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Review article

Possibilities of using unmanned combat assets in tactical operations in the mountains

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ABSTRACT

The dynamic development of technology related to unmanned combat assets significantly contributes to the possibilities of their deployment in armed conflicts. The use of broadly understood unmanned combat vehicles in difficult mountainous terrain may significantly increase the effectiveness of tasks carried out by units and units in this combat environment. The article presents basic information on autonomous vehicles, describes factors affecting the conduct of military operations in the mountains, and, on the basis of experience resulting from contemporary armed conflicts, a synthetic analysis of the possibility of using unmanned combat assets in military operations in a mountainous terrain was carried out. The main goal of the article is to present the potential tasks that can be performed by unmanned vehicles in order to achieve the assumed results during combat in the mountains while minimizing human losses.

KEYWORDS

mountain infantry, combat in the mountains,
unmanned combat assets, drones

Introduction

Contemporary armed conflicts reveal the intensity of changes taking place in the conduct of tactical operations. Along with the development of tactics, newer and more advanced combat assets are implemented. One of the main directions of the modernization of armament and military equipment both worldwide and in the Armed Forces of the Republic of Poland is the use of unmanned systems in military operations. Unmanned platforms allow for executing tasks in a variety of combat environments without the need to directly engage soldiers and expose them to danger. Unmanned systems, commonly referred to as drones, can perform the following tasks: combat operations, reconnaissance, search missions, engineering, electronic warfare, logistical support for operations, command support, as well as observation and target indication.

The deployment of unmanned combat assets in a mountainous terrain, which is an area being difficult to cross, characterized by significant differences in altitude, steep inclines and deep

valleys, allows for increasing the effectiveness of task execution in this specific combat environment. The most significant advantages of the use of unmanned systems in the mountains include the minimization of human losses, increased situational awareness of commanders and a variety of opportunities for their deployment.

1. Basic concepts and classification of unmanned combat assets

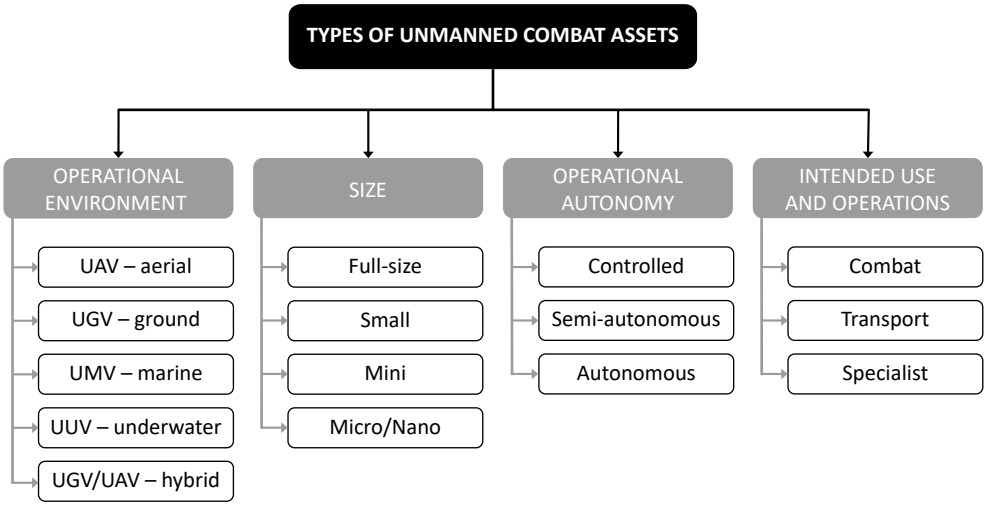
Unmanned combat assets as a collection of systems operating in all environments (land, air and water) have not yet been defined in military terminology. In the dictionary of the North Atlantic Treaty Organization (NATO), the concepts of Remotely Piloted Aircraft (RPA) and Unmanned Aircraft System (UAS) are distinguished [1, p. 110 and 133]. A remotely piloted aircraft is defined as an unmanned aircraft controlled from a remote control station by an operator trained and certified to the standards established for pilots of manned aircraft [1, p. 110]. On the other hand, the unmanned aircraft system was defined as a set of elements consisting of: an unmanned aircraft, a support system and all the personnel and equipment necessary to control the platform [1, p. 133].

The most commonly used term related to unmanned combat assets is the term *drone*, denoting an unmanned flying craft, usually small in size, remotely controlled or moving in accordance with a programmed trajectory [2]. In casual nomenclature, the term *unmanned aerial vehicle* (UAV) is also used, defined as an aircraft without a human pilot on board or drone [3]. Along with the development of unmanned systems, the term drone and unmanned aerial vehicle are becoming increasingly used to refer to land and water-based platforms, rather than just flying craft, as has been the case so far. In the simplest terms, an unmanned combat asset is a land, flying, water or mixed vehicle which does not require taking a human operator on board and is controlled remotely using various levels of automated functions [4, p. 169].

The huge dynamics of the development and modernization of the technology related to unmanned combat assets cause difficulties in their classification. In the source literature, only the division of unmanned aircraft was provided, which were ordered according to: size, weight, method of control and autonomy in operation, as well as the purpose and tasks performed in tactical operations [4, p. 172-177; 5, p. 1-2]. However, a precise classification of all unmanned combat assets does not exist. Certain criteria applicable for aerial platforms can be easily adapted to categorize all unmanned military systems. It is also required to create a new division based on the environment in which unmanned combat assets can perform military operations. Classification distinguishes following types: Unmanned Aerial Vehicles – UAV, Unmanned Ground Vehicles – UGV, Unmanned Marine Vehicles – UMV, Unmanned Underwater Vehicles – UUV and unmanned mixed platforms that can operate in at least two combat environments (e.g., aerial and ground – UAV/UGV) [6]. Figure 1 illustrates the classification of unmanned combat assets, taking into account four criteria: the operating environment, size, operational autonomy, and the purpose and tasks that can be performed.

2. Conducting tactical operations in the mountains

Mountainous terrain is an area lying at an altitude over 600 meters above the sea level, which is characterized by significant differences in elevation and includes mountains, cities, settlements and plateaus between mountain ridges and passages intersecting them [7, p. 144]. This kind of terrain covers approx. twenty-five percent of the world's land area and is difficult to cross [8, p. 14]. Conducting tactical operations in the mountains implies increased difficulty



UAV – Unmanned Aerial Vehicles, UGV – Unmanned Ground Vehicles,
UMV – Unmanned Marine Vehicles, UUV – Unmanned Underwater Vehicles

Fig. 1. Classification of unmanned combat assets
Source: Own work based on [4, p. 172-177; 5, p. 1-2].

and requires factoring in additional elements at the stage of planning and conducting combat. The goal of operations in such an area is to gain and maintain control over the key area, which includes: hilltops, passes, valley outlets, communication routes and towns [9, p. 192].

The factors that have a decisive impact on the conduct of military operations in the mountains are: terrain, weather, significant differences in altitude and the human aspect [10, p. 13-20]. The natural topography of the terrain, a small number of communication routes and the occurrence of numerous watercourses limit the possibilities of movement and military operations. Units equipped with heavy equipment such as tanks and infantry combat vehicles can perform tasks only in low-elevation mountain areas, mainly along the existing road network. Rocky ground, which can often be seen in such a combat environment, increases the time of engineering expansion, and forests located in low parts of the mountains make it difficult for troops to observe and support each other [9, p. 192]. Figure 2 illustrates an example of how mountainous terrain can be divided with regard to the possibility of crossing it.

Weather conditions in the mountains are very changeable and often go to extremes. From intense sunny weather to rapid meteorological changes, cool-down, high wind speed and extreme rain or snowfall. Proper assessment and forecasting of weather conditions, as well as considering the possibility of sudden changes are key factors in the process of planning operations in such an area. Significant differences in altitude affect observation ability. Higher parts of the mountains allow for conducting observation over long distances. Numerous terrain obstacles create blind spots which make it difficult to control the designated area of operations. Differences in altitude also affect maintaining radio communication and eye contact between troops and units of one's own troops [11, p. 27 and 29-31].

The last, but equally important factor determining the conduct of military operations in the mountains, which is related to all other factors, is the impact of the mountain environment on soldiers. Significant altitude differences cause human effort to increase during movement and tactical maneuvers. Changes in location from low to high mountain areas in a short period

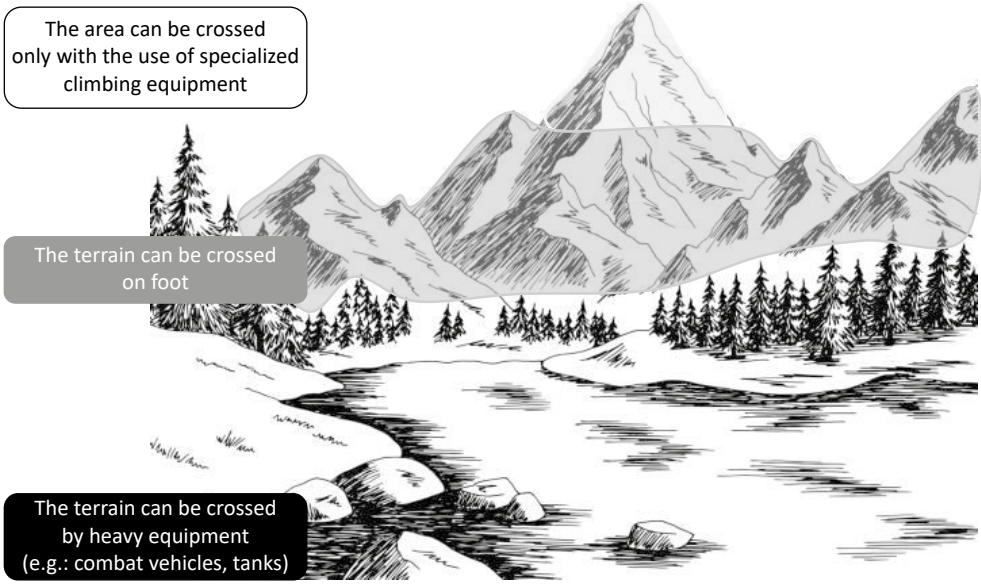


Fig. 2. Possibilities of crossing mountainous terrain
Source: The author's own development based on [11, p. 26].

of time may cause altitude sickness. Adverse weather conditions associated with terrain obstacles often result in fatigue, frostbite, as well as psychophysical problems. Therefore, specialized troops training, as well as acclimatization to the height at which they will perform tasks should always precede the implementation of operations in the mountains [11, p. 25-33]. Figure 3 shows the factors that have a decisive impact on the conduct of military operations in the mountains.

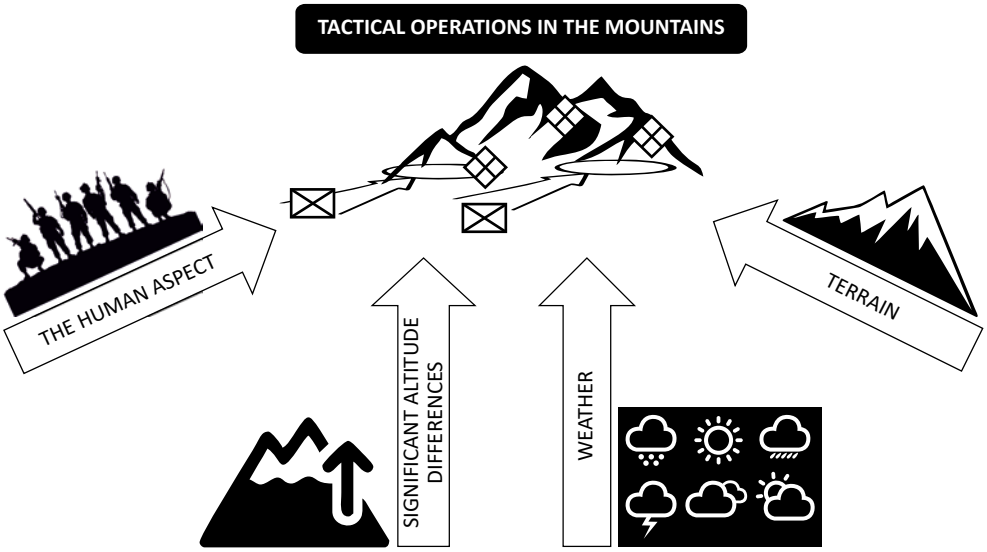


Fig. 3. Factors having a decisive impact on the conduct of military operations in the mountains
Source: The author's own development based on [10, p. 13-20].

Units and units fighting in the mountains must be ready to perform all types of tactical operations: Offensive, Defensive, Stability and Enabling Tactical Operations [12, p. 31]. This area creates more favorable conditions for conducting defensive operations than offensive ones, and also promotes the organization of ambushes, which under such conditions can be particularly effective. Guard and screen, wing protection and observation aimed at preventing the penetration of the enemy will also be of great importance in the mountain environment [9, p. 193].

An important aspect of mountain combat which should be considered when planning and organizing operations is the creation of a team or expert unit for mountain affairs at the battalion level. Specialists in the expert group should take part in planning the combat and put particular emphasis on risk management, as well as support the troops in the implementation of operations in this area. Their responsibilities include, among others, the construction of climbing systems for combat units that penetrate the terrain and tactical maneuvers in difficult-to-reach terrain. They can also assist the battalion commander in risk assessment and decision making during the implementation of operations in the mountains.

3. The use of unmanned combat assets in tactical operations in the mountains

Given the significant dynamics of the technology development with regards to unmanned combat assets, the scope of their use in military operations is being systematically increased. The most important and, from the point of view of the commanders, most critical tasks that unmanned combat assets can perform in the mountains include:

- reconnaissance,
- reconnaissance and surveillance,
- guard and screen,
- fire support,
- target acquisition and battle damage assessment,
- demining, construction of crossings, neutralization of improvised explosive devices (engineering support),
- combat service support,
- medevac and casevac,
- communication support.

Troops fighting in a mountainous terrain can use unmanned combat assets for conducting observation, reconnaissance and gathering information to create a clear picture of the tactical situation necessary for effective decision-making. By using mainly UAVs, the commander can increase the range of reconnaissance and observation operations, as well as the speed of transferring data to the command post or command point. Part of the above tasks can be taken over from soldiers who would previously perform these tasks in the field [4, p. 185-186].

When organizing and planning military operations in the mountains, unmanned combat assets can be an effective tool for reconnaissance of the area of future operations and identification of potential areas for deployment of troops and maneuvers. They can replace human reconnaissance which, in a hardly accessible mountainous terrain, engages a large number of soldiers and is time-consuming. Greater situational awareness of commanders enables

faster and more effective decision-making on the use of forces and resources at the right time and place. Reconnaissance with unmanned combat assets can also be used to identify risks associated with terrain and atmospheric hazards without the need to expose troops to them. Landslides or potential snow avalanche descents identified in advance accelerate a decision to change the route of the march or tactical maneuver.

Unmanned combat assets can also be used in the mountains for screening and guarding. Screening is the conduct of observation, identification and transmission of information by the screening unit without engaging in combat with the opponent. Guarding, on the other hand, is characterized by obtaining information and guarding the main forces by engaging in combat against the enemy in order to reduce its combat potential, counteract reconnaissance and gain time [12, p. 228-229]. While screening tasks can be performed by unmanned unarmed assets, in the latter case autonomous vehicles must be equipped with weapons properly prepared to conduct fire in this environment. Involvement of unmanned aerial vehicles to guard the main forces prevents excessive dispersion of troops in the mountains, which at the same time allows for faster response and concentration of efforts at the right place and time [4, p. 186]. Performing defensive operations in mountainous terrain usually takes the form of focal and cordon combat focused on the key terrain, such as the dominant hills. This type of conducting combat requires significant involvement of troops and resources. Unmanned combat assets can fill the gaps in the arrangement of a unit and thus increase the level of protection against the impact of the enemy. Figure 4 illustrates possibilities of using unmanned aerial vehicles during reconnaissance, observation and surveillance, as well as screening and guarding.

In mountainous terrain, unmanned combat assets can also be used to perform combat missions related to the direct fire delivery against enemy forces. The main advantage of this solution is the ability to fight in a difficult and dangerous environment without risking human life. The use of unmanned vehicles to destroy selected targets allows one to gain time and focus main operational efforts of the unit on another direction, important from the point of

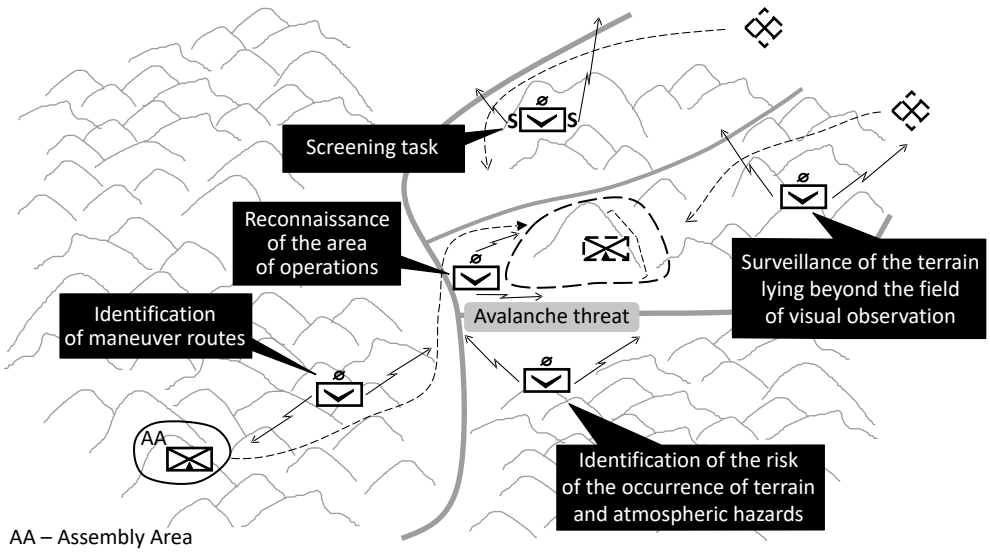


Fig. 4. Possibilities of using unmanned combat assets in the mountains
Source: The author's own development.

view of the commander. The deployment of unmanned vehicles in such tasks increases the combat capabilities of the unit, which otherwise would not be able to perform such a wide range of tasks set by the commander in the mountains. Additionally, delivering effective firepower by military vehicles in the mountains is often limited by the angle of elevation and depression of their armament. UAVs do not have such limitations since they strike the opponent from the air.

For performing combat missions in the mountainous environment, both UAVs and UGVs can be properly set up to move in this difficult terrain. Ground vehicles should be equipped with tracks enabling movement both along routes and cross-country. Unmanned vehicles equipped with automated rifles, carbines, guided munitions or other types of weapons can perform combat missions such as: fire strike, fire support, blocking the enemy in any given direction, or even ambush. Depending on the equipment, these assets may also be adapted to conduct indirect fire, which in the mountains may play the key role in the implementation of the task. UAVs, on the other hand, can conduct precise fire against important targets located within a concealed area (behind hills, in valleys, behind terrain obstacles). Fire strikes are then carried out by means of explosives dropped by unmanned aerial vehicles from the air, the use of air-to-ground missiles or the use of loitering munitions operating on the basis of a suicide mission.

The tasks directly related to fire strikes should include selecting targets and supporting the targeting process. Unmanned combat assets can locate, identify, support the process of selecting and prioritizing targets and guide indirect fire (barrel and rocket artillery) to the target [13, p. 73]. In mountainous terrain, which is characterized by large differences in altitude, the use of unmanned aerial vehicles can significantly increase the effectiveness of the targeting process and thus combat enemy forces more effectively. The use of unmanned assets in the above operations allows for extending the scope and distance of their implementation, limiting the time necessary to perform them, as well as minimizing losses in one's own troops and committing them elsewhere. Unmanned combat assets can significantly accelerate the transmission of information in the field of Battle Damage Assessment (BDA) [1, p. 19]. Using mainly UAVs, commanders can assess the fire impact on enemy's targets in real time in the "live-view" mode.

While conducting military operations in the mountains, unmanned combat assets can locate places where the enemy's engineering barriers or improvised explosives are located. These operations are especially important when moving along and patrolling narrow mountain paths. A limited number of communication routes influences the intensification of the enemy's counter-mobility operations and thus increases the risk of using various types of barriers, mines and explosives. Unmanned aerial vehicles can also perform operations in the field of clearing the area of anti-personnel and anti-tank mines, breaching identified engineering barriers and neutralizing improvised explosives. These operations can be carried out by both autonomous ground vehicles and aerial vehicles. Ground vehicles should then be equipped with tracked traction enabling access to hard-to-reach mountainous areas. Aerial assets can perform the above operations without direct contact with the detected engineering barrier by dropping a missile or an explosive onto it from the air. The main advantages of unmanned combat assets as part of engineering protection include minimizing potential personnel losses and increasing the mobility of troops performing operations in the mountains. Figure 5 shows the possible use of unmanned vehicles during a fire strike, to indicate targets and support the targeting process as well as engineering protection tasks.

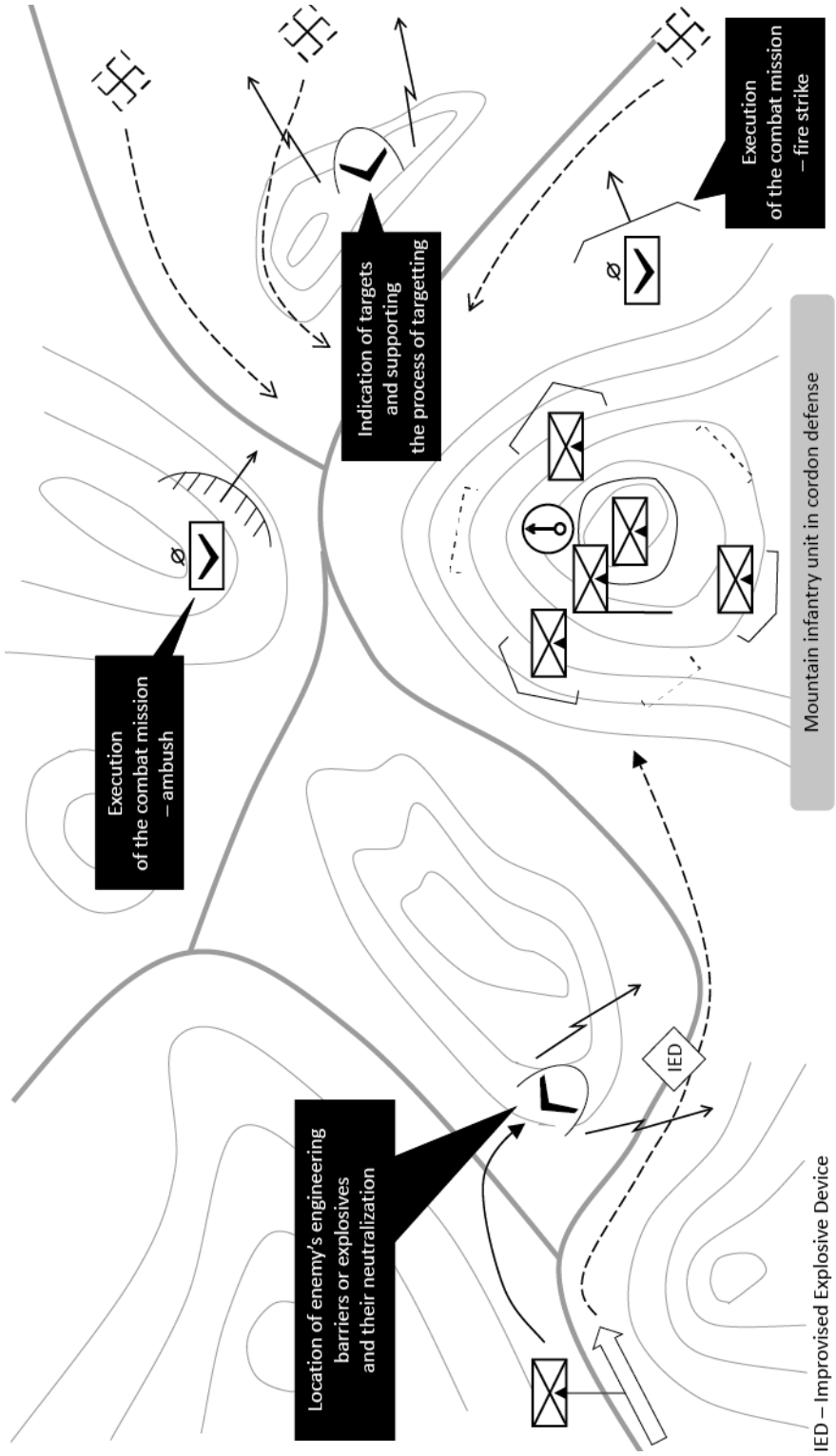


Fig. 5. Utilization of unmanned combat assets in the mountains for fire strike, support of the targeting process and engineering protection
Source: The author's own development.

One of the biggest challenges faced by troops fighting in mountainous terrain is logistical security, on which the conducted mission often depends. Numerous terrain obstacles, elevation differences, limited infrastructure and communication network, as well as difficult weather conditions negatively affect the ability to supply troops. Requirements in the field of logistics are higher in the mountains compared to missions carried out in low-lying terrain. Therefore, mountain infantry units should be provided with specialized equipment enabling timely implementation of logistical security in this difficult combat environment. For this purpose, among others, helicopters, cable cars, off-road vehicles, sledges and pack animals are used [14, p. 55-56].

The efficiency of supplying troops in the mountains can be significantly increased by the use of UGV or UAV to transport equipment. Ground drones can successfully replace pack animals, which are less and less common in the structures of mountain infantry troops due to the relatively high cost of living and the number of soldiers necessary to service them. The ongoing process of optimizing autonomous vehicles means that each subsequent generation has better parameters in terms of mobility and the size of the load carried, which increases their usefulness in military operations in the mountains. Tactical and technical requirements include the possibility of carrying around four hundred and fifty kilograms of cargo through unmanned combat vehicles, which in practice corresponds to four US military backpacks, six boxes of food rations and four water canisters. The range at maximum load should allow for covering a distance of up to one hundred kilometers with a device operating time of up to seventy-two hours. UAVs can perform logistical tasks by delivering supplies after landing or by dropping cargo without having to land. The amount of carried supplies is then limited and depends on technological solutions constantly improved by manufacturers of unmanned aerial vehicles.

Combat in the mountain environment poses additional threats to the life and health of soldiers associated not only with the direct impact of the enemy, but also with the specificity of the terrain, significant differences in altitude and difficult weather conditions. It is estimated that the number of victims in mountains requiring medical evacuation is ten times higher than in low-lying areas [14, p. 70]. The most difficult tasks in the field of medical protection in the mountains include medevac (short for medical evacuation which refers to the transport of injured persons by a medical vehicle with qualified personnel) and casevac (short for casualty evacuation which refers to the evacuation of injured personnel using non-medical vehicles) [15, p. 7]. UGVs can significantly increase the transport efficiency of injured personnel in this environment. Unmanned aerial vehicles prepared for the evacuation of the injured in the mountains can perform the work carried out so far by four soldiers (for transport using a stretcher), pack animals, a tracked vehicle adapted for the transport of injured soldiers or a helicopter. It saves time, which plays a key role in medical security, as well as the use of forces and resources to perform tasks elsewhere, thus maintaining combat capability to achieve the goals set. Currently, it seems unlikely that unmanned aerial vehicles will be used to carry out the medevac of soldiers.

Very often conducting military operations in the mountains boils down to focal combat, which is carried out in several places at the same time, to maintain possession of the key area. The battalion is considered to be the largest unit conducting operations in mountainous terrain. The specificity of this environment means that activities are planned in a centralized manner, while their implementation is carried out by lower-level units (platoon, company) on their own. An important problem in the process of commanding and directing military operations in the mountains is communication. The existing solutions in this area were limited to detailed

planning of activities enabling independent performance of the task in case of lack of communication and organization of the re-translation system (transmission of signals over long distances via autonomous relay stations located in the area), which were intended to improve this communication. The disadvantage of relay stations is the need to have a significant number of radio stations, as well as protect them from the enemy's influence.

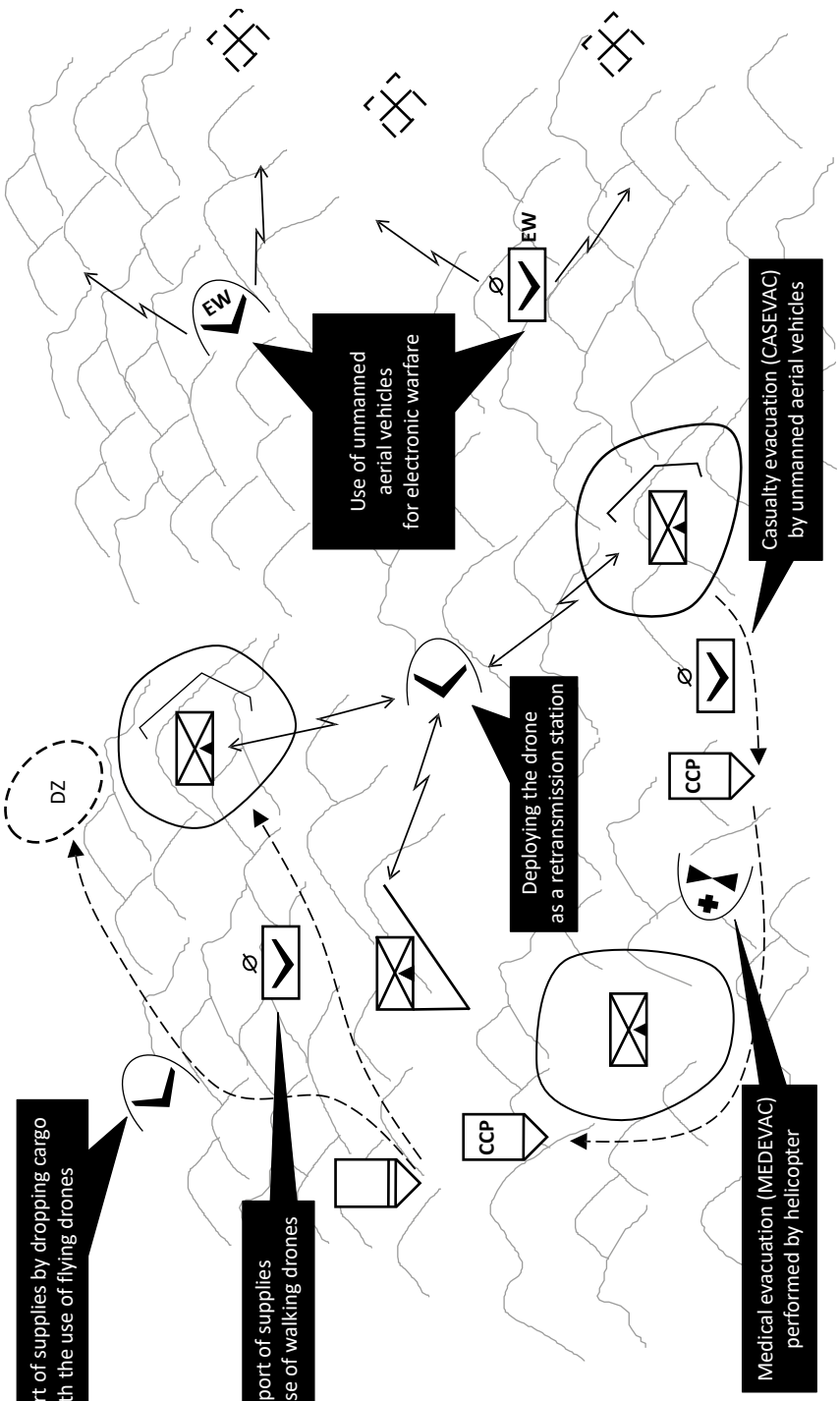
The use of unmanned aerial vehicles equipped with a communication system can significantly improve communication between units fighting in the mountains, as well as support the process of command and control by commanders. UAVs rising above mountain peaks will increase the range of communication for one's own troops. At the same time, it should be remembered that their operation will be limited at very high altitudes and at very low temperatures. Unmanned aerial vehicles can also be used for conducting electronic combat in mountainous terrain. Their main task will be then to disrupt the opponent's communication. Figure 6 shows the use of unmanned combat assets in the course of performing supply transport, medevac and support of the command-and-control process.

4. Possibilities and limitations of the use of unmanned combat assets in tactical operations in the mountains

The wide range of possibilities of using unmanned combat assets in the mountains has a significant impact on the change of methods and techniques of conducting military operations in this combat environment. The intensification of the use of unmanned aerial vehicles in armed conflicts in mountain areas can be observed on the example of activities carried out, among others, in Afghanistan, Nagorno-Karabakh and Ukraine. In Afghanistan, apart from traditional missions related to obtaining information, UAVs also carried out large-scale combat missions. In the fight against terrorism, unmanned aerial vehicles performed fire support operations, protection of critical infrastructure and elimination of military facilities. For this purpose, the US military used, among others, platforms such as Predator and MQ-9 Reaper [16, p. 183-185].

Another example of the growing role of unmanned aerial vehicles in military operations in the mountains is the conflict between Azerbaijan and Armenia in 2020 over the territory of Nagorno-Karabakh, often called the war of drones and artillery shells [17]. Autonomous vehicles belonging to the arsenal of Azerbaijani troops performed, among others, missions related to surveillance, obtaining information, indicating targets and guiding artillery fire. These missions were carried out by MALE, Hermes, IAI Heron, IAI Searcher and Thunder-B. Unmanned aerial vehicles also performed combat missions. Platforms such as Orbiter 1K and Sky Strike destroyed the enemy's anti-aircraft systems in the first place, and then fought against the main combat assets in the form of tanks, armored vehicles, artillery positions and reinforced infantry positions [17].

The conflict between Ukraine and Russia, which escalated in early 2022, confirmed the usefulness of unmanned combat assets, both in open and mountainous terrain. The most effective unmanned aerial vehicle at the disposal of the Ukrainian army has been so far the Bayraktar TB2 of Turkish production, which has already carried out operations in the Nagorno-Karabakh War. The most important advantages of this weaponry include its effectiveness and versatility. The discussed platform can not only detect and mark targets for artillery, but, more importantly, independently combat the enemy's armored assets. Ukrainian troops also used numerous unmanned reconnaissance, scouting and observation



DZ – Drop Zone, EW – Electronic Warfare, CCP – Casualty Collection Point, MEDEVAC – transport of victims in a medical vehicle with qualified personnel (Medical Evacuation), CASEVAC – evacuation of the injured with the use of non-medical vehicles (Casualty Evacuation).

Fig. 6. The use of unmanned combat assets in logistics protection and support of the command process in the mountains
Source: The author's own development.

assets, such as Bayraktar Mini, Polish FlyEye and Ukrainian Laleka-100. The conflict also involved the use of unmanned aerial vehicles with Warmate loitering munition, which were manufactured in the Polish company WB Electronics. The number of assets used on both sides of the conflict was crucial and had a significant impact on the implementation of tactical objectives [18]. At the same time, it should be noted that in the following months of the conflict, the Russian side intensified its work on systems for combating unmanned platforms, which brought tangible results.

Analyzing contemporary armed conflicts in which the combat area was a mountainous terrain, it can be inferred that the role of unmanned combat assets in military operations is systematically increasing and is proportional to the development of military and civilian technologies related to unmanned aerial vehicles. Currently, the vast majority of unmanned platforms used in armed conflicts in the mountains belong to the group of flying systems – UAV. UGVs used for both combat and logistical purposes are not yet widely used on the battlefield. The intensification of work on improving the capabilities of land-based unmanned combat vehicles and ground systems allows us to conclude that in the near future they will be used on a larger scale, including mountainous terrain. Figure 7 shows examples of a logistics UGV which can effectively carry out missions in the mountains in the future.

The undoubted advantage of using unmanned combat assets in military operations in the mountains is the variety of possibilities of their use. Autonomous vehicles can increase the efficiency of executing reconnaissance tasks, secure units, indicate targets for artillery, increase the situational awareness of commanders on the battlefield, carry out tasks of logistical and engineering security, as well as perform combat missions. By using unmanned aerial vehicles instead of soldiers, the military minimizes casualties, which is a critical advantage of this solution. Extreme atmospheric conditions in mountainous terrain, which negatively affect human performance, do not contribute significantly to the precise performance of

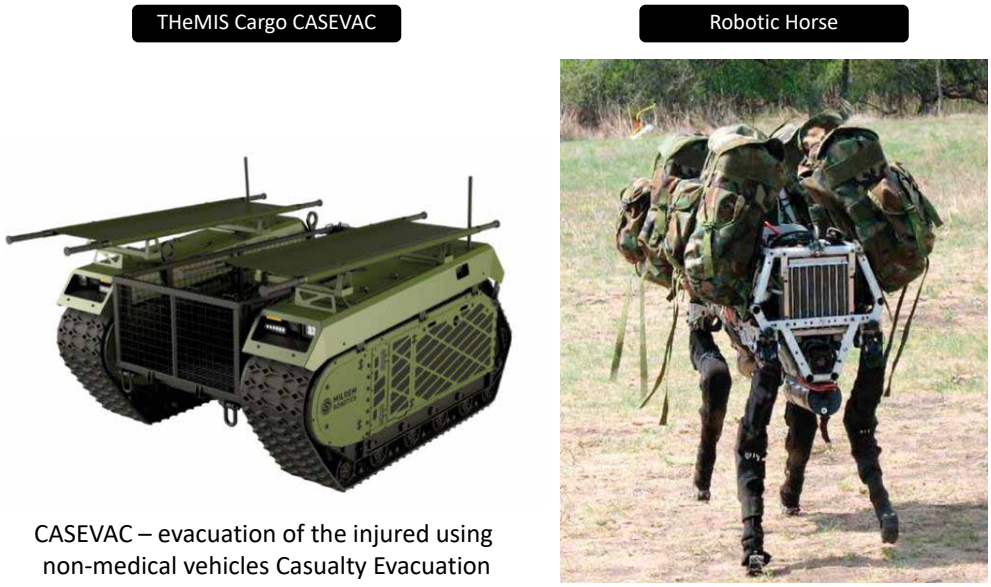


Fig. 7. Examples of unmanned ground vehicles (UGVs) designed for logistics
Source: The author's own study based on [19; 20, p. 16].

tasks by machines. Unmanned combat assets can operate in a contaminated environment, fire, explosion or avalanche hazard area, where conducting operations by soldiers would be extremely risky. The use of the discussed assets in the mountains allows for gaining time, thanks to which people can be assigned to perform more complex and important tasks.

Another advantage of using unmanned platforms in mountainous terrain is to increase the combat capabilities of units operating in this combat environment. Unmanned aerial vehicles are usually much smaller and lighter than standard military vehicles as they do not need space for soldiers in their design. This increases their maneuverability, which is extremely important in the mountains. Fire strike systems of unmanned warfare devices may also be more precise, and their variety (small arms, anti-tank and anti-aircraft weapons) increases the firepower of the entire unit. An additional advantage of autonomous vehicles, in which an electric motor is used, is the stealth of operation, which has a significant impact on the effectiveness of performing tasks inside the enemy's grouping or in contact with it, for example by conducting reconnaissance. An important positive impact of unmanned warfare devices in the mountains is also an increase in the situational awareness of commanders. In mountainous terrain, which is characterized by numerous concealed areas, i.e., places where we are not able to conduct effective observation, UAVs allow for obtaining information about the area and the enemy at much greater distances and in conditions of limited visibility. Unmanned aerial vehicles are also characterized by relatively low costs of production and training of operators compared to traditional crewed vehicles.

When analyzing the possibilities of using unmanned warfare devices in military operations in the mountains, it is also necessary to take into account their limitations resulting mainly from adverse weather conditions in this environment. The smaller the autonomous vehicle is, the more susceptible it is to bad weather. At extremely low temperatures, the performance of batteries used in unmanned aerial vehicles can drop significantly, which will reduce the available time in which they can carry out tasks. The icing of machine parts which occurs in sub-zero temperatures may lead to halting the operation of the discussed combat assets. In the case of UAVs, this will result in the fall of the device and its destruction. Additional factors which have a negative impact on the operation of unmanned aerial vehicles, mainly the flying ones, are strong winds, abundant rain and snowfall, as well as a low cloud ceiling and fog. Therefore, work aimed at checking the effectiveness of autonomous vehicles at high altitudes and in extreme weather conditions should be an extremely important element in improving the technology associated with the use of autonomous vehicles in the mountains.

The disadvantage of using unmanned combat assets is the possibility of disrupting their work by the enemy. Along with the development of unmanned aerial vehicles technology for military use, new solutions are being created regarding the disruption, interception or destruction of those vehicles, which can be observed, among others, on the basis of an analysis of the armed conflict in Ukraine. In order to avoid similar situations, it is advised to use the so-called *unmanned tethered devices*, which connect to the operator via a wire rather than radio waves or a wireless network. It is then impossible to disrupt the operation of the unmanned platform, but it is associated with a limited distance of its functioning. An important drawback of deploying autonomous vehicles in the mountains may also be communication problems between the device and the operator resulting, among others, from large differences in altitude occurring very often in these areas. The solution to this inconvenience may be to increase the autonomy of unmanned platforms by the fact that at the moment of communication loss between the machine and its user, the unmanned aerial vehicle continues the implementation of the task, the main objectives of which were

programmed before the mission. The described situation illustrates another dilemma related to the use of autonomous vehicles, namely moral issues. While this problem does not exist in the case of the use of unmanned reconnaissance and intelligence devices, in the case of unmanned combat assets the level of their autonomy raises a lot of controversy and requires special attention and control.

Conclusions

The dynamic development of unmanned combat assets, as well as the increase in their effectiveness in military operations, make the use of such devices in the mountains increasingly common. In modern armed conflicts, in addition to military autonomous vehicles, the use of low-cost, civilian unmanned systems adapted to performing military tasks can be increasingly observed. Commanders at each level of command should therefore have a basic knowledge of the possibilities and limitations of deploying unmanned aerial vehicles in order to be able to use their qualities on the one hand, and, on the other, to counteract the threats arising from the use of assets in question by the enemy. The intensification of the use of unmanned warfare devices in the mountains creates the need to develop appropriate operating procedures using the platforms in question and their cooperation with soldiers. When introducing autonomous combat assets for general use in the military, it should be remembered that the most effective element of the war system is the human being, and the role they play in the implementation of military objectives should invariably be paramount.

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Conflict of interests

The author declared no conflict of interests.

Author contributions

The author contributed to the interpretation of results and writing of the paper. The author read and approved the final manuscript.

Ethical statement

The research complies with all national and international ethical requirements.

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Możliwości wykorzystania bezzałogowych środków walki w działaniach taktycznych w górach

STRESZCZENIE

Dynamiczny rozwój technologii związanej z bezzałogowymi środkami walki w sposób znaczący wpływa na zwiększenie możliwości ich wykorzystania w konfliktach zbrojnych. Zastosowanie szeroko rozumianych bezzałogowców w trudnym, górskim terenie może istotnie podwyższyć efektywność zadań realizowanych przez pododdziały i oddziały w tym środowisku walki. W artykule przedstawiono podstawowe informacje dotyczące pojazdów autonomicznych, opisano czynniki mające wpływ na prowadzenie działań wojskowych w górach, a także na podstawie doświadczeń wynikających ze współczesnych konfliktów zbrojnych dokonano syntetycznej analizy możliwości zastosowania bezzałogowych środków walki w działaniach wojskowych w terenie

górzystym. Zasadniczym celem artykułu jest przedstawienie potencjalnych zadań, które mogą być wykonywane przez bezzałogowce, aby osiągać zakładane rezultaty podczas walki w górach przy jednoczesnej minimalizacji strat w ludziach.

SŁOWA KLUCZOWE piechota górska, walka w górach, bezzałogowe środki walki, drony

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