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THE EFFECTIVENESS OF USING BORDER GUARD CYNOLOGY UNITS IN AREAS WITH COMPLEX RELIEF AND DIFFICULT TERRAIN

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Abstract:
This article scientifically and tactically analyzes the role and effectiveness of border guard cynology units in ensuring the inviolability of state borders in geographically complex, remote, and impassable areas. It is substantiated that no matter how advanced modern technologies and unmanned aerial vehicles become, the biological capabilities of humans and service dogs (sense of smell, ability to move at night, skill in finding hidden traces) cannot be fully replaced. Furthermore, the tactical capabilities of the cynology service in organizing tracking activities in mountainous, desert, and forested border sectors, as well as combating cross-border smuggling and illegal crossings, are highlighted, and practical recommendations for their improvement are developed.

Keywords: border security, cynology units, service dogs, remote areas, tracking, cross-border crime, tactical capabilities.

Introduction

In the 21st century, the system of state border protection is undergoing radical changes, being rapidly enriched with technical means, artificial intelligence, and autonomous platforms. However, in remote areas with geographically complex relief – such as high mountain gorges, deep canyons, dense forest masses, swamps, and extremely hot desert zones – modern technologies also face their

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natural limitations. For example, detecting rule-breakers hidden within dense forests and caves or individuals moving at night using only technical means does not always yield full results.

The role of the cynology service in ensuring border security is incomparable. According to Article 63 of the Law of the Republic of Uzbekistan "On the State Border," service animals are one of the types of special means used to reinforce border details, search for and detain offenders, and detect contraband items [1]. However, the effectiveness of these tasks largely depends on the conditions under which service dogs operate.

Areas with complex relief – mountains, rocks, dense forests, deserts, and steppes – are among the most difficult segments of border protection. In such places, technical means (cameras, sensors) have limited effectiveness because the relief blocks surveillance, and sunlight and temperature regimes affect the operation of devices. It is precisely in these conditions that **cynology** units – the pair of a cynologist and a service dog – turn into a unique and irreplaceable tool.

International experience shows that special training is required for cynology units to operate effectively in complex conditions. In June 2026, a **cynology** course organized by the OSCE in a remote mountainous area of North Macedonia was attended by 40 units from the Ukrainian border service and other states. The course program included modules such as night search, crossing water obstacles, and movement in mountainous relief, allowing participants to learn "moving in dangerous mountain relief in complete darkness and severe weather conditions" [2]. This experience is also directly relevant to the border troops of Uzbekistan. In such conditions, cynology units tested for centuries, yet enriched with the achievements of modern science and selection, emerge as an integral and decisive link in border security. The keen sense of smell and extraordinary endurance of service dogs are considered an unparalleled tool in exposing state border violators in difficult-to-pass areas [3].

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Another important advantage of cynology units is their psychological impact. If individuals attempting to illegally cross the border are aware of the presence of service dogs, their behavior changes: they become more cautious, try to hide, or abandon their intentions altogether. This factor is especially amplified at night under conditions of limited visibility. The primary advantage of service dogs is their sense of smell. Dogs can detect the components of human odor (sweat, skin cells, fats, clothing odors) even at very low concentrations. International research shows that dogs can detect odor particles at concentrations as low as one part per trillion, allowing them to track a scent hours or even days later.

In areas with complex relief, this ability is of decisive importance. In mountainous places, tracks are virtually invisible on stony ground, but odor particles linger on plants, rocks, and soil particles. In dense forests, tracks invisible to the human eye serve as an open "book" for dogs. As emphasized in the OSCE course, cynology units are "effective in detecting complex hiding places that remain hidden from traditional technologies."

Service dogs can adapt to various forms of relief: they are capable of moving on stony slopes, snowy paths, crossing water obstacles, and among dense bushes. This feature is particularly important because a large portion of border regions features precisely such complex relief. As noted in the experience of the Polish Territorial Defense Forces, the "K9 component" (cynology units) was included among "solutions adapted for hard-to-reach areas," increasing the effectiveness of border control alongside mounted patrols [4].

The Uniqueness of the Cynology Service in Areas with Complex Relief and Difficult Terrain. Organizing protection and search measures in parts of border lines that are remote, lack sufficient artificial and natural infrastructure, and have limited vehicle movement has fundamental complexities, and the role of cynology units in overcoming them is invaluable:

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Line-of-Sight limitations of technical means and relief barriers: Stationary radar stations, opto-electronic surveillance complexes, and video surveillance cameras used in modern border security rely on a straight-line viewing sector (Line-of-Sight) due to their technical capabilities. However, deep gorges in high mountainous areas, canyons, rocky barriers, huge barchans in desert zones, or natural shadows and "blind spots" caused by dense forest masses sharply reduce the effectiveness of technologies. In such complex topographical conditions, the movement of highly qualified cynological groups becomes the only effective solution to directly inspect areas behind obstacles that technical devices cannot detect, open hidden crossing paths, and fully monitor objects.

The impact of extreme weather and climatic conditions: Sharp changes in weather conditions in remote border parts (severe winter frosts, thick mountain fogs, strong dust storms, or snowdrifts) seriously limit the work of optical and infrared systems and can even temporarily disable their lenses. On the other hand, the sharp olfactory receptors and biological sensory organs of service dogs that have undergone special selection and long-term training continue to successfully perform their functions in such harsh climatic environments. The fact that dogs' ability to perceive odor is preserved even under conditions of atmospheric pressure, humidity, or temperature fluctuations allows them to carry out search operations without interruption in any weather [5].

The human factor, biological traces, and the art of tracking: Transnational criminal groups and smugglers usually act with extreme caution, trying to bypass technical surveillance devices. However, the micro-traces they inevitably leave in the area where they moved – soil compaction, broken plant stems, clothing fibers, sweat, and unique skin-biological odors – are the primary source of tracking. Such subtle biological traces that modern optical devices do not sense can be detected by specially trained tracking dogs (Bloodhounds and other search

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breeds) from hundreds of meters away. This ensures the ability to determine the movement trajectory of violators in a short time and pursue and apprehend them on a hot trail.

Main Tactical Directions for Using Service Dogs. The application of service dogs in border guard practice is a multi-faceted and highly specialized process, and they demonstrate their incomparable effectiveness in practice within the state border protection and defense system. In areas with complex and hard-to-reach relief, service dogs are successfully used in the following main tactical directions:

Tracking and Search: The role of tracking dogs is decisive in picking up the trail of individuals who have illegally crossed the state border, determined their movement trajectory, and exposed hiding places. Although tracks left by violators in mountainous, earthy, or desert areas are erased by nature over time, specially trained tracking dogs can perfectly distinguish biological traces left several hours earlier. This provides rapid search groups (RSG) with a huge tactical advantage in accurately determining the direction in which violators went and pursuing them on a hot trail to capture them in a short period.

Detecting Contraband and Prohibited Substances: Service dogs trained in special scent detection work with absolute accuracy in exposing attempts by transnational criminal groups to secretly smuggle narcotic drugs, psychotropic substances, explosives, weapons, and ammunition (in special hidden compartments of vehicles, cargo, or attached to the body) at border-customs posts, crossing points, and remote border lanes. The extremely sensitive olfactory analyzers of dogs can detect molecular traces emanating from hermetically sealed containers or masked materials from dozens of meters away or within a few seconds, giving a quick signal to security personnel.

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Patrol-Guard Service: In parts of border posts and sectors with complex relief that technical means cannot fully cover, service dogs perform direct service as part of patrol groups. They provide warning signals to personnel by sensing suspicious individuals approaching stealthily at night or in complex climatic conditions with limited visibility. Also, the presence of service dogs acts as a strong psychological barrier against potential offenders, showing significant preventive effectiveness in preventing illegal actions.

Integration of Modern Technologies with Cynology Units. Currently, the process of radically improving the border security system requires the mutual harmonization of traditional methods with the latest digital technologies. In particular, the integration of the cynology service – which has proven its high effectiveness in practice for centuries – with modern information and communication technologies, IoT (Internet of Things) devices, and unmanned aerial vehicles raises the speed and accuracy of border control to a new stage [6]:

GPS and telemetry leashes (tactical sensors): To ensure the safety of cynological groups performing tasks in remote and difficult-to-communicate border areas and to manage them effectively, service dogs are equipped with special telemetry leashes and satellite GPS trackers. Through these systems, the central command post monitors the service dog's exact geographical location, movement trajectory, and physiological state (body temperature, respiration rate, and physical fatigue level) remotely in real-time. In emergency situations or when communication with the cynological group is lost, this telemetry data makes it possible to precisely direct rescue or aid groups to that exact point.

Synergy of Unmanned Aerial Vehicles (UAVs) and Cynological Groups: The seamless cooperation of air and ground forces is of decisive importance in modern border operations. Areas of suspicious movement or thermal traces

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detected from airspace via patrol drones equipped with thermal cameras and high-precision optical modules are immediately transmitted to the unified control center. The central staff directs the cynological group moving closest to the search area based on precise coordinates. The drone controls the overall situation from the air, tracking the violator's direction of movement, while directly leading the tracking dog and cynologist on the ground to the target. This shortens the time of search and apprehension operations several times over.

Synthesis of Digital Mapping and Databases: Operational information and trace results collected by cynological groups are digitally entered into GIS (Geographic Information Systems) platforms. This allows for the formation of an "odor and trace map" of border areas, predicting the usual movement directions of transnational violators in advance, and scientifically planning future cynological patrol routes.

Ensuring the inviolability of state borders in remote border parts with complex relief, rich in natural barriers, and lacking developed transport infrastructure requires the mutual harmonization of modern military-tactical approaches. No matter how advanced technological means, artificial intelligence, and autonomous patrol drones are used, in certain topographical conditions, no technology can fully replace the unique biological capabilities of humans and service dogs – keen olfactory receptors, the ability to move at night and under conditions of limited visibility, and the skill to find hidden traces.

The use of modern technologies is important in increasing the effectiveness of cynology units. As noted in the Polish experience, drones, mobile lighting towers, and the K9 component were used together to “improve border control and increase the operational capabilities of the state.” In particular, drones can detect body temperature even through dense vegetation using thermal cameras, which allows cynology units to narrow down the search area [5].

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However, technology does not replace the cynologist – it is only an auxiliary tool. Drones determine location, but tracking the trail, distinguishing the odor, and setting the exact direction are exclusively the ability of the service dog.

The cynology service operates within the Border Troops of the State Security Service of the Republic of Uzbekistan. During the "Service Dogs-2022" exhibition, the Border Troops of the SSS also participated with their service dogs. Border troops cynologists use service dogs to reinforce border details, search for and apprehend offenders, and detect contraband items.

An important aspect is that the National Cynology Center of the Customs Committee of Uzbekistan carries out the training, retraining, and advanced training of cynologists, as well as the selection, breeding, and training of service dogs on a contractual basis not only for customs bodies, but also for the Ministry of Defense, National Guard, Ministry of Emergency Situations, and the SSS Border Troops. This inter-agency cooperation allows for saving resources and exchanging experience.

In October 2026, a regional training course conducted by the OSCE in Tashkent brought together 15 border security and customs personnel from Uzbekistan, Kazakhstan, Kyrgyzstan, Tajikistan, and Turkmenistan. The course took place at the National Cynology Center of the Customs Committee of Uzbekistan.

An important aspect of the course program was paying special attention to "conducting search operations in complex environments," including vehicle inspection and identifying individuals from a crowd. This shows that the international community recognizes the role of cynology units in complex conditions and emphasizes the need for systematic training in this direction.

During the course, attention was also paid to maintaining the health of service dogs, identifying signs of stress, and ensuring their constant readiness for operational tasks [7]. This aspect is especially important because working in complex relief conditions causes high physical and psychological stress for both dogs and cynologists.

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Training Service Dogs for Complex Relief Conditions. Special programs are necessary to train service dogs for complex relief conditions. The experience of the OSCE course shows that such programs must include the following elements:

Movement and trace searching in mountainous relief: Developing skills to work on sloping ground, rocky surfaces, and in snowy conditions. For dogs, this requires physical endurance, while for cynologists, knowledge of navigation and safety rules is necessary.

Working at night: In the OSCE course, "night search" was singled out as a separate module [8]. At night, the dog's sense of smell is preserved, but it becomes difficult for the cynologist to observe the dog's behavior. This requires special training.

Crossing water obstacles: Rivers and other water obstacles are widespread in border areas. Training dogs to work in water and cynologists knowing water safety rules are necessary.

Extreme weather conditions: Hot climates (southern regions of Uzbekistan), cold and snowy conditions (mountainous regions)—both affect the working capacity of dogs. Adapted training reduces this impact.

The synergy of the traditional cynology service with modern digital systems (UAVs, GIS platforms, telemetry, and thermal visualization) forms the most reliable, multi-layered, and resilient defense system for border security. This approach not only sharply increases the effectiveness of preventing violations, but also ensures the safety of personnel and optimizes material resources.

In the conditions of Uzbekistan, the function of the National Cynology Center to train personnel for various agencies is an important advantage. A single methodological base and training standards for border troops, customs, the

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National Guard, and other structures increase effectiveness. Working in complex relief conditions also requires high physical fitness from the cynologist. As noted in the experience of the National Cynology Center of Uzbekistan, "cynologist-inspectors must be mentally resilient, able to subjugate a service dog with their physical strength and moral-psychological qualities, and resilient to various armed clashes" [6]. This requirement is especially relevant in border conditions. The OSCE course also focused on issues of "fatigue management in the team" and "decision-making under stress" [8]. This shows that the cynologist's training is as important as the dog's training. International cooperation is also important. OSCE courses, bilateral exchanges, and joint exercises allow for exchanging experience, learning new methods, and harmonizing regional standards.

Practical Recommendations. To further elevate the scientific-practical potential in this direction and increase the combat readiness of cynology units, it is important to implement the following practical recommendations:

Breeding and propagating service dog breeds adapted to extreme climates and mountain conditions: Based on the geographical features of Uzbekistan (sharp continental climate, scorching hot deserts, and high mountain regions), developing special breeding bases for scientific selection and improving the gene pool of service dog breeds that are physically and physiologically resilient and capable of adapting to heat and cold.

Equipping cynologist specialists with modern tactical techniques: Increasing the operational manageability of cynological groups performing tasks in remote and hard-to-reach areas by fully equipping them with personal navigation equipment (GPS/GLONASS), secure digital communication tools, night vision devices, portable thermal surveillance devices, and telemetry leashes transmitting data in real-time.

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Broadly introducing digital technologies and advanced international experiences into the training and practice process: Implementing modern simulators and artificial odor dispersion models into the training and preparation process of service dogs, as well as studying the experience of advanced cynology centers within the framework of international military cooperation and integrating modern tracking methods into educational programs.

Furthermore, future research and practical measures are advisable to be carried out in the following directions:

(1) developing and testing training programs adapted to relief;

(2) determining optimal methods for integrating drones and other technologies with cynology units;

(3) improving criteria for evaluating the physical and psychological preparedness of cynologists;

(4) expanding joint training exercises within the framework of regional cooperation.

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