial data[40].

An example of UAV deployment in search operations can be found in activities conducted by the Polish Police during searches for missing persons. The legal basis for such operations is provided by Order No. 48 of the Chief Commander of the Police of 19 July 2018 on Police Searches for Missing Persons and Procedures in Cases Involving Unidentified Persons, Unknown Human Remains, or Human Skeletal Remains[41]. This document establishes the procedures and principles governing missing-person investigations under various circumstances. The most demanding and critical situations are classified as Level I, where there is a direct threat to the life or health of the missing person.

It should be noted, however, that the aforementioned regulations do not explicitly address the use of UAVs by the Police during search operations. Nevertheless, considering the scale and dynamic nature of such activities, the deployment of unmanned aerial vehicles is fully justified.

The use of drones during search operations is supported by numerous advantages, including:
- the ability to be rapidly deployed in rescue and emergency response operations;
- the capability to conduct aerial reconnaissance over extensive areas significantly faster than traditional search teams operating in line formations or so-called "rapid-response trios";
- the ability to record and document areas subjected to search and reconnaissance activities;
- support for coordinating ground search teams, including determining movement directions and identifying locations that are not visible from ground level;
- the capability to conduct continuous operations, limited only by the time required to replace power sources;
- improved cost-effectiveness of search and rescue operations.

Research findings indicate that search teams equipped with UAVs are able to locate missing persons, on average, 3.18 minutes (191 seconds) faster than teams conducting operations without the use of such systems[42].

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39 Kamery multispektralne w rolnictwie, https://sokolmilenium.pl/kamery-multispektralne-w-rolnictwie/ (access:11.03.2026).

40 M.G. Pensieri, M. Garau, P.M. Barone, *Drones as an Integral Part of Remote Sensing Technologies to Help Missing People*. Drones 2020, 4, 15. https://doi.org/10.3390/drones4020015 (access:11.03.2026 r).

41 Zarządzenie nr 48 Komendanta Głównego Policji z dnia 19 lipca 2018 r. *w sprawie prowadzenia przez Policję poszukiwania osoby zaginionej oraz postępowania w przypadku ujawnienia osoby o nieustalonej tożsamości lub znalezienia nieznanych zwłok oraz szczątków ludzkich* (Dz. Urz. KGP poz. 77 z poźn. zm.),

42 R. Kochańczyk, BSP w poszukiwaniu osób zaginionych w praktyce policyjnej, (w:) *Wykorzystanie bezzałogowych platform powietrznych w operacjach* [red:] M. Feltynowski, Józefów 2019, p. 65.

In addition to search operations conducted by the Police, UAVs are also widely employed in crisis management and mountain rescue activities. A drone was first used for this purpose in 2016 by the Podhale Regional Group of the Mountain Volunteer Search and Rescue Service (GOPR). Since then, this technology has been increasingly adopted by other regional GOPR units[43]. Nevertheless, the number of rescue operations involving drones has remained relatively limited. For example, in 2022, the Bieszczady GOPR unit conducted 235 rescue missions, expeditions, and emergency interventions. Of these, 105 were carried out in mountainous terrain, 48 involved search operations, 5 were classified as false alarms, and 77 were categorized as "other." During these activities, rescuers provided assistance to 243 individuals, including 38 cases of sudden illness, 118 injured persons, 11 fatalities, and 76 individuals classified within the "other" category. Despite the large number of operations conducted, drones were employed in only 10 rescue missions during 2022.

According to the literature, the limited use of UAVs was primarily attributable to technical, legal, and financial constraints, as well as to the attitudes of rescue personnel toward the adoption of new technologies. It is emphasized, however, that while rescuers have limited influence over technical, legal, and financial conditions, they can actively contribute to overcoming psychological barriers associated with the use of UAVs. Increased training activities and the optimization of crisis management processes may significantly facilitate this transition[44].

One of the modern solutions enabling the effective use of drones in both search operations and crisis management is geofencing. This technology, also referred to as a *virtual perimeter* or *virtual fence*, involves the creation of digital boundaries around a designated area. It constitutes a digital representation of the operational boundaries within which search activities or crisis management tasks are conducted. Through the use of GPS modules and specialized software, it is possible to define areas within which designated devices or personnel may move.

As a location-based technology, geofencing facilitates the achievement of operational objectives while simultaneously monitoring whether resources, equipment, and personnel remain within designated areas. The principal benefits of geofencing include:

- Safety – the establishment of GPS-based boundaries increases safety by generating alerts whenever a designated geofence is breached;
- Security – geofencing enables automatic notification when individuals or objects cross predefined boundaries, thereby reducing response times;
- Operational monitoring – when integrated with activity logs, digital perimeters allow the monitoring of equipment performance and personnel activities within a specified area and time frame;

43 K. Kolasińska-Morawska, M. Opach, Ł. Sułkowski, J. Jończyk, R. Seliga, *Zarządzanie sytuacjami…*, p. 68.
44 Ibidem, p. 71.

– Operational planning – the establishment of virtual boundaries facilitates more effective planning of subsequent operational phases, thereby enhancing efficiency and improving the cost-effectiveness of ongoing activities[45].

Another innovative solution that leverages UAV capabilities is their integration with Cloud Computing (CC) infrastructure. Within this model, UAVs become integral components of a cloud-based ecosystem that provides ubiquitous access to data and computational resources. This approach is also consistent with the concept of the Internet of Things (IoT), enabling UAVs to interact with other intelligent devices connected to the Internet.

As a result, computational processes can be significantly accelerated, information exchange can be streamlined, and decision-making processes can be enhanced[46]. The literature also identifies several additional benefits associated with the application of cloud computing technologies. These include the ability to create, archive, and manage resources required for emergency response operations, such as UAV fleet management, flight planning, collection of telemetry data and flight histories, acquisition of sensor information, and the sharing of collected materials among all members of an operational team[47].

One of the most promising applications of UAVs in the field of civil protection is the delivery of humanitarian assistance. Unmanned aerial vehicles may be employed to transport essential supplies, including medicines, food, and medical equipment, to areas affected by natural disasters or armed conflicts. Research indicates that the use of drones can significantly reduce delivery times, particularly in remote or difficult-to-access regions where conventional transportation methods are limited.

The use of drones for transport operations is further justified by their increasing availability on the commercial market. Cargo drones belong to the category of commercial UAVs and are characterized by substantial payload capacities. Contemporary platforms are capable of transporting payloads weighing up to 200 kg and operating at altitudes exceeding 1,100 metres[48].

Humanitarian organizations have been employing UAVs since the early 21st century. The particularly intensive development of applications for this technology has followed the occurrence of numerous natural disasters. Unmanned aerial vehicles were used, inter alia, after Typhoon Haiyan in the Philippines in 2013 and Hurricane Sandy in Haiti in 2012. In both cases, they conducted aerial imaging to support humanitarian organizations in assessing the scale of destruction and in planning relief operations[49].

Another example was the deployment of UAVs following the 2015 Nepal earthquake. Drones equipped with thermal imaging cameras enabled the localization

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45 W. Leśnikowski, *Drony w służbie…* p. 148.

46 Ibidem, p. 146.

47 Ibidem, p. 153.

48 K. Kolasińska-Morawska, M. Opach, Ł. Sułkowski, J. Jończyk, R. Seliga, *Zarządzanie sytuacjami*.. p. 67.

49 R.Z.B. Bravo, A. Leiras, F.L. Cyrino Oliveira, *The Use of UAVs in Humanitarian Relief: An Application of POMDP--Based Methodology for Finding Victims.* Production and Operations Management, 2011, 28(2), 421-440. https://doi.org/10.1111/poms.12930

of survivors by detecting heat emitted by the human body. Additionally, the use of zoom lenses made it possible to observe terrain details from distances of up to approximately 1,000 feet[50].

Unmanned aerial vehicles were also utilized following the disaster associated with the breach of a mining dam in Mariana, Brazil. Drones supported both rescue operations and hazard monitoring processes. They enabled fire service teams, among other things, to identify a three-meter crack in the wall of the secondary dam[51].

A particularly notable example of UAV application was their use during the Fukushima Daiichi nuclear power plant disaster, which resulted from the earthquake and tsunami that struck Japan on March 11, 2011. The 9.0-magnitude earthquake caused widespread destruction, particularly in the prefectures of Fukushima, Miyagi, and Iwate. As a result of failures in the cooling systems, reactor core meltdowns occurred and radioactive substances were released. UAVs were deployed to assess the extent of the damage, including inspections inside damaged reactor buildings. Unlike standard remotely piloted platforms, the UAVs used autonomous navigation systems based on laser technology, enabling obstacle avoidance and safe exploration of hazardous environments[52].

The growing importance of UAVs in humanitarian operations is reflected in the activities of the United Nations. Numerous UN agencies, including the United Nations Office for the Coordination of Humanitarian Affairs (OCHA), are conducting research on the use of unmanned aerial vehicles in disaster response and emergency management[53].

Drones can also support healthcare systems by enabling the delivery of vaccines to regions with limited access to medical care[54]. Another area of application is the transport of blood and other biological materials. In 2014, Médecins Sans Frontières (Doctors Without Borders) demonstrated the potential of drone use in healthcare for the first time by transporting sputum samples intended for tuberculosis (TB) diagnostics in Papua New Guinea.

Since then, numerous healthcare-related UAV projects have been implemented worldwide. This phenomenon is particularly evident in Sub-Saharan Africa. The most well-known example is a project launched in 2016 by the Government of Rwanda, aimed at delivering blood packages to peripheral healthcare facilities. This initiative resulted in the full implementation of one-way aerial delivery systems and remained the only fully operational undertaking of its kind in Sub-Saharan Africa.

50 L. King, *Nepal Earthquake Relief And The Urgent Boost From Drones,* https://www.forbes.com/sites/leoking/2015/04/30/nepal-earthquake-drones-relief-aid/ (access:11.04.2026)

51 R.Z.B. Bravo, A. Leiras, F.L. Cyrino Oliveira, *The Use of UAVs in Humanitarian……*

52 Ibidem.

53 R.Z.B. Bravo, A. Leiras, F.L. Cyrino Oliveira, *The Use of UAVs in Humanitarian …*

54 L.A. Haidari, S.T. Brown, M.C. Ferguson, E. Bancroft, M.L Spiker, ,A.J. Wilcox, B.Y. Lee, *The economic and operational value of using drones to transport vaccines.* Vaccine, 2016, 34(34), 4062-4067. https://doi.org/10.1016/j.vaccine.2016.06.022

The literature also highlights UAV applications in healthcare systems in Madagascar, Malawi, and Senegal[55]. Between 2016 and 2018, the "DrOTS: Drones Observed Therapy System in Remote Madagascar" project was implemented to test the feasibility of using drones in healthcare delivery in remote areas. The project integrated multiple technologies, including drones, digital adherence monitoring systems, and educational materials, thereby creating an innovative model of healthcare provision in poorly connected regions. UAV technology was used to eliminate logistical barriers that hindered the delivery of high-quality care to tuberculosis patients. Drones transported sputum samples and medications between a central, well-equipped laboratory and remote settlements located within a single district[56].

In Malawi's healthcare sector, two projects involving bidirectional medical transport using UAVs were implemented, addressing regulatory and operational issues. In 2016, UNICEF Malawi, in cooperation with VillageReach, conducted a feasibility study on the use of drones to transport dried blood spot samples for early infant HIV diagnosis in two rural districts. In Senegal, since late 2017, the government, in collaboration with PATH, has been assessing the feasibility, public health impact, and cost-effectiveness of integrating drones into healthcare logistics systems. The project is being conducted in an area where medical facilities are significantly isolated due to geographical constraints. Three primary UAV use scenarios are being analyzed: transport of diagnostic laboratory samples, delivery of emergency medical supplies, and distribution of essential medicines and medical materials between routine supply deliveries[57].

The effectiveness of UAV deployment was also confirmed during the COVID-19 pandemic. Drones were utilized across multiple domains of anti-epidemic response, serving as a safe and efficient means of transporting medical supplies. An illustrative example is China, where UAVs were employed to transport medical samples from Xinchang Hospital to the Center for Disease Control and Prevention in Zhejiang Province, located approximately three kilometers away. Furthermore, during the pandemic, drones were used for the spraying of disinfectant agents in public spaces, with agricultural UAV platforms being adapted for this purpose[58].

When considering the potential applications of drones, it is also necessary to account for factors that limit their operational functionality. The first of these is the still insufficient payload capacity of many UAV platforms. Consequently, drones are able to transport loads of significantly lower mass and volume compared to conventional ground-based transportation systems. Another important limitation is meteorological conditions. Severe atmospheric phenomena may adversely affect the safety

55 A.M. Knoblauch, S.D.L. Rosa, J. Sherman, C. Blauvelt, C. Matemba, L. Maxim, S.G. Lapierre, *Bi-directional drones to strengthen healthcare provision: experiences and lessons from madagascar, malawi and senegal. BMJ* Global Health, 2019, 4(4), e001541. https://doi.org/10.1136/bmjgh-2019-001541

56 Nouvet E, Knoblauch A.M, Passe I*, et al Perceptions of drones, digital adherence monitoring technologies and educational videos for tuberculosis control in remote Madagascar: a mixed-method study protocol* BMJ Open 2019;9:e028073. doi: 10. 1136/bmjopen-2018-028073, https://bmjopen.bmj.com/content/9/5/e028073

57 Ibidem.

58 W. Leśnikowski, *Drony w służbie…* p. 63.

and effectiveness of flight operations, posing risks both to the transported payload and to individuals located within the UAV operational area. The final key constraint is the requirement to ensure the safety of manned civil aviation. This necessitates appropriate airspace coordination and the implementation of procedures designed to minimize the risk of collision between manned and unmanned aircraft[59].

Conclusion

The conducted analysis demonstrates that unmanned aerial vehicles (UAVs) constitute a significant component of contemporary civil protection and civil defence systems. The rapid development of unmanned technologies has contributed to a substantial expansion of their application scope, encompassing both search and rescue operations as well as crisis management, critical infrastructure protection, and support for healthcare systems. Owing to their capability to conduct aerial surveillance, rapidly acquire information on emerging threats, and operate in areas inaccessible or hazardous to humans, UAVs are increasingly becoming an essential tool supporting public safety stakeholders.

The presented examples of drone deployment by police forces, emergency services, and humanitarian organizations confirm their high effectiveness in performing tasks related to the protection of human life and health. Of particular importance are UAV applications in the search for missing persons, the assessment of the consequences of natural disasters and technological failures, as well as the transport of medical supplies to areas with limited transport accessibility. Additionally, the integration of UAVs with modern information and communication technologies, such as geofencing, the Internet of Things, and cloud computing, enhances operational efficiency and increases the situational awareness of crisis response units.

In conclusion, it should be stated that unmanned aerial vehicles possess considerable potential for increasing the effectiveness of activities within the domain of civil protection and civil defence. Further technological development, together with the refinement of organizational and legal frameworks, will facilitate the continued expansion of their applications, making UAVs one of the key instruments supporting the safety of contemporary societies.

Bibliography:

Abid, S. K., Sulaiman, N., Chan, S. W., Nazir, U., Abid, M., Han, H., Ariza-Montes, A., Vega-Muñoz, A., *Toward an Integrated Disaster Management Approach: How Artificial Intelligence Can Boost Disaster Management.* Sustainability, 2021, 13(22), 12560. https://doi.org/10.3390/su132212560.

Adamski M., Rajchel J., *Bezzałogowe statki powietrzne. Część I: Charakterystyka i wykorzystanie*, Dęblin, Wyższa Szkoła Oficerska Sił Powietrznych, 2013.

59 Ibidem, p. 63.

Bravo, R. Z. B., Leiras, A., Cyrino Oliveira, F. L., *The Use of UAVs in Humanitarian Relief: An Application of POMDP-Based Methodology for Finding Victims.* Production and Operations Management, 2019, 28(2).

Fellner A., *Determinanty operacyjnego zastosowania RPAS (wybrane zagadnienia)* (w:) *Wykorzystanie bezzałogowych platform powietrznych w operacjach* [red:] M. Feltynowski, Józefów 2019.

Gromek P., *Nowe technologie w ochronie ludności w Polsce. Rozwiązania dotyczące projektu SILVANUS. Część 2 – Twarde technologie i rozwiązania służące angażowaniu społecznemu.* Zeszyty Naukowe Pro Publico Bono 2024, nr 1(1).

Haidari, L. A., Brown, S. T., Ferguson, M. C., Bancroft, E., Spiker, M. L., Wilcox, A. J.,Lee, B. Y. (2016). *The economic and operational value of using drones to transport vaccines.* Vaccine, 2016, 34(34), 4062-4067. https://doi.org/10.1016/j.vaccine.2016.06.022 .

Kasprzyk P., *Bezzałogowe statki powietrzne. Nowa era w prawie lotniczym. Rozwój regulacji prawnych dotyczących bezpieczeństwa lotnictwa bezzałogowego,* C.H. Beck, Warszawa 2021.

Knoblauch, A. M., Rosa, S. D. L., Sherman, J., Blauvelt, C., Matemba, C., Maxim, L., Lapierre, S. G., *Bi-directional drones to strengthen healthcare provision: experiences and lessons from madagascar, malawi and senegal.* BMJ Global Health,2019, 4(4), e001541.

Kochańczyk R., *BSP w poszukiwaniu osób zaginionych w praktyce policyjnej*, (w:) *Wykorzystanie bezzałogowych platform powietrznych w operacjach* [red:] M. Feltynowski, Józefów 2019,

Kolasińska-Morawska K., Opach M., Sułkowski Ł., Jończyk J., Seliga R., *Zarządzanie sytuacjami kryzysowymi w ratownictwie górskim z wykorzystaniem bezzałogowych statków powietrznych.* International Journal of New Economics and Social Sciences, 2023, 24(8), 61-76. https://doi.org/10.5604/01.3001.0054.5463.

Konert A., *Bezzałogowe statki powietrzne. Nowa era w prawie lotniczym, zagadnienia cywilnoprawne,* Warszawa, C.H. Beck, 2020.

Leśnikowski W., *Drony w służbie ochrony infrastruktury krytycznej na wojnie z COVID-19,* Toruń 2021.

Matuszek G., *Monitoring miejski jako narzędzie bezpieczeństwa i porządku publicznego,* Dąbrowa Górnicza 2025.

Meissner J., *Aplikacje mobilne na froncie wojny rosyjsko-ukraińskiej,* Studia Bezpieczeństwa Narodowego, Zeszyt 31 (2024).

Nowak A., *Zdalnie sterowana oraz bezzałogowa broń III Rzeszy* (w:) *Wykorzystanie dronów i robotów w systemach bezpieczeństwa. Wybrane aspekty* [red.] Kamporowski R, Skarżyński M, Poznań 2019.

Nouvet E., Knoblauch A.M., Passe I., *Perceptions of drones, digital adherence monitoring technologies and educational videos for tuberculosis control in remote Madagascar: a mixed-method study protocol* BMJ Open 2019;9:e028073.

Parczewski P., Wojtaszek M., *Wybrane aspekty stosowania bezzałogowych statków powietrznych w systemie bezpieczeństwa,* Kultura Bezpieczeństwa 40,2021 (9-21).

Pensieri, M.G., Garau, M., Barone, P.M., *Drones as an Integral Part of Remote Sensing Technologies to Help Missing People.* Drones 2020, *4*, 15. https://doi.org/10.3390/drones4020015

Świsulski D., *Nikola Tesla i jego wynalazki.* Wiadomości Elektrotechniczne, 2020 1(1).

Konwencja o międzynarodowym lotnictwie cywilnym – Konwencja chicagowska (Dz. U. z 1959 r. Nr 35, poz. 212, z późn. zm).

Regulation (EU) 2018/1139 of the European Parliament and of the Council of 4 July 2018 on common rules in the field of civil aviation and establishing a European Union Aviation Safety Agency, and amending Regulations (EC) No 2111/2005, (EC) No 1008/2008, (EU) No 996/2010, (EU) No 376/2014 and Directives 2014/30/EU and 2014/53/EU of the European Parliament and of the Council, and repealing Regulations (EC) No 552/2004 and (EC) No 216/2008 of the European Parliament and of the Council and Council Regulation (EEC) No 3922/91 (Text with EEA relevance.) https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32018R1139.

Commission Implementing Regulation (EU) 2019/947 of 24 May 2019 on the rules and procedures for the operation of unmanned aircraft (Text with EEA relevance.) lex.europa.eu/eli/reg_impl/2019/947/oj?eliuri=eli%3Areg_impl%3A2019%3A947%3Aoj&locale=en

Commission Delegated Regulation (EU) 2019/945 of 12 March 2019 on unmanned aircraft systems and on third-country operators of unmanned aircraft systems. https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32019R0945.

Ustawa z dnia 5 grudnia 2024 r. *o ochronie ludności i obronie cywilnej* (Dz. U. z 2024 r. poz. 1907).

Ustawa z dnia 8 grudnia 2006 r. *o Polskiej Agencji Żeglugi Powietrznej* (Dz. U. 2024, poz. 1272 – tekst jednolity).

Ustawa z dnia 3 lipca 2002 r. *Prawo lotnicze* (Dz. U. z 2025 r. poz. 1431,1668 z 2026 – teks jednolity).

Ustawa z dnia 24 stycznia 2025 r. *o zmianie ustawy – Prawo lotnicze oraz niektórych innych ustaw* (Dz. U. 2025 poz. 179).

Wytyczne nr 7/2024 Prezesa Urzędu Lotnictwa Cywilnego z dnia 20 maja 2024 r. w sprawie sposobów wykonywania operacji przy użyciu systemów bezzałogowych statków powietrznych w związku z wejściem w życie przepisów rozporządzenia wykonawczego Komisji (UE) nr 2019/947 z dnia 24 maja 2019 r. w sprawie przepisów i procedur dotyczących eksploatacji bezzałogowych statków powietrznych.

Zarządzenie nr 48 Komendanta Głównego Policji z dnia 19 lipca 2018 r. *w sprawie prowadzenia przez Policję poszukiwania osoby zaginionej oraz postępowania w przypadku ujawnienia osoby o nieustalonej tożsamości lub znalezienia nieznanych zwłok oraz szczątków ludzkich* (Dz. Urz. KGP poz. 77 z poźn. zm.),

About the Author

Grzegorz Matuszek (PhD), Employee of the Department of Security Studies at the WSB University. Director of the Research Center for Video Surveillance at WSB University. Former Municipal Police Commander in Chorzów.