Review

Evaluation of the Effectiveness of Search and Rescue Dogs in Finding Survivors During Disasters: The Case of Serbia, Croatia, and Slovenia

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Review

Evaluation of the Effectiveness of Search and Rescue Dogs in Finding Survivors During Disasters: The Case of Serbia, Croatia, and Slovenia

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Abstract: Disasters, whether natural or human-induced, pose significant threats to human lives, property, and infrastructure. This study examines the effectiveness of search and rescue (SAR) dogs in locating survivors during disasters, with a focus on the experiences in Serbia, Croatia, and Slovenia. The primary goals are to evaluate training protocols, operational challenges, success rates, and the overall impact of SAR dogs in disaster scenarios. The findings indicate that SAR dogs greatly enhance the efficiency of disaster response operations. Their superior sense of smell, agility, and ability to manoeuvre through complex terrains make them crucial for quickly locating survivors. However, the performance of SAR dogs is affected by various factors, including the quality of their training, environmental conditions, and the coordination between handlers and dogs. The research highlights several challenges encountered by SAR dogs, such as extreme weather conditions, hazardous terrains, fatigue, and psychological stress. Additionally, limited resources and inconsistent training standards can hinder their effectiveness. The study underscores the importance of standardized training protocols, increased resource allocation, and better coordination among SAR teams. By addressing these challenges, the efficiency of SAR dogs can be further optimized, resulting in more effective disaster responses and higher survival rates. SAR dogs play an essential role in disaster management in Serbia, Croatia, and Slovenia. Ongoing investment in their training and welfare, along with improved operational protocols, will ensure their crucial contribution to saving lives during disasters. This study contributes to a broader understanding of the effectiveness of SAR dogs and provides practical recommendations for enhancing disaster response strategies.

Keywords: rescue dogs; natural disasters; disaster response; survivor search and rescue; Serbia; Croatia; Slovenia; effectiveness; training standards; deployment protocols

1. Introduction

Disasters, whether natural or human-induced, pose severe threats to human lives, property, and infrastructure (Cvetković, 2023a; Cvetković, Nikolić, & Lukić, 2024; Cvetković, Tanasić, et al., 2023; Cvetković & Šišović, 2023, 2024; Nikolić, Cvetković, & Ivanov, 2023). Also, disasters present profound threats to human lives, property, and the environment, causing widespread loss and disruption in communities across the globe (Cvetković, Čvorović, & Beriša, 2023; Cvetković et al., 2022; Cvetković, Nikolić, & Ivanov, 2023; Cvetković & Planić, 2022; Cvetković, Romanić, & Beriša, 2023; Cvetković et al., 2021; Phillips, 2014). These catastrophic events can be natural, like earthquakes, floods, hurricanes, and volcanic eruptions, or human-made, such as industrial accidents, terrorist attacks, and armed conflicts. Regardless of their origin, disasters often strike without warning, creating chaos and an immediate need for a rapid and effective response (Hasan & Sultana, 2024; Molnár, 2024; Starosta, 2023; Sudar, Cvetković, & Ivanov, 2024).

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The initial hours and days after a disaster are critical for rescuing survivors and delivering emergency aid to the injured (Islam, 2023; Marceta & Jurišic, 2024; Ulal & Karmakar, 2023). In these circumstances, search and rescue teams are indispensable, utilizing various methods and technologies to find and free individuals trapped in debris or stranded by floods and other disasters. Prompt and efficient actions can be the difference between life and death for many victims (Cvetković, 2023b; El-Mougher, Abu Sharekh, Abu Ali, & Zuhud, 2023; Phillips, 2014; Sergey & Gennadiy, 2022; Shibru, Operea, Omondi, & Gichaba, 2022).

Nevertheless, conducting search and rescue operations is fraught with numerous challenges, including adverse weather, inaccessible terrain, limited resources, and logistical hurdles. Despite these obstacles, the international community is continually striving to improve disaster response capabilities through training, the advancement of new technologies, and enhanced cooperation among nations and organizations. Consequently, studying the effectiveness of different search and rescue methods and tools, including the deployment of specially trained dogs, is crucial for advancing disaster response and boosting the survival rates of those affected. By understanding and overcoming the challenges in these operations, we can help build more resilient communities equipped to handle future disasters more effectively (Ice, Dufour, & Stevens, 2015).

In such critical times, effective rescue operations become essential to minimize casualties and mitigate the impact of these events (Cvetković & Jovanović, 2021). Search and rescue (SAR) dogs play a crucial role in these operations, thanks to their extraordinary detection and search capabilities. Their exceptional sense of smell, agility, and speed enable them to locate survivors trapped under debris or in inaccessible areas where human rescuers might struggle to reach (Grandjean, 2007). In disaster response scenarios, the swift identification and rescue of survivors is crucial. Among the various methods employed, search and rescue (SAR) dogs are particularly notable for their exceptional ability to detect human scent, navigate through difficult terrains, and perform under conditions that might impede human rescuers. These canine heroes are indispensable assets in disaster situations, greatly improving the efficiency and success rates of rescue missions (Fischer et al., 2020).

SAR dogs represent a highly specialized and invaluable group of working dogs trained for diverse search and rescue missions. Their training equips them to locate survivors under rubble, in wilderness areas, or other challenging environments, making them indispensable during disasters. These dogs are distinguished not only by their rigorous training but also by their innate abilities, including a keen sense of smell, agility, and endurance. Historically, SAR dogs have demonstrated their worth as loyal and brave assistants, often risking their lives to save humans (Gerbec, 2010). The global effectiveness of SAR dogs in disaster response is well-documented, with numerous case studies highlighting their significant contributions. This research centres on the effectiveness of SAR dogs in Serbia, Croatia, and Slovenia—countries that have faced a variety of natural and human-made disasters over the years. The distinct geographical and socio-political landscapes of these regions provide a rich context for examining how SAR dogs are integrated into their disaster management systems (Kovačević & Petrović, 2018).

The training and preparation of SAR dogs are vital to their effectiveness. These dogs undergo rigorous training from a young age to refine their natural abilities and acquire new skills tailored for search and rescue missions. Their training includes exposure to diverse environments, scents, and simulated disaster scenarios, ensuring they are well-prepared for actual operations. Psychological resilience is also a key focus, as SAR dogs must remain calm and focused amidst the chaos of disaster scenes (Moehlmann & Otto, 2017). Training SAR dogs begins at an early age, with basic commands and behaviours. As they mature, their training becomes more specialized and challenging, incorporating simulations of real-life disaster scenarios.

Trained SAR dogs can identify human scents under layers of concrete, earth, and other materials, making them essential members of rescue teams (Otto et al., 2019). Additionally, the psychological readiness of SAR dogs is crucial. They must remain calm and focused in chaotic and stressful situations, achieved through continuous training and positive reinforcement methods. This readiness is also ensured by rigorous selection processes, focusing on both genetics and early behavioural traits (Otto et al., 2019).

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However, the successful deployment of SAR dogs depends not only on the dogs but also on their handlers. The relationship between a SAR dog and its handler is symbiotic, requiring coordination, communication, and trust for effective operations. This study examines these dynamics, underscoring the necessity of comprehensive training programs that encompass both technical skills and the handler-dog relationship (Bryson et al., 2019). Despite their heroic contributions, SAR dogs and their handlers face numerous challenges. Field conditions can be extremely harsh, including working in earthquake rubble, flooded areas, or mountainous regions with avalanches. These dogs are exposed to physical injuries, stress, and exhaustion, necessitating meticulous care and support from their handlers and veterinary teams (Jones et al., 2004).

In Serbia, Croatia, and Slovenia, the operational environment presents unique challenges and opportunities for SAR teams. These countries have developed specific protocols and standards for using SAR dogs, shaped by their respective legal and organizational frameworks. By analyzing these protocols and the experiences of SAR teams in recent disasters, this study aims to provide insights into best practices and areas for improvement (Mlađan & Cvetković, 2020). Recent disaster case studies in these countries offer valuable lessons on the deployment and effectiveness of SAR dogs. The responses to the 2014 Balkans floods and the 2020 Zagreb earthquake, for instance, highlighted both the successes and the challenges faced by SAR teams. These events emphasized the importance of continuous training, sufficient resources, and international cooperation in enhancing the capabilities of SAR dogs (Mijalković & Cvetković, 2013).

This study provides a comprehensive theoretical and conceptual framework for understanding the role and significance of SAR dogs, international standards, and the legal frameworks governing their use. It also examines the organization of rescue services with dogs in Serbia, Slovenia, and Croatia. The research focuses on the conditions under which SAR dogs operate during disasters, the obstacles they encounter, and the cultural differences in the perception and treatment of dogs within rescue operations. A detailed case study is presented on the use of SAR dogs following the earthquake in Turkey, highlighting the rescue operations involving SAR teams from Serbia, Slovenia, and Croatia. This case study provides specific examples of the challenges faced by these dogs and their handlers and evaluates the effectiveness of their deployment in life-saving efforts post-disaster. The findings underscore the significant role SAR dogs play in disaster scenarios.

2. Background and Significance of Search and Rescue Dogs in Disaster Response

Rescue dogs, also known as search and rescue (SAR) dogs, are specially trained canines whose main function is to assist in locating missing or trapped individuals during disasters. Their exceptional sense of smell, agility, and rigorous training render them invaluable in situations where human capabilities are limited. SAR dogs are trained not only to find survivors but also to perform specialized tasks tailored to the nature of the emergency. Fischer et al. (2020) emphasize that SAR dogs significantly enhance the efficiency of rescue missions worldwide due to their unique abilities and comprehensive training. According to Milojević (2023), a rescue dog can be of noble (pedigree) or mixed breed origin. These dogs are registered as vital assets by state or private legal entities, and trained for specific tasks within these entities' operational scope. Generally referred to as "service dogs," they are integral to various rescue missions (Milojević, 2023). Milojević's definition further explains that rescue dogs can also be privately owned, provided they are specially trained under clearly defined legal frameworks and within specific time intervals. When privately owned rescue dogs are deployed, both the owner and the trainer authorized by the owner must be involved (Milojević, 2023).

In literature, rescue dogs are mainly categorized based on their purpose into three primary groups (Milojević, 2023): a) dogs that search by following a known or unknown track; b) dogs that search above or below the ground surface; c) dogs that perform searches on the water surface.

Additionally, there are sledge dogs and draft dogs used for transportation in snow or difficult terrains. These dogs can transport injured individuals, essential search and rescue equipment, medical supplies, and even deceased bodies, ensuring a dignified burial. Consequently, they are also considered a type of rescue dog (Milojević, 2023). These three primary categories of SAR dogs are

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defined based on their training methods for locating individuals. Tracking dogs can work on a leash or off-leash, keeping their noses close to the ground, following the exact trail left by the missing person. They primarily respond to specific ground scents, detecting items like clothing or places where the person stayed (Jones et al., 2004).

Air-scenting dogs, on the other hand, can work effectively in areas shared with other rescue teams. Operating typically off-leash, these dogs can cover large areas quickly and are trained to detect the scent of living people, deceased individuals, or body parts. Air-scenting dogs do not require a scent item from the missing person, making them more flexible than tracking dogs (Jones et al., 2004). Once these dogs identify a human scent, they follow it to its source, quickly recognizing when they lose the scent and changing direction until they return to the point of highest scent concentration. The handler usually searches the area in a grid pattern against the wind. Besides search and rescue missions, air-scenting techniques are also used by police dogs to locate explosives, drugs, or crime scene evidence (Jones et al., 2004).

Water search dogs conduct searches while riding in boats, from the shore, or while swimming. On boats, the dog and handler typically position themselves at the bow. Upon detecting a victim's scent, the dog signals the handler by lowering its nose into the water or displaying anxious behaviour such as scratching the boat, biting the water, whining, barking, or jumping into the water to get closer to the scent source. If the boat moves away from the scent, the dog will shift from one side of the boat to the other, trying to "catch" the scent. If no scent is detected during the boat ride, the dog remains calm (Hardy, 1992).

Rescue dogs have a rich history, dating back to the 17th century when monks in Switzerland used Saint Bernard dogs to locate travellers lost in snowstorms. Known for their strong build and keen sense of smell, these dogs were the precursors to modern SAR dogs. Over time, the role of rescue dogs has evolved significantly, encompassing various breeds and specialized training techniques tailored to different disaster scenarios (Mantrailing, 2022). Modern SAR dogs undergo extensive training from a young age, starting with basic obedience and progressing to advanced search techniques. Otto et al. (2019) note that SAR training includes exposure to a wide range of environments, scents, and simulated disaster scenarios to ensure they are well-prepared for actual operations. This rigorous training helps dogs develop the necessary skills and psychological resilience to remain calm and focused amidst the chaos of disaster scenes.

The success of SAR operations relies heavily on the symbiotic relationship between the dog and its handler. Effective communication, coordination, and trust are essential for successful operations. Bryson et al. (2019) stress the importance of comprehensive training programs that cover both technical skills and the handler-dog relationship, highlighting the necessity of a cohesive partnership for optimal performance in rescue missions. Despite their heroic contributions, SAR dogs and their handlers face numerous challenges. Harsh field conditions, such as earthquake rubble, flooded areas, or mountainous regions with avalanches, can expose these dogs to physical injuries, stress, and exhaustion. Therefore, meticulous care and support from handlers and veterinary teams are crucial to maintaining the dogs' well-being and effectiveness (Jones et al., 2004).

In Serbia, Croatia, and Slovenia, SAR teams operate under specific protocols and standards shaped by their respective legal and organizational frameworks. Analyzing these protocols and the experiences of SAR teams in recent disasters provides valuable insights into best practices and areas for improvement. Case studies, such as the responses to the 2014 Balkans floods and the 2020 Zagreb earthquake, highlight both the successes and challenges faced by SAR teams, underscoring the importance of continuous training, sufficient resources, and international cooperation to enhance the capabilities of SAR dogs.

3. Historical Overview of the Use of Search and Rescue Dogs

For millennia, dogs have been indispensable partners to humans, assisting in various tasks. In the 17th century, monks at the Hospice of the Great St. Bernard in Switzerland bred a specific dog breed, now known as the St. Bernard, to locate human tracks buried under snow. Numerous accounts document these dogs guiding lost individuals through the snow to the safety of the monastery

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(Mantrailing, 2022). One of the most renowned St. Bernards, Barry, served at the hospice from 1800 to 1812 and is credited with saving forty lives. In 1812, Barry was moved to a monastery in Bern, Switzerland's capital, where he died in 1814. His preserved body is currently on display at the Natural History Museum in Bern (Gerritsen & Haak, 2014).

The Industrial Revolution brought significant societal changes, leading to new roles for dogs. Military campaigns further advanced dog training. Around 1885, the German (Prussian) army began utilizing dogs as pack animals for transporting ammunition and supplies and as guards for military installations. Jean Bungartz, a German animal painter, writer, and book illustrator, developed training programs for dogs to locate wounded soldiers. In 1890, he founded the "Deutschen Verein für Sanitätshunde" (German Association for Medical Dogs), training dogs for war voluntarily, with the army covering the costs while private individuals conducted the training (Mantrailing, 2022).

In 1903, Bern's chief of staff, Berdez, published "Anleitung zur Dressur und Verwendung des Sanitätshundes" ("How to Train and Use Medical Dogs"), with illustrations by Bungartz (Mantrailing, 2022). Despite these advancements, early 20th-century economic hardships and limited understanding of dogs' potential hindered widespread support. By 1911, the war ministry had abandoned the use of dogs. However, World War I saw a resurgence in the use of medical dogs. Initially, only a few were employed, but as the war continued, their numbers increased to over 4,000. These dogs were privately owned or recruited from breeders. During World War I, over 30,000 dogs were used, with only 10% returning to their owners (Mantrailing, 2022). Training techniques evolved, and interest in preserving medical dogs persisted. Public perception of dogs in Germany improved, with civilians primarily supporting their popularity, though training remained under military jurisdiction (Mantrailing, 2022).

Heroic stories of dogs during World War I and II represent some of the earliest organized search and rescue teams involving dogs. Military, ambulance, and Red Cross dogs were used on battlefields to locate the wounded and deliver first aid (Jones et al., 2004). In 1940, Ferdinand Schmütz began systematically training dogs for avalanche search and rescue. During World War II, the use of dogs increased significantly, with over 200,000 dogs in service across all fronts, 25,000 of whom died on the German front. The demand for military dogs was so high that pets were requisitioned for service (Mantrailing, 2022). Two types of dogs were in use at the time: those using air scent to locate wounded soldiers and avalanche dogs. In the final years of World War II, rubble search dogs were also trained. The development of these dogs began when dogs repeatedly found people under the rubble of bombed houses by chance. With the help of just four dogs, over 35 people were found alive (Mantrailing, 2022).

After World War II, the concept of rubble search dogs spread from England, and efforts were made to properly train these dogs. In Switzerland, work with disaster dog teams began in 1968. In 1972, the "Schweizerische Verein für Katastrophenhunde" (Swiss Association for Disaster Dogs) published a training guide. Public awareness of the importance of these dogs grew, especially after earthquakes in Italy in 1967, Romania in 1977, and Algeria in 1980, significantly increasing their use and trust (Mantrailing, 2022). However, in Germany, scepticism towards dogs led to more investments in technology. Civilians again took responsibility for training search and rescue dogs (Mantrailing, 2022). Disaster protection responsibilities were assigned to individual states, with search and rescue teams assisting, including fire departments and privately formed teams. The "Bundesverband für das Rettungshundewesen e.V." (Federal Association for Rescue Dogs) now acts as a regulatory body (Mantrailing, 2022).

In the former Yugoslavia, the first avalanche rescue seminar was organized in 1952 by the police, mountain rescue service, and alpine enthusiasts in the village of Tamarje, Slovenia. Similar efforts followed for rubble search dogs, with the first seminar in 1977 during the construction of a highway near Vrhnika, organized by the Slovenian Kennel Club, police, and mountain enthusiasts (Vasiljević, 2023). In the 1980s, Serbia made pioneering attempts at working with avalanche dogs. Ilija Latinović, a physical education professor from Kikinda, initiated these efforts on Šar Mountain. Sixteen years later, Serbia had its first rubble and avalanche rescue dog. In 2009, the Ministry of Defense created an internal program, and in 2010, the Ministry of Interior, in collaboration with France, established a

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rescue dog department, training ten dogs. The Rescue Dog Training Association in Niš started its program in 2013, and in 2019, the Water Rescue Association prepared its first water rescue dog. By 2023, the Mountain Rescue Service had its first five certified dogs (Vasiljević, 2023).

4. Comparative Analysis of Search and Rescue Dog Operations in Natural Disasters: Case Studies from Serbia, Croatia, and Slovenia

4.1. Organization and Deployment of Search and Rescue Dogs in Serbia

National teams for the training and utilization of rescue dogs in Serbia operate under the auspices of the Ministry of Defense and the Ministry of Internal Affairs. Civilian associations such as the Rescue Dog Training Association in Niš, the Water Rescue Association, the Mountain Rescue Service, the Club for Training Sporting and Service Dogs in Belgrade, and various individuals also play crucial roles in this field. The Dog Training Center, a division of the Ministry of Defense, offers specialized training for veterinary services and advanced courses for experts, covering training, retraining, breeding, and healthcare for defence system dogs. Located at the "Prince Mihailo" barracks in Niš, the centre comprises command, logistics, a training company, and a breeding and reproduction unit. Its primary responsibilities include training and professional development for veterinary staff, soldiers, non-commissioned officers, civilians, and international trainees, along with organizing veterinary service courses. The centre also extends its services to entities outside the Serbian Armed Forces and the Ministry of Defense (see further and more at https://www.vs.rs/sr_cyr/jedinice/vojska-srbije/komanda-za-obuku/centar-za-obuku-pasa).

The Center conducts various specialized professional courses, including:

a) Training handlers and guard service dogs: Focuses on the fundamental tasks of guarding and securing facilities or territories.
b) Retraining guard service dogs and their handlers: Emphasizes retraining dogs to respond appropriately in specific situations, such as aggressive behaviour towards intruders.
c) Training handlers and protective service dogs: Prepares dogs and handlers for protection and security tasks.
d) Retraining protective service dogs and their handlers: Specializes in retraining dogs for high-risk scenarios.
e) Training handlers and dogs for special actions: Prepares dogs and handlers for specialized tasks such as locating missing persons or detecting hazardous substances.
f) Training handlers and dogs for rubble and avalanche searches: Essential for rescue missions in debris or snow avalanche scenarios.
g) Tracking service dogs and their handlers: Trains dogs and handlers for tracking and locating specific targets.
h) Retraining tracking service dogs and their handlers: Focuses on refining the responses of tracking dogs in unpredictable or risky situations.
i) Training handlers and dogs for mine and explosive detection: Critical for identifying and marking mines or explosive materials.
j) Retraining dogs for mine and explosive detection: Specializes in dogs' reactions when encountering dangerous materials.
k) Training handlers and dogs for detecting psychoactive substances: Vital for the detection of drugs or other psychoactive substances.
l) Retraining dogs for detecting psychoactive substances: Focuses on refining dogs' quick and precise reactions in specific contexts.

These courses comprehensively cover the essential aspects of training dogs for specialized rescue and search missions, equipping them for various scenarios to protect and save lives or detect hazardous materials. The Dog Training Center was established in September 2020 from the Dog Handlers Training Company and the Breeding and Training Company of the Logistics Training Center, continuing the tradition of the 40th Center for Training Dog Handlers and Dogs of the SFRY Ministry of Defense, founded on October 21, 1957 (https://www.vs.rs/sr_cyr/jedinice/vojska-srbije).

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The Ministry of Internal Affairs houses the Sector for Emergency Situations, which includes the Administration for Fire and Rescue Units and Civil Protection. This Administration ensures timely and lawful oversight of fire and rescue units, including those of legal entities and volunteer fire brigades. It also coordinates their efforts during major emergencies, directly impacting regional units' effectiveness in improving fire and rescue operations. Key tasks include organizing and coordinating fire and rescue units, equipping them with necessary materials and technology, enhancing emergency response readiness, managing activities during significant emergencies, drafting laws and regulations, supervising volunteer fire societies, and educating, equipping, and training civil protection units, alongside destroying explosive remnants of war (http://prezentacije.mup.gov.rs/).

Fire and Rescue Units (FRU) are the first to respond to emergencies, aiming to save lives and protect health, property, and the environment. They collaborate with other relevant entities to mitigate emergency consequences. Emergency Management Administrations in Belgrade, Niš, Novi Sad, and Kragujevac feature fire and rescue brigades, while Departments for Emergency Situations have fire and rescue battalions. Since 2017, efforts have been ongoing to select, train, equip, and recruit new members. Specialized teams for water rescue and rubble rescue operate within the FRU, and firefighters receive special training for technical interventions in traffic and hazardous material incidents. FRUs work with other Ministry of Internal Affairs units (Helicopter Unit, Gendarmerie, Special Anti-Terrorist Unit), other ministries, the Serbian Armed Forces, and services during joint emergency actions. They also provide international assistance during natural disasters and other accidents outside Serbia, adhering to international agreements (http://prezentacije.mup.gov.rs/).

Within the Administration, the Specialist Team for Rubble Rescue and the Center for Dog Handler Training, equipped with trained rescue dogs, play pivotal roles. They are responsible for managing dog handlers, maintaining the health and training of service dogs, and conducting daily training for various tasks. Handlers are stationed in Novi Sad, Belgrade, Kragujevac, Niš, and Valjevo, with some training taking place in Moldova and Turkey. These teams also collaborate effectively with the Slovenian Civil Protection and their instructor (Vasiljević, 2013).

A notable member of this specialist team is Zigi, a Belgian Shepherd Malinois, who participated with the Serbian team in Turkey, searching for survivors in the rubble following the devastating earthquake in February 2023, saving two lives. Zigi has completed basic obedience and rescue training and has participated in international exercises in Ljubljana in 2017 and 2019, as well as searches for missing persons at the "Technical-Overhaul Institute" in Kragujevac. He has been actively involved in numerous open space searches for missing persons in areas like Zaječar, Niš, and Valjevo. Zigi is under the care of his handler, Mili Radojević, a firefighter-rescuer and member of the Specialist Team for Rubble Rescue (MUP RS, 2023).

The Mountain Rescue Service (MRS) of Serbia conducts searches for missing persons, frequently involving lost hikers. The MRS team studies the terrain, develops strategies, and searches the area, providing medical assistance and ensuring the safe return of the missing. Since early 2014, MRS dog handlers and rescue dogs have been actively participating in rescue missions. MRS dogs undergo training that typically spans around two years, after which the handler and dog must pass an exam to demonstrate their readiness for the most challenging tasks. MRS has several dogs that have completed this training and have participated with their handlers in various rescue missions (https://www.gss.rs/predstavljamo-nove-clanove-gss-a).

In February 2024, a training session for avalanche search and rescue dogs was held on Kopaonik, in collaboration with the Club for Sporting and Service Dogs Belgrade. This session included MRS dogs and other dogs trained in Serbia, now internationally licensed for forest searches, enhancing Serbia's capability with dogs trained and licensed for avalanche rescues (Tanjug, 2024).

The training and utilization of rescue dogs in Serbia are relatively recent and still developing. Significant investment is required in training handlers and dogs and increasing their numbers, particularly by the state. The growing enthusiasm from the civilian sector, with individuals joining organizations, undergoing training, obtaining licenses with their dogs, and participating in various operations, is a positive development. An increase in the number of trained handlers and rescue dogs for various conditions and circumstances is anticipated in the future.

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4.2. Protocols and Training Standards for Search and Rescue Dogs in Croatia

The Croatian Mountain Rescue Service (HGSS) operates as a national, voluntary, professional, humanitarian, and non-partisan organization recognized for its public significance. Its primary goals are to prevent accidents, conduct rescue operations, and provide initial medical assistance in mountainous and other inaccessible terrains, as well as in emergencies requiring specialized knowledge and technical rescue equipment, all aimed at preserving human life, health, and property (Croatian Mountain Rescue Service, 2024). HGSS encompasses mountain rescuers who cover the entire territory of Croatia. The operation of HGSS is governed by the Civil Protection Act and the Croatian Mountain Rescue Service Act, enacted by the Croatian Parliament on June 30, 2006 (Croatian Mountain Rescue Service, 2024).

HGSS collaborates with various governmental bodies, local self-governments, institutions, the Croatian Armed Forces, health and social institutions, the Croatian Mountaineering Association, and other legal and natural persons in fields such as culture, sports, tourism, nature protection, traffic, and the environment. Additionally, it works closely with public institutions and relevant authorities to protect and preserve mountain nature and the environment. HGSS's activities also extend to urban areas and non-mountainous regions, including operations in high-rise buildings, tunnels, pipes, traffic accidents, and at sea, as well as during extreme sports events like paragliding, mountain biking, and rafting. Besides rescue operations and providing first aid in remote areas, HGSS emphasizes education and prevention to avoid accidents, particularly in mountaineering (Croatian Mountain Rescue Service, 2024).

HGSS currently has 68 active search teams with dogs. Thirty-six of these teams are licensed and trained for searches in non-urban areas, while the others are in training. Dogs entering HGSS undergo long-term training and can start the licensing process at eighteen months old, which lasts an entire day. Before licensing, they must pass obedience and socialization exams. HGSS has advanced significantly in standardizing its K9 rescue teams. Internal protocols for accessing, testing, and licensing these teams include numerous rules for their use. Among these protocols is the "Regulation on Licensing HGSS Search Teams," which outlines exercises such as marking, handling and direction, abseiling, path searching, open terrain searching, inaccessible terrain searching, persistence, conditioning, and independence in work. Another important document is the "Regulation for Mantrailing Exams," which involves finding and tracking human trails (Croatian Mountain Rescue Service, 2024).

The establishment of search dog teams in Croatian firefighting began in 2010 when Zoran Laslavić, a member of DVD Opatija, in collaboration with JVP Opatija and the Firefighting Association of Primorje-Gorski Kotar County, started training a Belgian Malinois for search purposes. After the training, Zoran and his dog "Ginger Runningwild - Rain" joined JVP Opatija, marking the beginning of the use of search dogs in firefighting. Following Opatija, other units joined the project, including JVP Zadar, JVP Osijek, DVD Kras Šapjane, JVP Čakovec, DVD Lipovljani, DVD Karlovac, JVP Split, DVD Halubjan, DVD Plamen Višnjan, JVP Dubrovačko Primorje, JVP Mljet, JVP Pula, DVD Čačinci, DVD Slatina, DVD Omiš, and DVD Sunger. Today, around 23 firefighting K-9 teams operate in Croatia, ensuring that the entire country is covered within an hour's reach of the nearest K-9 team (K9 Vatrogasci, n.d.).

Firefighting K-9 teams are licensed for various tasks, including (K9 vatrogasci, n.d.): a) searching for missing persons under rubble; b) searching for missing persons in nature; c) searching for missing persons in avalanches; d) helicopter-assisted activities. In addition to their basic training at the Firefighting K-9 Training Center in Šapjane, these teams participate in specialized training sessions covering various rescue segments, with the most recent being helicopter training (K9 vatrogasci, n.d.).

The Croatian Association for Search Dog Training (HUOPP) was founded on June 14, 2004, though its members began their first rescue efforts in the summer of 1999 at an international summer camp for rescue dogs in Slovenia. In 2005, HUOPP became a member of the International Search Dog Organization (IRO), and from April of the same year, HUOPP members became active participants in specialist civil protection units for rubble rescue (https://www.huopp.hr/o-nama/).

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Search dog handlers must master various skills, and their exams consist of theoretical and practical parts, including (https://www.huopp.hr/o-nama/): a) hazards in rubble; b) hazards in mountains; c) orientation and topography; d) basic techniques of mountaineering and speleology; e) first aid for humans; f) first aid for dogs. In 2009, HUOPP established the Rijeka Search Dog Group, followed by the Zagreb Search Dog Group in 2011. Today, HUOPP has a total of 16 members in Zagreb and Rijeka (https://www.huopp.hr/o-nama/).

4.3. Effectiveness and Challenges in Using Search and Rescue Dogs in Slovenia

The Rescue Dog Unit of Slovenia, known as Enota reševalnih psov Slovenije (ERPS), functions within the Commission for Rescue Dogs under the Slovenian Cynological Association. Comprising 18 units within various cynological societies, ERPS includes organizations such as KD Ljubljana, KD Šmarna Gora, KD Krim, KD Storžič, KD Naklo, KD Žiri, KD Tolmin, KD Nova Gorica, KD Obala, KŠP Prečna-Novo Mesto, K9 Dog Lovers Club, KD Brežice, KD Zagorje, KD RP Celje, KD Zg. Savinjske Doline, KD Kamnik, KD Izvinite, and KD Logatec. These units consist of handlers and dogs trained to rescue victims from rubble, and avalanches, and to search for missing persons in various terrains. Depending on their performance in tests and exams, these handlers and rescue dogs are allocated to Regional Units, the Missing Persons Search Group (SIP), and the National Intervention Unit (MERP), which is qualified for large-scale disaster interventions both domestically and internationally. This unit is also part of the MUSAR (Middle Urban Search and Rescue) team within the Administration of the Republic of Slovenia for Protection and Rescue (URSZR) (Gerbec, 2010).

ERPS organizes numerous events for its members as part of its annual training. At the beginning of each year, seminars for beginners are held, offering both theoretical and practical knowledge crucial for rescue dog handlers. Additionally, the Rescue Dog Commission conducts a five-day winter and summer training annually, focusing on avalanche rescue in winter and rubble and field searches in summer. Further training and education take place at the Police Training Center in Gotenica and the Educational Center for Protection and Rescue in Ig, along with regular joint exercises for all units and international training sessions (Gerbec, 2010).

The Association of Rescue Dog Handlers' Associations and Clubs of Slovenia, or Zveza društev in klubov vodnikov reševalnih psov Slovenije, was established in November 1995 to unite clubs and societies primarily focused on training handlers and dogs for rescue tasks. That same year, the founding associations left the Rescue Dog Unit of Slovenia and the Slovenian Cynological Association. The founding assembly saw the inclusion of the Association of Rescue Dog Handlers of Slovenia, the Rescue Dog Handlers' Club of Kranj, and the Rescue Dog Handlers' Club of Postojna. Later, in 1999, the Cynological Society for Rescue Dogs of Maribor joined, followed by the Burja Koper Rescue Dog Society in 2008 (Gerbec, 2010).

The Association collaborates with various individuals and organizations, such as Civil Protection and the Mountain Rescue Service of Slovenia, municipalities, regions, and the state. Members have participated in numerous domestic and international rescue operations and successfully competed in national and international competitions and trials. Knowledge level tests are conducted by domestic judges, and the exams are aligned with the difficulty of international IPO exams. Organizational, professional, and financial matters are managed by the Board of Directors, comprising representatives of member associations and the president, while the Expert Commission oversees the coordination, workflow, annual training programs, and proficiency testing for handlers and dogs (Gerbec, 2010).

The Association of Rescue Dog Handlers of Slovenia (Društvo vodnikov reševalnih psov Slovenije) is a voluntary, amateur organization founded in 1994, focusing on amateurism and humanitarian activities. The association has over fifty handler-rescue dog pairs trained to search for missing persons in natural settings, buried under rubble, and in avalanches. They have participated in international rescue missions, assisting earthquakes in Egypt, Turkey (twice), and Sumatra in 2009. The association's involvement in the IPO organization, particularly through its vice president Dr. Dušan Nećak, has helped achieve one of its goals of integrating its expertise and high professional training into international rescue activities (Gerbec, 2010).

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The Rescue Dog Handlers' Club of Postojna (Klub vodnikov reševalnih psov Postojna) is a voluntary association that trains handlers and rescue dogs. Covering municipalities such as Bloke, Cerknica, Divača, Hrpelje-Kozina, Ilirska Bistrica, Komen, Loška Dolina, Pivka, Postojna, and Sežana, the club assists around 74,000 residents but also operates beyond their territory if necessary. They cooperate with various organizations needing their assistance, such as firefighters, police, and the Mountain Rescue Service. Due to the specific terrain, they also train their dogs to search in caves, aiding cave rescue teams (Gerbec, 2010).

Founded in 1997, the Cynological Society for Rescue Dogs of Maribor (Kinološko društvo za reševalne pse Maribor) focuses on training rescue dogs. They have trained several handlers and rescue dogs equipped with theoretical knowledge about mountain hazards, rubble, veterinary first aid, first aid for injured persons, radio communication, field orientation, rope techniques, and dog psychology. The society collaborates with the Municipality of Maribor and the Protection and Rescue Service, extending their work to the municipalities of Podravje, Prekmurje, and Koroška. The Cynological Society for Rescue Dogs of Maribor is a co-founder of the Rescue Society Organizations of Slovenia for international aid and was granted humanitarian organization status by the Ministry of Health of the Republic of Slovenia in 2010. The association is also verified by the Organization for the Coordination of Humanitarian Assistance in Case of Natural Disasters at the United Nations (Gerbec, 2010).

The Burja Rescue Dog Society (Društvo za reševalne pse Burja), founded in August 2008, is dedicated to saving human lives. To stay current with rescue dog training developments, they regularly participate in competitions, exercises, and seminars domestically and internationally. Despite being a young association, they have many experienced members involved in Slovenia's protection and rescue system and the international IPO unit. Among their ranks is a world champion from 2008 and a world vice-champion from 2009, the dog Kan, who works closely with Roman Starman, the president of the Burja Rescue Dog Society (Gerbec, 2010).

The Mountain Rescue Service (Gorska reševalna služba) of Slovenia has a history dating back to 1912, with the primary mission of voluntarily assisting people in mountain accidents and difficult-to-access terrains. Operating throughout Slovenia, the Mountain Rescue Service is an association of independent, voluntary, non-profit mountain rescue societies and mountaineering societies with registered rescue activities. They perform humanitarian tasks of public importance: protection, rescue, and assistance in mountain environments and during natural and other disasters when safety, health, and lives are at risk. The Mountain Rescue Service's operations are geographically divided into 17 regions in Slovenia. They conduct rescue, preventive, and other actions and activities according to their rules and regulations. Members join as trainee mountain rescuers and can specialize further upon obtaining their mountain rescuer license, including becoming rescue dog handlers (Gerbec, 2010).

Significant advancements have been made in training rescue dogs within the Mountain Rescue Service of Slovenia. Handlers now purposefully select future rescue dogs from puppyhood, ensuring consistent training from an early age. The handler and dog go through all training phases together, both in winter avalanches and summer missing person courses. After completing their training, they are placed on an alert list following a two-day annual test. Rescue pairs on the alert list participate in all rescue operations in their home Mountain Rescue Service station's area. They also assist other stations when needed, although the team leader on the ground is always from the home station. This is especially common in avalanche rescue operations, which are often prolonged and physically and mentally demanding (Gerbec, 2010).

The organization of rescue dog handlers within the Administration of the Republic of Slovenia for Protection and Rescue (URSZR), an agency under the Ministry of Defense, focuses on developing national protection programs against natural and other disasters, proposing research and development projects, preparing risk and hazard analyses, and implementing preventive measures in emergency prevention, as well as rescue and assistance in emergencies. URSZR includes rescue dog handlers in its protection, rescue, and assistance forces, which comprise units and services of associations and other non-governmental organizations, companies, institutions, and other

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organizations, civil protection units, services, and authorities, police, and the Slovenian army (Gerbec, 2010).

The Rapid Intervention Unit MUSAR (Enota za hitre intervencije MUSAR) was established in 2001 by order of the Minister of Defense, defining its organization and equipment criteria. The unit was created following bilateral mutual assistance agreements, particularly with neighbouring countries, to provide aid both domestically and internationally. MUSAR participates in international humanitarian and rescue operations within the frameworks of the UN, NATO, EU, and other international organizations. EHI (state rapid intervention rescue unit) is designed for particularly demanding rescue interventions, requiring rapid action during earthquakes, floods, landslides, and other large-scale disasters. EHI comprises 221 members from state units, civil protection services, and other protection, rescue, and assistance forces under state jurisdiction or co-financed by the state (URSZR, 2009).

The Technical Rescue Squad is a subunit of EHI, including the Mechanized Rescue Platoon, the Technical Search Department, the Dog Search Team, and MUSAR. This team encompasses all units performing search and rescue operations for buried and missing persons using dogs and technical means, as well as rescuing and caring for found persons. The Dog Search Team conducts protection, rescue, and assistance tasks independently or with other EHI units, performing search and rescue for buried victims of natural and other disasters, assisting survivors, and locating missing persons in major disasters. The team includes three administration members and two dog search units, each with a commander and nine rescue dog handlers, totalling 23 members. Members who pass the international exam join the MUSAR unit after a preliminary exam (URSZR, 2009).

The MUSAR platoon is organized, equipped, and trained to independently conduct search and rescue operations for large-scale natural disaster victims abroad. It operates within the EU Civil Protection Mechanism and follows the guidelines and methodology of the UN International Search and Rescue Advisory Group. The unit includes seven rescue dog handlers. Organizationally, the MUSAR platoon consists of a search group, a rescue group, a medical care group, and a logistics support group. The search team comprises 12 members, including the leader (a member of the EHI Dog Search Unit), four geophonists (from the EHI Technical Search Department), and seven rescue dog handlers (from the EHI Dog Search Unit) (URSZR, 2009).

The MUSAR platoon has a total of 47 members. The core group consists of operational firefighters with additional technical rescue skills, while other groups or members from different EHI units join the MUSAR platoon. The platoon must be capable of performing its tasks in smaller formations when transportation limitations prevent the entire unit from operating abroad (URSZR, 2009).

The State Intervention Unit (Državna intervencijska enota - MERP) requires handlers to pass exams outlined in the Regulations for Testing Knowledge and Skills of Rescue Dogs and Handlers of the Slovenian Rescue Dog Unit for Rubble (IRP-R). Handlers must have passed all six handler exams and be of legal age. When applying for testing, handlers must submit a written statement of voluntary participation in MERP as civil defence members in Slovenia's protection and rescue system. The regulations specify that trial searches cover larger areas (500 to 2000 square meters), with markers buried up to 1.5 meters deep. Various distractors may be used, and dogs must not wear collars or leashes for safety reasons. Searches during trials occur both day and night, lasting up to 36 hours with a maximum of seven searches. Light usage is permitted at night, and a maximum of three searches can be conducted consecutively, with a minimum 20-minute rest between searches. Each search lasts 20 minutes, with a maximum of 14 markers allowed, and one search area may have no hidden marker (Gerbec, 2010).

In addition to searching, each participant must pass tests in rope techniques, providing first aid to the injured dogs, physical fitness for handlers, and using a handheld radio. Successful rescue pairs based on these results are placed in the state intervention unit MERP, with their placement valid for one year (Gerbec, 2010).

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5. Challenges and Limitations Faced by Search and Rescue Dogs During Operations in Disasters

We are witnessing rapid technological advancements that significantly enhance our quality of life and accelerate progress in fields like science and medicine. Yet, despite these modern marvels, human ingenuity alone remains insufficient for finding loved ones trapped under debris. In contrast, a well-trained search and rescue (SAR) dog can effectively perform this critical task. During earthquakes, snow avalanches, or when individuals are lost in forests, SAR dogs prove to be invaluable partners in rescue missions. The term "partner" is used intentionally, as the dog is as vital as the handler for a successful rescue operation. Both must work in harmony and understand each other (Gerbec, 2010).

When the handler's excellent skills and the dog's consistent, systematic training are combined with loyalty and genuine friendship, they form a coordinated, efficient, and indispensable human-animal team. This partnership remains irreplaceable in rescue missions, even amidst numerous modern technological achievements (Gerbec, 2010). Dogs have the ability to detect scent particles at a ratio of 1 to 1,000,000,000,000 (one trillion), compared to traditional analytical instruments that can detect at a ratio of only 1 to 1,000,000,000 (one billion) (Otto et al., 2019). For decades, SAR dogs have been successfully used to search for missing persons or individuals buried in avalanches or rubble. Despite the development of technical detectors, SAR dogs remain irreplaceable due to their unparalleled speed and efficiency in locating missing persons in inaccessible terrains (Schneider et al., 2005).

SAR dogs are often selected from working lines renowned for their strong olfactory abilities and tireless work ethic, driven by rewards such as toys or food (Otto et al., 2019). These dogs use their keen sense of smell during searches and are trained to identify specific scents, which are combinations of various chemicals. For example, hunting dogs learn to identify the scents of specific animals, drug detection dogs identify the scent of narcotics, and SAR dogs are trained to recognize and pinpoint human scents (Jones et al., 2004). Numerous instances underscore the importance of SAR dogs during disasters. Notable examples include the devastating earthquake in the Avellino region of southern Italy in November 1980 and the Mexico City earthquake in September 1985, where more than 200 people were rescued from the rubble thanks to the efforts of SAR dogs (Gerritsen & Haak, 2014). Globally, the critical role of well-trained SAR dogs is widely acknowledged. Experiences from past rescue operations consistently highlight the necessity of a well-trained dog and its handler for successful rescues.

Search and rescue dogs face a myriad of challenges in the field that can affect their performance and safety. Below are some key factors:

a) Environmental conditions (extreme weather conditions such as heavy rain, snow, high temperatures, or strong winds can hinder the dogs' ability to scent and navigate effectively);
b) Hazardous terrain (debris, sharp objects and unstable surfaces can pose physical dangers to the dogs, increasing the risk of injury);
c) Contaminated areas (exposure to hazardous materials, chemicals, and biological contaminants can affect the dogs' health and impair their performance);
d) Fatigue and exhaustion (extended hours of work without adequate rest can lead to physical and mental exhaustion, reducing the dogs' efficiency and effectiveness);
e) Distractions (the presence of other animals, loud noises, and chaotic environments can distract the dogs and make it difficult for them to focus on their search tasks);
f) Psychological stress (the high-stress environment of disaster scenes can cause anxiety and stress in dogs, impacting their ability to perform);
g) Limited access to resources (in remote or heavily damaged areas, there may be limited access to food, water, and medical care for the dogs, affecting their overall well-being and performance);
h) Communication challenges (difficulties in communication between the dogs and their handlers due to noise, distance, or obstacles can impede the effectiveness of search operations);
i) Training limitations (differences in training methods and the level of preparedness among search and rescue teams can affect the dogs' ability to perform optimally in various disaster scenarios);

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j) Health issues (pre-existing health conditions or injuries sustained during operations can limit a dog's ability to participate in search and rescue missions effectively);
k) Time sensitivity (the urgency of locating survivors quickly can place immense pressure on the dogs and their handlers, sometimes leading to rushed or less thorough searches);
l) Adaptation to different scents (in multi-disaster scenarios or areas with diverse human populations, the dogs may need time to adapt to different scents, potentially delaying search operations);
m) Navigational difficulties (in complex structures or densely populated areas, dogs may face challenges in navigating through narrow passages, collapsed buildings, or other obstacles)
n) Interference from untrained animals (stray animals or pets in the disaster area may interfere with the search dogs' work, causing confusion and delays);
o) Limited deployment time (the physical and mental limits of the dogs require frequent rotation and rest periods, which can reduce the overall time available for search operations).

6. Conclusion and Recommendations

The assessment of search and rescue (SAR) dogs' effectiveness in locating survivors during disasters in Serbia, Croatia, and Slovenia highlights the crucial role these expertly trained canines play in disaster response. The study reveals that SAR dogs are invaluable due to their exceptional sense of smell, agility, and ability to navigate difficult terrains, which significantly boost the efficiency and success rates of rescue missions. Key factors impacting the effectiveness of SAR dogs include the quality of their training, environmental conditions during operations, and the coordination between handlers and dogs. The research identifies several challenges that SAR dogs encounter, such as extreme weather, hazardous terrain, fatigue, psychological stress, and limited resources. Addressing these issues is vital for optimizing the performance and well-being of SAR dogs.

The study underscores the necessity for standardized training protocols, sufficient investment in resources, and improved coordination among SAR teams. Ongoing training and support for both dogs and handlers are essential to maintaining high-performance levels during rescue missions. Additionally, the research points to the importance of international cooperation and the exchange of best practices to refine SAR dog deployment strategies. In summary, SAR dogs are an indispensable part of disaster response teams in Serbia, Croatia, and Slovenia. Their ability to swiftly and effectively locate survivors makes them a critical asset in saving lives during disasters. Continued investment in training, resources, and international collaboration will ensure that SAR dogs remain at the forefront of effective disaster management, thereby enhancing the resilience of communities and their capacity to respond to future disasters.

To further enhance the effectiveness of SAR dogs in disaster response, the study proposes several key recommendations:

a) It is essential to develop and implement standardized training protocols across all SAR teams. This ensures consistent, high-quality training for both SAR dogs and their handlers. Regular drills, exposure to various environments, and advanced training techniques tailored to specific disaster scenarios should be included.
b) More resources should be allocated for the training, care, and deployment of SAR dogs. This includes funding specialized training facilities, veterinary care, and the acquisition of necessary equipment.
c) Improving coordination and communication among SAR teams, both domestically and internationally, is crucial. Establishing clear communication channels and collaborative frameworks will facilitate better resource sharing and more efficient deployment of SAR dogs during disasters.
d) Providing psychological support and ensuring the welfare of SAR dogs and their handlers is vital. Addressing the mental and physical health of both dogs and handlers helps maintain high-performance levels and ensures long-term effectiveness.

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e) Raising public awareness about the role and importance of SAR dogs in disaster response is important. Educational campaigns can help garner support and funding for SAR programs and foster a greater appreciation for these canine heroes.
f) Ongoing research and development in SAR dog training and deployment should be encouraged. Innovations in training methods, scent detection technologies, and health monitoring can further enhance the capabilities of SAR dogs.
g) Strengthening international collaboration and sharing best practices among countries is essential. Participation in international training exercises, conferences, and knowledge exchange programs will contribute to the continuous improvement of SAR dog deployment strategies.

SAR dogs are a crucial part of disaster response teams in Serbia, Croatia, and Slovenia. Their remarkable ability to swiftly and efficiently locate survivors makes them indispensable for saving lives during emergencies. Ensuring continued investment in their training, and resources, and fostering international collaboration will keep SAR dogs at the cutting edge of effective disaster management. This, in turn, will enhance the resilience of communities and their preparedness for future disasters. Implementing the recommendations from this study will not only boost the effectiveness of SAR dogs but also contribute significantly to the overall improvement of disaster response strategies in the region.

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