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Unmanned Aerial Vehicles Serve as Crucial Support for Water Rescue Operations in Poland: Characteristics of UAV Utilization Along the Polish Coastline

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Abstract:

Purpose: *The aim of this article is to explore how modern UAV drone technology can enhance the effectiveness of water rescuers on Polish sea beaches. Within the article, a research hypothesis has been formulated, assuming that the use of UAV drones in water rescue significantly improves rescue operations by enabling faster assistance to a drowning person. In line with the stated objective and hypothesis, the article poses the following research question: What specific rescue actions do water rescuers operating over the Polish sea employ with the assistance of UAV drones?To answer this question, the article begins by presenting the global applications of UAVs, and subsequently, it analyzes the historical use of drones over the Baltic Sea by Polish water rescue services.*
Design/Methodology/Approach: *A critical analysis of the literature and an observational method using argumentation to support generalized theses were used to achieve the aim. This research was supplemented with an in-depth interview among dispatchers among construction companies in Poland.*
Findings: *The results obtained in the study indicate a growing use of unmanned aerial vehicles (UAVs) in rescue operations, as well as the effective provision of assistance to an increasing number of people worldwide through their use.*
Practical Implications: *The practical implications of the research results outlined in the article serve as recommendations for future actions in the field of water safety management, the establishment of intervention teams, and response groups equipped with the necessary gear and qualified rescuers. This will enable the optimal utilization of the potential to reduce the response time to the victim. These actions are anticipated to yield concrete results and enhance overall effectiveness and safety levels.*
Originality/Value: *The article presents the results of own desk research. The issue presented has not previously been addressed in discussions published internationally.*

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1. Introduction

Unmanned aerial vehicles support humans in various activities, primarily in transportation and image transmission. These applications can have military or civilian purposes, aiming to replace, or more precisely, relocate the pilot from the cockpit to the control device screen.

Due to relatively fewer restrictions on air movement, the speed and reliability of operations may, in the future, lead to increased safety and a higher number of people surviving various incidents and accidents. (Merkisz and Nykaza, n.d.).

According to estimates World Health Organization every year, 372,000 people lose their lives as a result of drowning (Bloomberg LP and World Health Organization, 2014). Drowning is just one of many forms of water-related accidents, but it is one of the easiest to measure and among the most extreme in its consequences (Zalewski and Czapiewski, 2014).

Among the factors influencing the survival rate in drowning incidents, one of the most crucial is the duration of immersion in water and the time it takes for medical rescue teams to provide assistance. As indicated by the authors, a shorter duration of submersion, not exceeding 10 minutes, and the prompt arrival of the Emergency Medical Services (EMS) team within less than 9 minutes still provide favorable survival prospects for drowning victims (Quan *et al.,* 2016).

Therefore, it is crucial to interrupt the drowning process as quickly as possible after obtaining information about the incident, preventing the victim from submerging underwater, and then evacuating them to the shore where medical assistance (EMS) can be provided. Rescuers aiding drowning individuals have been racing against time for centuries to provide help before the drowning person disappears underwater.

Lifeguards engage in an ongoing battle against time, constantly employing new solutions to enhance assistance and swiftly interrupt the drowning process. Likely, the next milestone in water rescue, which can be observed, is the integration of unmanned aerial vehicles (UAVs), commonly known as drones (Kurylczyk and Apoloniusz, 2021).

Drones are equipped with modern technical solutions that allow for immediate takeoff and high cruising speed, often reaching over 60 km/h and a maximum of over 80 km/h (Matrice 200 Series V2 - Product Information - DJI, n.d.). They are equipped with a high-quality camera (cameras) and technology that enables real-time transmission of images from the UAV's flight location - FPV (First Person View) technology (Borkowski *et al.,* 2018) to the operator, piloting the flying platform, located at a distance ranging from several dozen meters to several kilometers away (Matrice 200 Series V2 - Product Information - DJI, n.d.).

It is difficult to pinpoint a single boundary date from which unmanned aerial vehicles (UAVs) have been supporting the work of lifeguards, as this process is at varying stages in different countries. Analyzing literature and online sources reveals several applications in which UAVs assist rescuers in their work over water areas.

2. Literature Review

In order to gather scientific materials for the study, databases such as Google Scholar, Web of Science, and industry-specific websites were searched. In the year 2017, a total of 1593 publications were found for the keywords "drone" and "unmanned" in the Web of Science and Science Citation Index Expanded (SCI-E) databases. (Chabot, 2018).

Between 2018 and 2020, there were 1097 publications with the term "unmanned" and 317 with the term "drone." In the years 2021-2023, there were, respectively, 584 publications for "drone" and 1299 for "unmanned." A small portion of these publications focuses on the application of UAVs in water rescue. The Drone Rescues Around the World search engine proved helpful in identifying events involving UAVs, (DJI Drone Rescue Map, n.d.), available at https://enterprise.dji.com/drone-rescue-map/, the website collects reports of UAV usage in searches for missing, often unconscious individuals, the transportation of supplies to stranded survivors, searches in smoky, swampy, and forested areas.

The map provides a compilation of all reported drone rescue actions known from news and social media posts by rescuers. The website features reports from 40 countries, detailing 609 drone-assisted rescue operations that aided 1014 individuals (status as of November 10, 2023). As of mid-March 2021, there were reports from 29 countries, documenting 342 UAV-assisted rescue operations, providing assistance to 563 individuals.

3. Methodology

In the process of collecting data on the utilization of drones in sea rescue, the Water Rescue Coordination Centers (WRCC) located in Sopot (Pomeranian Voivodeship, Poland) and Szczecin (West Pomeranian Voivodeship, Poland) proved to be highly valuable. Dispatchers working at WRCC have current knowledge about the resources and capabilities ready to provide assistance along the Baltic Sea coast (Adamczyk *et al.*, 2020).

The author of the study obtained information about the use of drones over the Baltic Sea by contacting dispatchers at WRCC in Sopot and Szczecin, as well as analyzing press releases (newspapers, radio, television, internet sources, industry-specific discussion forums on social media). Based on the acquired information, primarily from WRCC, four Water Rescue Services (WRS) were

identified that utilized UAVs for rescue operations over the Baltic Sea in the years 2018-2020, at least once.

The WRS utilizing drones over the Baltic Sea during 2018-2020 are Water Volunteer Rescue Service from Sopot, Water Volunteer Rescue Service of Słupsk, Water Volunteer Rescue Service of Gniewino (all three operating in the Pomeranian Voivodeship), and Water Volunteer Rescue Service of West Pomerania (operating in the West Pomeranian Voivodeship).

The author of the study prepared an information survey containing questions about the address details of the survey participant on behalf of the Water Rescue Service. The survey consisted of 8 closed-ended questions of both single and multiple choices. The questions covered the following aspects: the location of UAV utilization, the duration of usage, the number, type, and equipment (functionalities) of owned UAVs, the number, type, and duration of flights conducted in the specified period, ownership and funding sources for UAVs, and the number and qualifications of pilots operating UAVs for the Water Rescue Service (WRS).

The survey aimed to collect and standardize information on the number and characteristics of drones (installed functional solutions) used by rescue entities over the sea. The collected information from the survey was intended to be used to inventory the number, frequency, and average duration of flights using UAVs. An information survey, incorporating the aforementioned questions, was sent to each of the four water rescue entities.

4. Results

Responses were received from all four Water Rescue Services (WRS), and the results were collected and compared among them. The Water Rescue Services operating in the Pomeranian Voivodeship, namely the Water Volunteer Rescue Services of Sopot, Słupsk, and Gniewino, utilized UAVs (in the years 2018-2020) in seaside towns such as Ustka, Rowy, Dąbki, Sopot, and Jastrzębia Góra.

In the West Pomeranian Voivodeship, the Water Volunteer Rescue Service of West Pomerania stationed there employed UAVs exclusively in 2020 for rescue operations in seaside towns, including Kołobrzeg, Międzyzdroje, and Mielno. The surveyed Water Rescue Services indicated that they collectively possessed 6 UAVs during the examined period. One drone was an octocopter (with eight arms), while in 5 cases, they were quadrocopters (with four arms).

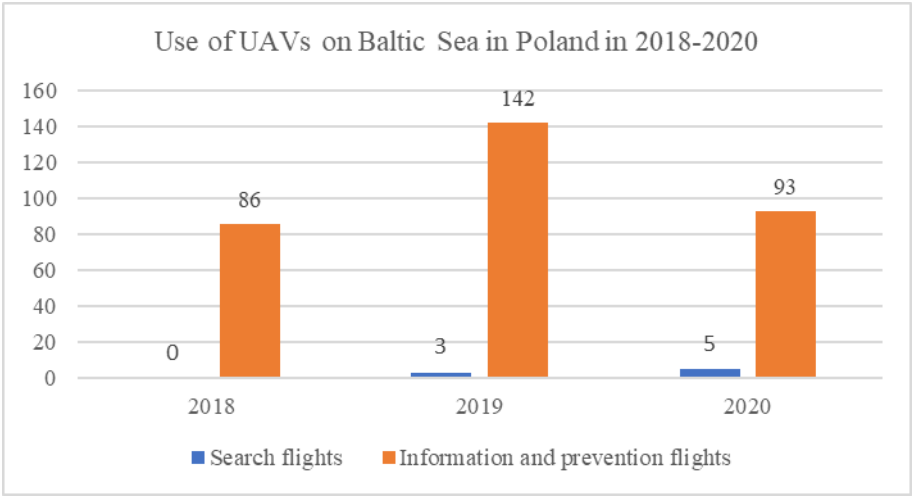
Two drones were equipped solely for monitoring and transmitting live camera feed to the pilot, one UAV featured a thermal imaging camera, and two had a camera and a gripper allowing the release of objects (e.g., a rescue buoy) and towing a drowning victim holding onto the rescue buoy (SAR function).

One of the drones had a modular solution enabling the attachment of an optional thermal imaging camera or a camera (real-on) and a speaker for conveying voice messages from the pilot-rescuer. During the specified period, none of the Water Rescue Services (WRS) utilized UAVs for providing assistance to a drowning individual.

One entity, the Water Volunteer Rescue Service of West Pomerania, employed a UAV in a search and rescue mission for a 6-year-old child ((2) Watch | Facebook, n.d.). The Water Rescue Services (WRS) utilized drones for a total of 329 flights during the specified period. 97.5% of these flights were preventive and informational, aiming to warn about danger or survey the circumstances accompanying an incident (such as the number of drowning individuals), assess the condition of swimmers, without involving water rescuers to enter the water.

Only 2.43% constituted search flights for individuals over water areas or in adjacent areas (beaches). The nature of the use of UAVs for rescue operations is presented in Figure 1.

Figure 1. *Use of UAVs in rescue operations in 2018-2020 by the WRS on the Baltic Sea.*

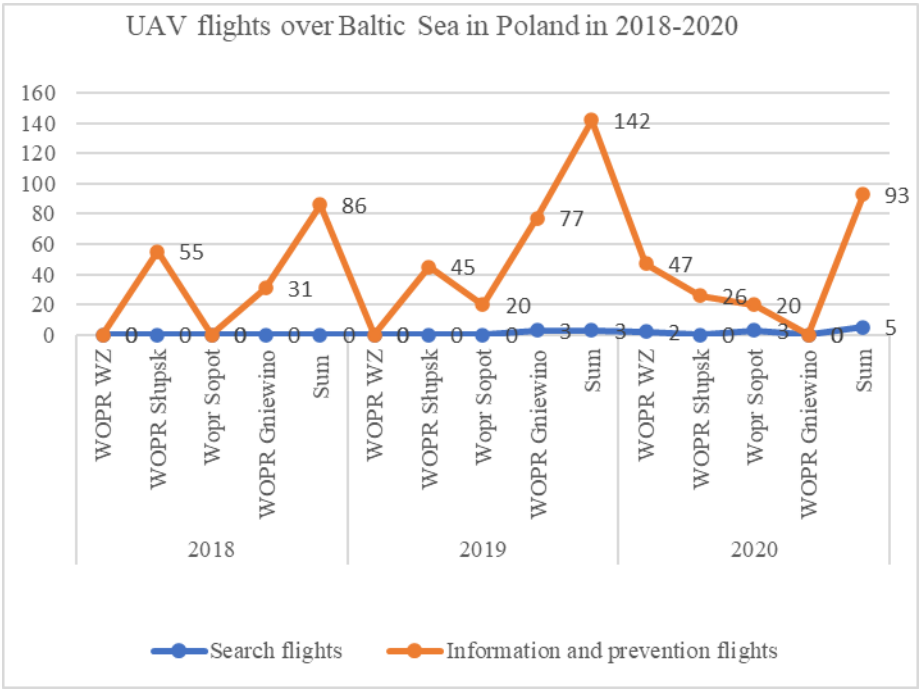


Source: *Original work based on surveys.*

The number of flights over the Baltic Sea in the years 2018-2020 carried out by water rescue entities is presented in Figure 2. During the specified period, no use of drones for rescue operations was recorded.

The number of search flights along the Polish coastline is increasing, although at present, it constitutes a fraction of the overall utilization of UAV drones in rescue operations.

Figure 2. *Number of flights over the Baltic Sea in 2018-2020 performed by water rescue entities*



Source: *Original work based on surveys.*

The responses regarding the average flight times in search and informational-preventive missions carried out by WRS pilots over the Baltic Sea in the years 2018-2020 are presented in Figure 3.

The number of Water Rescue Services (WRS) utilizing drones in water rescue is linearly increasing in Poland: in 2018 - 2 entities, 2019 - 3 entities, 2020 - 4 entities. Similarly, the number of flights conducted - a total of 321 flights in the years 2018-2020 - exhibits a linear upward trend.

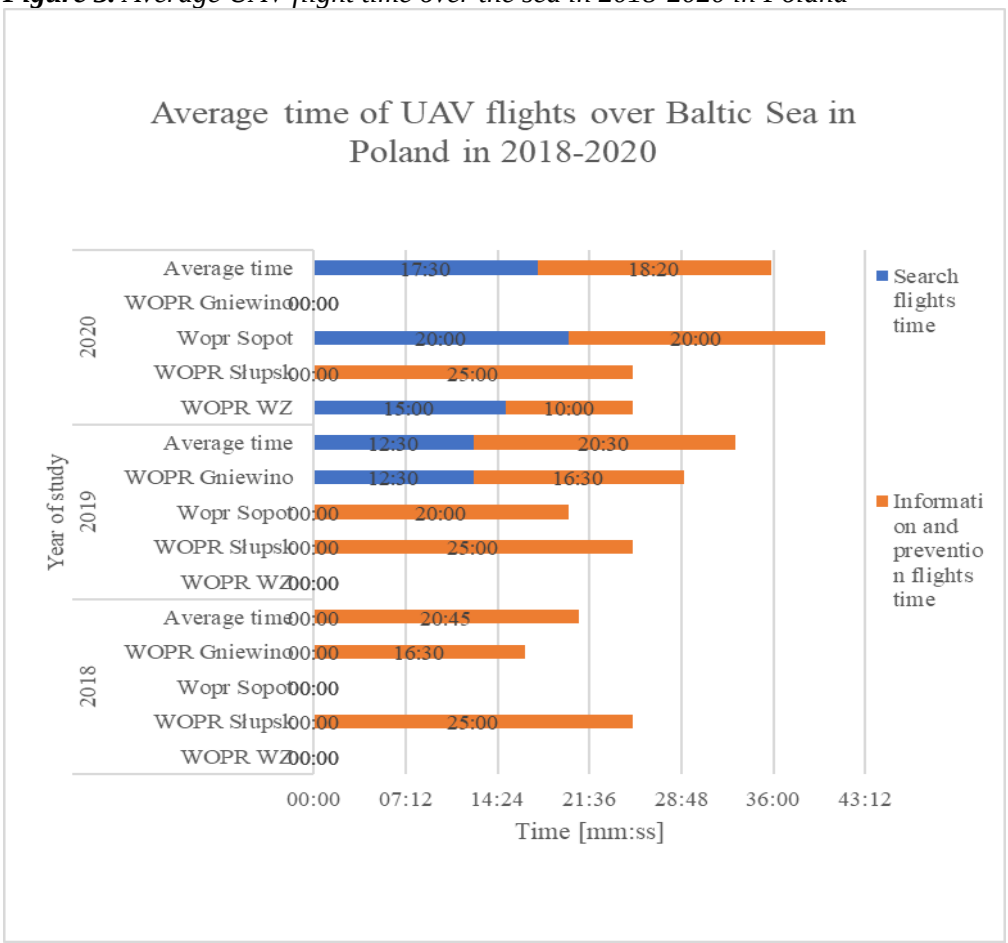
5. Discussion

As the research results indicate, the use of UAVs in coastal rescue operations in Poland is not an entirely new concept among rescue entities. However, it is not a widely popular equipment and is not frequently encountered among lifeguards on Polish beaches. The author found it challenging to locate similar cross-sectional studies involving the use of UAVs in water rescue in other countries.

When press reports do emerge, they often concern spectacular rescue actions, such as the saving of a 14-year-old boy off the coast of Valencia by delivering a buoy to him through a UAV (Lifeguard Drone Saves 14-Year-Old Swimmer's Life | IoT World Today, n.d.), or using of UAVs and modern technologies to recognize and

protect beaches against sharks and other marine predators (Butcher *et al.*, 2021).

Figure 3. *Average UAV flight time over the sea in 2018-2020 in Poland*



Source: *Original work based on surveys.*

It seems that UAV vehicles can technologically significantly improve and speed up reaching a drowning victim in water with equipment. At the moment, that is, as of November 2023, it cannot be clearly stated that UAVs will significantly contribute to improving or replacing lifeguards carrying out rescue operations. Despite the rather scanty data on the use of UAVs in Poland and other countries, their role in supporting rescue operations over water areas in preventive, informational and search roles cannot be ignored.

6. Conclusions

As research indicates, drones will be significantly more frequently utilized by lifeguards for informational-preventive actions, notably (far less frequently) for

search and rescue operations. It can also be assumed that the application of drones by water rescuers for life-saving interventions, such as delivering personal flotation devices (PFD), will be the least common.

A greater number of drones is likely to facilitate quicker skill acquisition for operators working at bathing sites. Increased expertise will result in more frequent utilization for operational purposes at bathing sites. This will lead to a more frequent use of unmanned aerial vehicles (UAVs) instead of standard actions involving water rescuers.

The rescue of a drowning person in Poland using Unmanned Aerial Vehicles (UAVs) is only a matter of time, as substantiated by an actual increase of 80% (451 individuals) in the number of individuals rescued using drones, as documented and reported through the website: https://enterprise.dji.com/drone-rescue-map/ over a span of 32 months.

It should be acknowledged that in the future, drones will increasingly support lifeguards primarily in preventive and informational activities. They will not replace water rescuers in all tasks, but they can significantly enhance (accelerate) and assist in rescue operations, including the rescue of drowning individuals.

In the longer term, this may lead to a reduction of 1-3 individuals in a several-member water rescue team stationed in coastal areas, directly impacting the costs of maintaining water rescue services by the municipality/security operator.

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