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OSCE Organization for Security and Co-operation in Europe
Project Co-ordinator in Ukraine

International Symposium MINE ACTION 2021

16th to 18th June, Novi Vinodolski, Croatia

Book of Papers

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Mine Action 2021

16th to 18th June, Novi Vinodolski, Croatia

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MINE ACTION SYSTEM MODELS

Mine action system in the Republic of Croatia

Damir Trut

Mine action system in the Republic of Croatia

Damir Trut

PhD, Assistant Minister, Ministry of the Interior, Civil Protection Directorate

After the liberation, the Republic of Croatia faced the problem of mines as one of the most severe consequences of the war in this area, and joined many other countries around the world whose state territories are highly contaminated with mines and explosive remnants of war.

The mine situation in the Republic of Croatia is additionally complicated by the fact that prescribed methods of classic tactics and adopted mine laying systems have rarely been applied in mine deployment. The consequences of such procedures are unmarked minefields and imprecise and incomplete minefield records. The locations of a large number of mines are unknown, and the lack of minefield records poses a problem, since the mines were planted by unprofessional persons. Under the influence of weather and soil erosion, a part of the mines changed their positions. Special problem is posed by large portions of configurationally complex suspected hazardous areas in mountainous and karst terrain and around river banks, where, in most cases, separation lines between the warring parties were. Another aggravating factor is the vegetation complexity, especially of the forested areas in the continental part of the Republic of Croatia. Additional problem is posed by the overgrowth and long-term neglect of arable land on which the first mines were deployed. Explosive remnants of war are an integral part of the general mine situation, and their removal and destruction require additional procedures, and removal from greater depths also requires significant financial resources.

Although mine action around the world is based on very similar principles, due to different characteristics of wars, their duration and climate diversity, every country in the world affected by this problem should build and develop its own model of mine action. According to this, it is clear that there is no single, uniform and generally acceptable model of mine action in the world.

I. HISTORICAL DEVELOPMENT

The Republic of Croatia has developed its own mine action system model, which, as a system derived from practice, is recognized in the global mine action community as one of the most efficient and respected systems. The mine action system developed in such way, accompanied by acquired experience and knowledge, as well as with achievements in the development of its own capacities, methods, techniques and technologies and motivated staff who are educated, trained and ready to carry out all goals and challenges posed by mines and explosive remnants of war, guarantee the accomplishment of the strategic goal - solving the mine problem by 2026.

Considering the manner and the entities that have performed these tasks to date, the development of the mine action system in the Republic of Croatia can be divided into three periods:

The 1st period refers to the war years from 1991 to 1995, when the emphasis in demining was placed on the needs of conducting combat operations and creating basic security conditions for the movement of the population in those areas, in which demining was carried out by Croatian Army, Police and Civil Protection units.

The 2nd period refers to the time from March 1996, i.e., from the enactment of the Law on Demining until the first half of 1998, when the Croatian Mine Action Center was established. In this period, demining activities were performed by a state-owned company AKD »MUNGOS« d.o.o., and in August 1996 the UN Mine Action Center was established, which played a significant role in raising funds for demining but also in collecting data on mine deployment from all participants of war operations in the territory of the Republic of Croatia. Furthermore, in December 1997, the Republic of Croatia signed the Ottawa Convention.

The third period begins with the establishment of the Croatian Mine Action Center (Decree of the Government of the Republic of Croatia of 19 February 1998), i.e., with amendments to the Law on Demining from June 1998, when a market model was introduced into the demining system, and all activities of planning, management and coordination of the mine action process in the Republic of Croatia were taken over by the Croatian Mine Action Center (CROMAC). With the establishment of CROMAC, the process of building and developing a sustainable mine action system in the Republic of Croatia began. As of 1st January 2019, following the reform priorities of the Government of the Republic of Croatia, the Croatian Mine Action Center, the pillar of mine action in the Republic of Croatia to that date, was integrated into the Ministry of the Interior. This logical and comprehensible step was a result of achieving a satisfactory level of state security defined by the directions and scope of the National Security Strategy, i.e., the concrete operationalization and implementation of the Homeland Security System Law.

II. CROATIAN MODEL OF MINE ACTION

From the very beginning, the Government of the Republic of Croatia recognized the mine problem as a security, economic and environmental issue and resolutely set out to solve it, confirming this decision through the following key factors:

- Normative regulation of mine action, the National Mine Action Program, the Law on Mine Action with related bylaws and national mine action standards harmonized with the International Mine Action Standards (IMAS).
- Establishment of CROMAC in 1998 as the umbrella institution of the Government of the Republic of Croatia for planning, organization, coordination and implementation of mine action,
- Ensuring permanent and stable sources of financing from the state budget, through the World Bank loan and through pre-accession, structural and investment funds of the European Union,
- Implementing all the commitments took over by the signing of the Ottawa Convention and the Cluster Munitions Convention.

In addition to these steps, the basis of the excellent results achieved in solving the mine contamination issue, is the cooperation of all relevant public bodies and ministries and other direct stakeholders in the mine action system in the Republic of Croatia. Certainly, an important stakeholder in the mine action system was The Croatian Mine Action Center (CROMAC), which had the role of planning, organizing and implementing activities in the field of mine action. The Croatian Mine Action Center has been developing and has grown into a significant institution whose activities were followed beyond the borders of the Republic of Croatia. Its development path includes the integration of all positive experiences in mine action, with the assistance and support of the international community and UN institutions. Currently, the Croatian Mine Action Center plans, organizes and implements its activities within the Civil Protection Directorate of the Ministry of the Interior. The Croatian Mine Action Center has 89 employees, most of whom are deminers and other experts in all areas of mine action. Pursuant to the Law on Mine Action, CROMAC performs a number of responsible tasks, from non-technical and technical survey data collection and analysis with the aim of defining suspected hazardous areas, marking of suspected hazardous areas (SHA), development of preliminary demining plans, development of technical survey implementation plans, demining quality control activities, up to mine and ERW risk education and issuing Certificates of land release.

In 2003, CROMAC established a company CROMAC - Center for Testing, Development and Training, which has been recognized in the international mine action community as one of the leaders in the field of research, development and improvement of techniques, technologies and methods of mine action, as well as of testing demining machines and mine detection dogs, and operational evaluation of modern technologies and education.

III. ACHIEVEMENTS OF THE SYSTEM

The initial estimate by the United Nations Mine Action Center from 1996, of 13,000 km2 of SHA and one million antipersonnel and antitank mines planted in the Republic of Croatia was rough and inaccurate.

Aware of these facts, in the period from 2004 to 2008, CROMAC conducted a systematic non-technical survey of entire territories of municipalities and towns affected by war operations and mine contamination. This was the first time that, instead of a general assessment of the SHA, the Republic of Croatia had a defined situation, i.e., the SHA was defined.

Today, after systematic and continuous work, the defined and marked suspected hazardous area in the Republic of Croatia covers 241 km2 in 8 counties and 45 towns and municipalities.

In the CROMAC mine information system (MIS) there are still 716 known minefield records containing 15,797 mines, of which 14,813 antipersonnel mines and 984 antitank mines.

The entire SHA in the Republic of Croatia is fully marked with 9,548 mine danger signs.

Given the defined structure of the SHA according to the intended purpose of the area, the largest portion is made up of forest areas with 237.8 km2 or 98.7%, followed by agricultural land with 2.7 km2 or 1.1% and other areas with 0.5 km2 or 0.2% of the total SHA.

The reduction of SHA in the Republic of Croatia is the result of continuous and intensive implementation of demining, as well as of non-technical and technical surveys.

Since 1998, over 670 km2 have been demined, and over 880 km2 released through non-technical and technical surveys.

We are especially proud of the results achieved by surveying the suspected hazardous areas, in particular of the results achieved by the implementation of the non-technical survey method. Certainly, the method of aerial survey of suspected hazardous areas, as a qualitative upgrade of the method of non-technical survey, contributed significantly to such results, and especially its application in inaccessible and difficult to pass hilly mountainous terrains. This method of aerial survey and data collection was designed by Croatian experts, which places us among the pioneers of remote sensing of mine contaminated and suspected hazardous areas.

Unquestionably, demining companies in the Republic of Croatia have contributed greatly to the reduction of the SHA, having demined over 670 km^2.

Currently in the Republic of Croatia, demining operations are performed by 40 accredited companies with a total of 542 deminers, 82 support staff, 163 mine detection dogs and 43 demining machines. It is worth emphasizing that nowadays the Republic of Croatia is a leading mine contaminated country in terms of the use of demining machines.

I would like to emphasize the expertise and high level of training of our deminers, because only highly trained, organized and equipped staff guarantee professional and high-quality demining.

Furthermore, a big improvement was achieved in the field of information technology, databases and cartography.

CROMAC has developed its own mine information system (MIS). CROMAC MIS is a complete and dynamic user system of data collected on mine contamination in digital form. The system reflects CROMAC's real needs and goals and enables CROMAC employees direct access to all information and data in real time.

Thanks to the donation of the Kingdom of Norway in 2005, the SCAN CENTER started operating, which enabled the collection, analysis and processing of data from large-format operational combat maps and other graphic-type information available to CROMAC.

In order to raise the quality and level of informing the population about the SHA and the status of its marking, CROMAC has designed and implemented a mine information system portal unique in the world. MIS PORTAL is a web application that allows every Internet user to see the state of the SHA displaying the positions of mine danger signs located in the field. This significantly improved the interaction between land users and CROMAC.

IV. FINANCING OF THE MINE ACTION SYSTEM

From the very beginning, demining in the Republic of Croatia has been mostly financed from the state budget.

The Republic of Croatia is one of a few countries with a mine contamination problem that each year allocates significant funds for demining from the State Budget. By 2019, the Republic of Croatia, including the companies in its predominant ownership, allocated a total of 603 million EUR, which makes 73% of the total funds spent on demining.

Donations make up 10% of the total funds spent, of which 84% are foreign donations.

In the period from 2015 to 2019, the level of financing from the European Union funds was constantly increasing and currently they are the leading source of financing for mine action activities.

In 2016, for the first time since the systematic implementation of mine action in the Republic of Croatia, funds received from the European Union structural and pre-accession funds were predominant and made up 62% of the total funds planned.

The total amount spent for demining from all financial sources amounts to 6.3 billion HRK.

V. CHALLENGES

The fundamental challenge is to address the remaining mine contamination problem in an efficient and safe way.

Namely, after demining almost entire mine contaminated agricultural land, in 2018, the remaining confirmed and suspected hazardous area mostly covers forested, mainly hilly and mountainous areas. As a result, the use of demining machines, especially medium and heavy ones, was significantly reduced. The use of demining machines will be limited to small, mobile machines that can be efficiently transported and used in such areas. Reducing the possibility of mechanical demining, the manual demining rate will increase, which will reduce the safety of deminers and productivity and increase the cost of demining and technical surveys. Accordingly, the method of using mine detection dogs can play a significant role in demining, and especially in technical surveys. Therefore, intensive efforts will be made in the development of methods and techniques of application of mine detection dogs in forested mountain areas.

Demining of known and confirmed mines is certainly the first priority in solving the remaining mine contamination problem in the Republic of Croatia.

However, identification and positioning of the remaining unknown mines in the forested mountain areas will pose the biggest challenge. Accordingly, intensive efforts are made in the development of a unique methodology that would integrate non-technical survey, which includes airborne micro-level airborne survey, with targeted technical survey.

Such a model will enable efficient and safe reduction of mine suspected areas, and focus demining capacities on actually mined areas.

Furthermore, creating conditions for the promotion and transfer of Croatian knowledge, experience and technology will remain one of important challenges.

CONCLUSION

By signing the Convention on the Prohibition of the Use, Stockpiling, Production and Transfer of Anti-Personnel Mines and on Their Destruction (Ottawa Convention) in December 1997 and ratifying it in May 1998, the Republic of Croatia became one of a few countries recognized as leaders in the international fight against antipersonnel mines. In the past twenty two years, the Republic of Croatia has developed one of the highest quality and most respected demining systems, with technical resources comparable on the global level and with motivated staff who are educated, trained and ready to implement the National Mine Action Program. The mine action system developed in this way has, in the previous period, performed all the set tasks and goals. A mine action system is a "living" system that is primarily built by people and resources connected through processes and information. Continuous improvement of the system through optimization of certain functions and processes, as well as the results achieved in the development of capacities, methods, techniques and working technologies, guarantee that the strategic goal of the mine action system in the Republic of Croatia will be achieved, i.e. that the Republic of Croatia will be free from the danger of mines by 2026 and that the acquired experience, knowledge and ability will be incorporated into solving the global mine contamination problem. Thus, the Republic of Croatia will continue to have the role of a stable and effective partner in the global mine action community.

Mine Action Activity in Ukraine

Colonel Ruslan Berehulia

MINE ACTION 2021

Mine Action Activity in Ukraine

Colonel Ruslan Berehulia

Deputy Director of Mine Action and Environmental Safety Department, Ministry of Defence of Ukraine

Introduction

Ukraine is one of the most affected countries in the world by contamination by mines and explosive ordnance. The contamination is result of the ongoing conflict in the east of the country since 2014. Total area of contaminated territory is estimated to more than 14,000 km2 in Luhansk and Donetsk regions including temporary occupied territories. Huge amount of mines and explosive objects pose a big danger to the population.

The main components of mine action in Ukraine are:

1) informing about the dangers of explosives and education to prevent the risks associated with explosives;
2) demining (humanitarian demining);
3) providing assistance to victims and implementing measures for their rehabilitation;
4) destruction of surplus ammunition, ammunition unsuitable for further use and storage, as well as ammunition subject to destruction in accordance with international obligations;
5) advocacy and educational work on non-use of anti-personnel mines.

Ukraine is recording and reporting numerous cases of usage of mines and explosive devices by representatives of armed formations and occupation administrations of the Russian Federation, banned by Ottawa Convention. In majority of cases, it is antipersonnel mines PMN-2 and POM-2 but they are also using Improvised Explosive Devices (IED).

Humanitarian Demining

Since 2014, demining teams of the Armed Forces of Ukraine, State Special Transport Service (SSTS) and State Emergency Service of Ukraine (SESU) provided demining activities on the area of almost 400 km2 more than 510,000 explosive devices were found and destroyed. Besides capacities of state organisations, significant role in humanitarian demining have international operators Halo Trust, Danish Demining Group (DDG), Fondation Suisse de Déminage (FSD) and first Ukrainian operator Demining Solutions. All together, they identified 414 Confirmed and Suspected Hazardous Areas (CHA/SHA) with a total size of 58.9 km^2 and cleared 15.64 km^2.

In 2019, Ministry of Defence started with first hand-over procedures of the territories cleared by operators. According to the results of the inspection, 61 demined polygons with a total area of 4.44 km2 were handed over to local authorities.

In the situation of ongoing aggression against Ukraine and limited humanitarian demining activities in the area close to the confrontation line, explosive ordnance risk education (EORE) have significant role in preventing mine causalities and teaching population in mine affected communities on correct behavior. EORE in the time of COVID 19 pandemic was extremely challenging but using new methods and means of education, in 2020 mine action operators were able to reach more than 130,000 citizens with EORE messages.

Very important part of every mine action program is availability of information on the CHA/SHA. With the help of GICHD and material support of OSCE PCU, Ministry of Defence developed interactive map of areas contaminated with explosive objects. Currently map is providing basic information on the size, categorization (CHA or SHA), type of marking, planned and ongoing activities on the polygon and operator preforming humanitarian demining activities.

Law on Mine Action

On September 20, 2020 Verkhovna Rada (Ukrainian Parliament) adopted "Amendments to the Law on Mine Action in Ukraine". Even before 2014, Ukraine had vast experience and well developed capacities dealing with the explosive remnants of WWI and WWII. With the Amendment to the Law on Mine Action, Ukrainian authorities wanted to, as much as it's possible, engage all available capacities of state organisations, giving them the role in the newly developed system. They also take in consideration specific situation in which country is, especially concerning occupation of territories of Luhansk and Donetsk Oblasts in the east of Ukraine and annexation of Crimea by armed formations and occupation administrations of the Russian Federation.

Planning, co-ordination, management and regulation of mine action activities will be in responsibility of National Mine Acton Authority, interministerial collegial body thet will be responsible to the Cabinet of Ministers of Ukraine (Government). The chairperson of NMAA is Minister of Defence during the special period. After the restoration of the territorial integrity of Ukraine within the internationally recognized state borders, the chairperson of NMAA will be the head of the Ministry responsible for safety, liquidation of emergencies and rescue work.

Two mine action centres were established:
- Mine Action Centre (Ministry of Defence) within the SSTS with HQ in Chernihiv;
- Humanitarian Demining Centre (Ministry of Internal Affairs) within the SESU with HQ in Merefa near Kharkiv.

The main activities and responsibilities of these two centres that will be territorially divided, are:

- Participation in the planning of mine action activities;
- Management of MA data within the scope of authority, ensuring the functioning of the demining quality management system, certification of operators and mine action processes and inspection of demined areas;
- Issuance of certificates with quality guarantee for the clearance of mined areas and their transfer to local state administrations, local governments;
- Participation in international cooperation;
- Reporting to the national mine action authority
- Humanitarian demining;
- Staff training.

Coordination of MA operations, preparation of planning documents, generalization of information in the information management system will be responsibility of NMAA Secretariat that will be unit within MoD and later in MoIA, after special circumstances in country cease to exist.

Conclusions

Next important step in the process of establishment of well-functioning MA system is revision of National Mine Action Standards (NMAS) adopted by Ukrainian Standardization Authority in April 2019. NMAS has to be aligned with the Amendments to the Law on Mine Action and with changes in IMAS using the world best practices and lessons learned during the humanitarian demining operations in past 6 years.

Humanitarian Mine Action in Ukraine. National Dimension.

Tymur Pistriuha

MINE ACTION 2021

Humanitarian Mine Action in Ukraine. National Dimension.

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Introduction

In 2014, at the beginning of combat action in the East of Ukraine, the huge problem of contamination by explosive remnants of war (ERW) appeared in the middle of Europe. Unfortunately, every year of the war the situation in Eastern Ukraine is getting worse. Therefore, on 12 November 2018 a national nongovernmental (non-profit) organization «Ukrainian Deminers Association» (hereafter – UDA) was created. The main goal of the UDA is solving problems on Humanitarian Mine Action (hereafter – HMA) in Ukraine.

The UDA was created by the initiative group of deminers and currently, the members of the organization are 179 people from all regions of Ukraine.

The UDA is a permanent member of UNDP Protection and FAO Clusters, Mine Action sub-cluster. The organization is an active participant of HMA activities (meetings, round tables, conferences, etc.) under international organizations (UNDP, PCU OSCE etc.) and governmental authorities (Ministry of Defence, State Emergency Service, Ministry for the Reintegration of Temporarily Occupied Territory, etc.). The UDA is listed in the database of the HMA organizations of the Geneva International Center for Humanitarian Demining [1]. The members of the UDA are part of various working groups aimed to solve state issues in the HMA sphere, in particular, the lawmaking process.

HMA Problems in Ukraine

Based on analysis of official reports on situation of humanitarian demining in Ukraine the UDA's Expert Board achieved the following outcomes.

1. The latest report Landmine Monitor 2020 indicates that Ukraine is among the first three most affected countries in the world and needs an immediate response. [2] According to reports of the Office of the United Nations High Commissioner for Human Rights, between 16 February 2020 and January 31, 2021, 75 civilians were caused by mines and explosive remnants of war, including 17 of whom died. [3, 4]

2. According to UN data, the area size of Government-controlled territory of Donetsk and Lugansk regions that is contaminated with mines and explosive ordnance is more than 7000 square km. Moreover, another mined territory of the non-Government-controlled territory of Donetsk and Lugansk regions is about 9,000-16,000 square km.

   Based on world practice, the «year of the war is ten years of humanitarian demining». Taking into account that the fighting in the eastern part of Ukraine, at present, has characteristics of a position war, it is possible to assume that the humanitarian demining of the territory of the Donbas can reach more than 40 years.

   It should be noticed, that only a few per cent of the Donbas are cleared. The map of sites contaminated with explosive objects in the Donetsk and Luhansk regions and more detailed statistics are on the official website of the Ministry of Defense of Ukraine.

3. On 6 December 2018 the Ukrainian Parliament (Verkhovna Rada) adopted the Law on Mine Action in Ukraine. On April 25, 2019, and September 17, 2020, significant changes were made to the law. However, only in 2021 did the measures for creation begin the establishment of the national mine action authority as an administrative body and two mine action centres as an operational body [5]. As a result, it brings Ukraine to the effective execution of humanitarian demining tasks.

4. One of the key issues in the humanitarian demining of the Donetsk and Lugansk regions is that the hostile party is not a signer of the Ottawa Convention [6] and the aggressor uses anti-personnel mines actively, which are the greatest threat to the civilian population.

   In addition, some particularities of the territory of Donetsk and Lugansk regions that are contaminated with explosive objects are:

   - a large number of unexploded ordnance of the canon and jet artillery systems ("GRAD", "URGAN", "SMERCH");

   - unexploded artillery shells and mortar mines;

   - different various of grenades and grenade launches;

   - anti-personnel (in particular, PFM-1, PMN, PMN-2 - prohibited by the Ottawa Convention), anti-tank, anti-vehicle, anti-missile and special mines;

   - cluster munitions;

   - improvised explosive devices (IED), mine (booby) traps (surprises) (such as MS, ML) installed for non-extermination with various sensitive sensors;

   - the latest designs and designs of the regular ammunition of the Russian Army [7].

   - mined areas of agricultural fields, forests, infrastructure objects (roads, bridges, overpasses, buildings, etc.) and the coastal zone of the Azov Sea.

5. It should be noted, that the Ukrainian national capacity for humanitarian demining was increased significantly. In particular, Ukrainian deminers gained knowledge and a huge practice, a valuable experience; humanitarian demining operators became more technical equipped; the first Ukrainian operator – Demining Solutions company appeared.

   Yet, the national capacity is not enough for solving mine action problems in Ukraine. Partner countries do not pay enough attention to develop the Ukrainian national capacity; the first of all, for supporting the humanitarian demining procedures.

   Despite high statistics of Mine/ERW casualties in Ukraine, there is no use of any remote-controlled mine clearance system, e.g. MV-4, MV-10, etc. Involving the above-mentioned machines would increase effectiveness significantly and save the lives of deminers [8].

   The results of the conference "Military-Technical Cooperation between Ukraine and Croatia on the Mechanical Clearance. Experience, Status and Prospects" (November 26, 2020, Kyiv) with the participation of all HMA state bodies showed that Ukraine needs multi-mission EOD robotic system MV-4 and MV-10 [9].

7. Nevertheless, the key point of humanitarian demining issues in Ukraine is the lack of financial support by donors.

   A total of 41 states and three other areas received $561.3 million from 35 donors in 2019. As in previous years, a small number of countries received the majority of funding. The top five recipient states - Iraq, Afghanistan, Syria, Lao PDR and Colombia – received almost 50% of all international support in 2018. Iraq received the largest amount of funding (17% of all international support) from the largest number of donors (18) [10]. Even though Ukraine is one of the third most affected countries, our country received just 22,3 million in financial support from donors; yet Ukraine is not included even in to top eight recipients.

Furthermore, due to lack of financial resources for humanitarian demining in Ukraine, there are only one Ukrainian operator Demining Solutions (without any donors) and three international NGOs: The Halo Trust, The Danish Refugees Council – Danish Demining Group, Swiss Foundation for Mine Action. That number of humanitarian demining operators is obviously not enough for Ukraine.

Conclusion

Ukraine has been facing a huge problem as contamination of its territory with mines/ERWs for 7 years of war in the Donbas and the situation becomes worse day by day. Based on the UDA analysis of the humanitarian demining problem in Ukraine, key points for solving these issues are:

comprehensive financial support by international donors and organizations directly for clearance of contaminated areas;

immediate implementation of Mine Action regulatory framework in Ukraine and establishment of national authorities in this sphere;

absence in Ukraine of the mechanical clearance process by multi-mission EOD robotic system;

development of Ukrainian capacity for humanitarian demining, in particular, Ukrainian operators by close cooperation with country partners.

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QUALITY MANAGEMENT IN MINE ACTION

Management of ERW risks in Montenegro

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Management of ERW risks in Montenegro

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Abstracts

For a small country, Montenegro has a long, rich, and eventful history. Its rugged terrain and jagged shoreline have witnessed many conflicts and wars. The legacy of this colourful Montenegrin history is still dangerously present today for its citizens and the rising numbers of tourists visiting each year. With an annual average of more than 12.000kg of ERW needing safe removal each year this past decade, the Department for UXO, in the Emergency Management Directorate of the Ministry of Interior of Montenegro faces tremendous challenges and threats in building an efficient system of disposal.

This paper considers the lessons-learned in Montenegro and ideas on how to build an effective and efficient national system of ERW removal with the support of the international community.

Photo 1: ERW after industrial demilitarization

Introduction

The diversity of ERW risks in Montenegro is a direct consequence of its long, rich, and eventful history. Today, almost all types of ordnance from the last 100 years can be found on the territory of Montenegro: underwater UXOs from WWI and WWII in the Adriatic Sea, lakes, and rivers; ERW's on the land; scatter ammunition from UEMS; and cluster sub-munitions and air bombs from raids 1999.

Montenegro, as a responsible country and a reliable partner, supports and participates in all regional initiatives.

Convention	Sign	Ratify	Status
Mine Ban Policy	2006	2007	Fulfilled
Cluster Munition Ban Policy	2008	2010	Ongoing 2020
Casualties and Victim Assistance	2006	2006	Permanent obligation
CCW Protocol (V)	2016	2016	Permanent obligation

Table 1: Status of conventions
Note: Montenegro regained independence in 2006.

From the very beginning, the Montenegrin government, with the support of the U.S. State Department, established the Regional Diving Centre for Underwater Demining and divers training 2002; the same organizations play the role of NMAC till 2014. In 2014, the Montenegrin government posted information that all areas affected by landmines and cluster bombs have been addressed and thus decided to shift NMAC to the MoI, Emergency Management Directorate – Department for UXO as part of permanent activities on residual ERW contamination.

Photo 2: Preparation for UXO disposal at a temporary demolition site

Organization history

Shortly after this reorganization, the Department for UXO gained new information on cluster munition SHA, which demanded continuity of Montenegro's MACs exiting.

The Department for UXO, with just five employees, plays several roles in Montenegro:

1. Montenegro MAC
2. National EOD unit (hotspot tasks across the country),
3. Supporting the forensic center in the explosive ordnance field,
4. Storage of explosive ordnance with an unknown history,
5. UXO clearance teams for national interest sites.

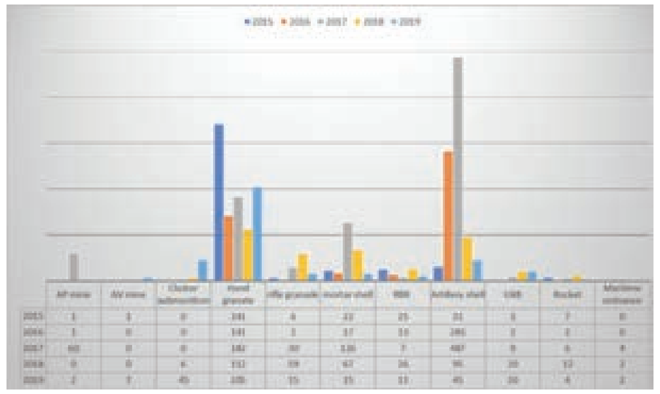
Due to its vast range of responsibilities, EMD, MoI, decided from the beginning to ask the international community for support. At the same time, the Department for UXO worked daily to clear what it could.

The clear outputs, transparency, proactivity, and dedication of the whole of Government resulted in the Norwegian Peoples Aid starting a cluster munitions clearances project in 2018. This project will help Montenegro to achieve the status of a "Cluster Munition Free Country" this year. To date, the NPA has safely cleared 1,613,146 sqm of land and found 82 sub-munitions (BLU-97, Mk-118 and Mk-4).

The ITF was active in Montenegro from the early beginning (2002–2012), supporting the Mine Action and Conventional Weapons Destruction Program. ITF started demining activities on the border between Montenegro and Croatia in 2003 and later continued with underwater demining at the Bay of Kotor.

Since 2016, ITF and the Montenegro Mine Action Centre (MMAC) have carried out several meetings and field visits through which it was determined that Montenegro is still struggling with various mine/cluster/UXO challenges both on land and underwater. Currently, the ITF, with support from the U.S. State Department Office of Weapons Removal and Abatement (PM/WRA), is restarting its activities in Montenegro, specifically in physical security, stockpile management, and conventional weapons destruction in cooperation with relevant national authorities.

Results



In this article, we focus on the period of 2015-2019. Activities of the Department in the field and its media presence helped gain the trust of local populations across Montenegro. This fact results in an increasing number of „harvest" ERW and decreasing numbers of ERW in „strange" places, i.e., wells, potholes, under the bridges, etc.

Total munitions found average more than 12,000 kg of various ERW per year. In the first quarter of 2020 alone, the Department of UXO collected more than 30,000kg of ERW.

Due to Montenegro's environmental regulations, all unnecessary blow in place (BiP) disposal must be avoided. This has led to a vast number of collected ERW being stored by the Department of UXO (Photo 3). In the beginning, the Department utilized what they had, all disposal relied on „temporary" sites. (Photo 2). However, those sites cannot serve as permanent solutions. With the restart of cooperation between the ITF and Government of Montenegro, as a gesture of commitment, the Montenegrin government reallocated financial support to the industrial demilitarization of ERW.

With support from the U.S. State Department, ITF, together with its Montenegrin colleagues, has found that industrial demilitarization of ERW is the best (safest, most cost-effective, and environmentally friendly) option for already collected ERW. Due to the nature of the risk of handling ERW, in cases of the highest risk identified before additional transport, the EOD team performed X-ray inspection of ordinance. Activities on demilitarization have been followed by the Department for UXO, ITF team, and inspected by all Montenegrin authorities, particularly ecological authorities.

Photo 3: Department of UXO temporary storage place

Plans

With experience and discussions with the international community and its partners, the Department for UXO found the below weaknesses of the system and strategy:

No	Weakness	Status	Founds
1	Missing legal frame	In preparations	Partially funded from Montenegro Government
2	Lack of appropriate training	Ongoing with support of USA via ITF	Founded by USA, State Department
3	Lack of demolition polygons	Waiting decision of the Government	-
4	Temporary ERW storage out of dated	Ongoing with support of USA via ITF	Founded by USA, State Department
5	Missing national ERW risk map	In preparations	Partially funded from Montenegro Government
6	Disposal aircraft engine with ionizing radiation	Environmental Protection Agency of Montenegro start activities	Partially funded from Montenegro Government- According to the national strategy
7	Underwater UXO - Zeta river	Technical solution	No founds
8	Land release locations affected by UEMS	Land release	No founds
9	Reduce the stockpiles of obsolete and hazardous Explosive Remnants of War (ERW).	Ongoing with support of USA via ITF	Founded by USA, State Department
10	Underwater UXO-Boka Kotorska bay	Technical solution	No founds
11	Underwater UXO-Adriatic sea	Technical solution	No founds
12	Reduce the stockpiles of obsolete and hazardous stockpile ammunition (MoD).	Ongoing activities	Founded by the USA, State Department via ITF NSPA OSCE SEESAC
13	Assessment and potential clearance of ERW abandoned storage in Herceg Novi/Petrovići-Potkop	Technical solution	No founds

Synergy between national authorities, the international community, and donors, with clear outputs, transparency, proactivity, dedication, and last but not least open communication, is the safest, fastest, and only realistic approach for all ERW risks.

Instead of conclusion

“The slowest person, if he does not lose sight of the goal, is faster than one who wanders aimlessly” Gotthold Ephraim Lessing

Historical Research as Tool in the Residual Unexploded Bomb Risk Assessment: Case Study Sarajevo

Sead Vrana

Historical Research as Tool in the Residual Unexploded Bomb Risk Assessment: Case Study Sarajevo

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Fifteen unexploded aircraft bombs are found in Sarajevo area since 2013. Ten of those are found inside the city limits, eight of them were 1000 lbs. (454 kg) bombs and seven are under the already processed or built up surfaces. One is found in the foundations of the house, one under the street, one under the parking lot, and four in the factory building foundations, all at depths from 1 to 5.5 meters. Four bombs were found over a 6-day period in September 2019. All bombs found within the city limits were less than 150 meters away from the residential buildings and five of those were less than 50 meters away. Fourteen bombs, all those found in the city area among them, originate from the World War Two period, 10 were British, three French, one US and one German.

Even though the majority of the bombs were found in the populated urban area where uncontrolled detonation may cause severe consequences, until now no formal risk analysis has been undertaken. Following International Mine Action Standards and GICHD MORE guidelines risk exists on the location where contamination is present during the activities which may interact with the contamination, so for the understanding of the risk it was necessary to analyze all available pieces of information related to the characteristics and distribution of the contamination. Practically that meant search for the available historical sources and testimonies, their verification and the analysis of the data collected from those sources.

Sources and data collecting

As 14 out of 15 bombs originate from the World War Two, focus of the research is put on that historical period. In order to identify data sources that contain satisfying level of information, initial research, reduced to the examination of the previous studies on the air war from 1941 to 1945, is done. Works of Shores and Cull, Richard G. Davis, Kevin A. Mahoney, Allan Grainfeld were extraordinarily useful for this part of work, since above mentioned authors identified units engaged in bombardment and in few cases dates of the attacks and gross tonnage dropped.

Based on the results of the initial research detailed research is undertaken in the published and unpublished archives, in order to find bombing related documents with more detailed data. Unpublished archive materials were found in The National Archives of UK and in the Air Force Historical Research Agency (AFHRA). From these sources we obtained following documents: operational orders, summary and narrative reports, operational records and aerial photographs related to the bombardment groups' and squadrons' missions.

Published archive materials were found on the historical web sites of the bombardment groups that were part of the USAAF 12th and 15th Air Force. These sources provided facsimiles and transcripts of the operational orders, narrative reports and vertical photographs of the bombing of the targets in Sarajevo. Problem which aroused during the analysis of these documents was their verification. To avoid working with the unverified documents all data were exclusively collected from the official web sites and all collected documents were crosschecked by comparing to the verified data. If document was not verified in this manner, it was not used. Primary sources in the work were authentic archived documents while documents obtained from the web were used only in cases in which no other source was found. Data found in the documents obtained from mentioned sources were used in the analysis of the contamination characteristics; types and quantities of the bombs dropped and fuzing setups. These sources have also contributed data about the attacked targets; ie. distribution of the contamination, but many more details on this subject were found in the documents produced by the local military and civilian authorities in Sarajevo. Military authorities' documents are published in the Corpus of the Documents and Data from The Liberation War by Military History Institute of the Yugoslav People's Army in Belgrade, while civilian authorities' documents are kept in the inventory of The Historical Archives of Sarajevo.

Data interpretation

Through the analysis of the information available in different sources, 18 bombing missions on targets within Sarajevo city limits, and 51 fighter/fighter-bomber attacks in the vicinity of Sarajevo are identified. Due to the fact that bomber attacks delivered approximately 20 times more bombs across a much narrower area, this analysis is focused on the bombings within the city limits. In the documents obtained from The National Archives and AFHRA, data related to the 11 attacks were collected while the documents obtained from the web provided data for the 4 attacks. No original documents related to the 3 German bombings were found. Also in the local military and civilian authorities' archives, records of all bombings, except the German ones, were found. So German attacks were researched indirectly by coopting data from the previous studies and recorded testimonies so this part of the work is not complete and results are not final.

Air force unit's records contain following sets of related data; target, sighting method, formation and bearing of attack, amount and types of bombs, fuzing setups and delay, target area coverage and bombing efficiency. Local authorities' records contain data on; estimated number of bombs dropped, stricken locations, unexploded bombs found after the attacks, damage and victims. While analyzing these data it was noted that data provided by the different sources related to the same aspect of the same bombing might be significantly different. To avoid equivocality and confusion in the analysis, only data that could be reliably identified by the author of the record or the document, and which were relevant for the outcome, were used. From air force unit's records data related to the types and quantities of bombs, fuzing setups and target area coverage are used, while from local authorities' records are used data on damage, stricken locations and unexploded bombs. Also, for the specific bombings, number of the remaining craters, if available, was compared to the number of dropped bombs. Level of data in collected records enabled successful establishing of the contamination distribution ie. identifying locations where presence of the unexploded bombs is plausible. For several locations technical characteristics of the possible contamination are identified while for some, the only characteristic determined is the origin of the bombs with no data on type and quantity.

Results

By analyzing the data two main targets in Sarajevo are identified, Alipašin Most marshaling yards or Sarajevo West m/y and Railway workshops and junctions or Sarajevo East m/y. 90% of bombs dropped on Sarajevo targeted these areas. Alipašin Most was an exclusive target in 6 and shared in 3 allied attacks, while Railway workshops were exclusive target in 3 and shared in 3 attacks. As Alipašin Most is the area of interest in future

Case Study Sarajevo

construction works, focus is put on this area. In the attacks that aimed this area total of 3237 bombs form 250lbs to 4000lbs were dropped with the average accuracy of the 37% (percent of bombs which fell within 300-meter radius around the aiming point). As nearly 2/3 of the dropped bombs ended up elsewhere the challenge was to identify areas hit by bombs which missed the target. Aerial photos of the bombings provided fair portion of the needed data and in cases where no photos were available local authorities reports were used. Specific criteria were applied for the evaluation of this data, so evaluation is made upon the frequency and quality of mentioning of each specific single location in the narrative reports.

Total of nine stricken areas are identified, including Sarajevo downtown, and narrower spots where bombs hit are isolated within their boundaries. As no data on bombs disposed from 1945 to 1992 are found, assessment is established by cross-referencing recent findings and data obtained from the historical sources.

Out of 10 bombs found within Sarajevo city limits during last 15 years, 2 were found within 500 meters from the railway switch and the bridge at Dolac Malta, one within 500 meters from old train station at Pofalići and 7 within 700 meters from Alipašin most marshaling yards (four in the target area). Comparing this number with the historical analysis' findings, localities of Alipašin most, Buljakov potok, Alipašino polje and Švrakino selo in municipality of Novi Grad have a high risk from unearthing of an unexploded bomb at depth of 3 to 6 meters. Localities of Dolac Malta, Hrasno, Čengić vila, Otoka, Pofalići and Buća Potok in municipality of Novo Sarajevo have an intermediate risk of finding of an unexploded bomb. As bombings struck every part of the city, findings are also possible in the areas within municipalities of Centar and Stari Grad but risk of finding them in these areas is low.

Alipašin Most, as area of specific interest, where two major civil engineering projects are planned in near future, is subjected to mathematical calculation of the probable unexploded bomb according to the distribution and density of the craters. For this purpose is used methodology explained in paper „Calculation Of Per Parcel Probability For Dud Bombs In Germany" by Seyed Mohammad Tavakkoli Saboura, Jürgen Agariusb and Javad Sadidia published in "The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences", Volume XL-2/W3 in 2014. For the purpose of this part of the analysis density and distribution of the craters is determined from the available aerial and the bomb plot photos aligned with the city plan in the geographical information system (see image). Five layers/photos from the different attacks were used in the process. After the craters and known bomb impact spots were plotted and spatially identified, local 20x20 meter grid is established over the area and the probability is calculated for each of the grid squares which fit within the determined locations of interest (location for the congress center building, the route of the city expressway). This analytical method is tested by calculating probability of the unexploded bomb presence on the locations where bombs are previously found with the accuracy of 76%. Upon obtained data possible presence of the two unexploded bombs is calculated on the location where congress center building is planned. Calculations for the expressway are not completed at the moment of the writing of this paper.

Technical characteristics of the contamination obtained from the historical sources match with the field findings. Bombs used for the bombing of the targets in Sarajevo range from 50 to 250 kg in German attacks and from 250 to 4000 lbs plus flares and target markers in allied attacks. Fuzes used are impact fuzes with .01 to .25 sec delay. In two occasions long delay fuzes set to 6-72 hrs were used on total of 109 bombs. Gross tonnage dropped is 1100 tons in all attacks.

Conclusion

As a method historical research is highly dependable on the quality of the entry data for each specific location, so consistency of the research, amount and quality of the pieces of information directly affect the outcome. Insufficient entry data may give incomplete result while inadequate processing might lead to even completely wrong conclusions. That might cause in taking the incomplete results for final, so all results must be constantly reevaluated, especially in light of every new related piece of information obtained.

Historical research is a strong asset in the risk prediction and assessment especially as all the work can be done during the periods with no field activity while it provides 'field related' result. As a tool it is primarily applied in the unexploded aerial bombs risk management, but it's elements can be used in other similar residual UXO risk analysis. Applied methodology can be fairly used for the risk assessment throughout South-East European cities which sustained bombardment of the similar intensity as Sarajevo. This research provides an input for the upgrade of the present practices in the unexploded bomb management. The most prominent are improvement of the training curriculums for specific rendering safe and disposal procedures, more efficient planning of the ground search and support to the excavations, population evacuation and area isolation protocols, damage mitigation and control processes and implementation of the risk education in the endangered population like construction workers and public safety officers.

Image: Crater distribution in Alipašin most area over the aerial photos aligned with the city plan.

Quality Management in Mine Action

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Quality Management in Mine Action

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Abstract

Quality and safety are the most important factors in the process of land release. Even the slightest omission may lead to immense consequences in terms of loss of human lives and material damage. In order to achieve the required product quality (cleared land), high quality management of all processes that contribute to achieving the set goal is necessary.

The goal of quality management is to provide confidence to the user, the organization and the national authority that all requirements have been met and that the land has been returned to the end user for safe use.

Normative regulation in the form of international and national standards is very important for consistent quality management. International Mine Action Standards (IMAS) provide guidance to national authorities for efficient and high quality mine action system establishment, as well as for its management. The Republic of Croatia has chosen a model of developing its own standards, primarily due to the fact that international standards were been developed in parallel with the establishment of the mine action system in the Republic of Croatia.

Standards should ensure the safety of all participants in the process, the consistency and repeatability of all activities, the quality of products and services, greater efficiency and utilization of available resources and finally, confidence in the land returned to end users.

Figure 1: What standards provide

Quality management comprises:

- accreditation of equipment, processes and demining organization,
- monitoring and
- inspection – control upon completion of operations.

The most important parts of the accreditation process are trials and testing of equipment and tools used in mine action.

The Law on Mine Action prescribes the conditions for conducting trials and testing of equipment, the conditions to be met by mine action equipment and it also stipulates that only certified equipment may be used in mine action operations. Mine action equipment includes demining machines, mine detection dogs, hand-held metal detectors and personal protective equipment.

Key words: Quality management, accreditation, mine action equipment, testing, trial, conformity assessment

Introduction

The Law on Mine Action prescribes technical requirements for equipment and tools as well as procedures for obtaining conformity certificates. Mine action participants are obliged to use only equipment and tools that have been certified and certificates must be renewed regularly.

Furthermore, the Law specifies conditions for issuing approval to authorized legal entities to conduct conformity assessment of equipment and tools. To be approved to conduct conformity assessment, an authorized legal entity must have expert staff, a test site and a proof that the authorized accreditation body has established that the legal entity is professionally and technically qualified for conducting trials of equipment and tools within the conformity assessment process.

Upon completion of the conformity assessment procedure, the authorized assessment body issues a conformity certificate. The authorized body is obliged to perform its activities professionally, independently and impartially and it has to keep records of conformity certificates issued for mine action equipment and tools.

In the Republic of Croatia the authorized conformity assessment body is the Croatian Mine Action Center – Center for Testing, Development and Training (HCR-CTRO) that possesses necessary approvals and accreditation to conduct conformity assessment of demining machines, mine detection dogs, metal detectors and personal protective equipment.

The Croatian Accreditation Agency (HAA) has accredited HCR-CTRO in accordance with the standard HR EN ISO/IEC 17065:2013

Figure 2: Accreditation field and HAA standard sign for performing conformity assessment activities.

The procedure of conducting trials and tests is prescribed and documented in a Quality Manual and in associated procedures.

The Quality Manual defines key processes in the testing and trial procedures of equipment and tools:

- application,
- application review,
- testing and trial,
- evaluation,
- issuing conformity certificates,
- directory of certified products and
- complaints and appeals

A testing is conducted on a new type of an equipment before putting it into use, while a trial - annual check-up is conducted once a year, except with mine detection dogs, where trials may be more frequent, depending on the conformity certificate validity period (six, nine or twelve months).

Results of trials and testings

In the observed period from 2018 to 2020, HCR-CTRO conducted 8,240 trials and testings of equipment and tools.

Type/year	Number of trials			
	2018	2019	2020	Total
Machines	54	48	46	148
Metal detectors	892	896	750	2.538
Dogs	268	338	204	810
PPE	1.597	1.647	1.500	4.744

Table 1: Trials conducted in the observed period

Nonconformity of equipment and tools observed

During the equipment testing and trial procedures in 525 cases non-conformities were identified, that resulted in non-issuance of the conformity certificate.

Type/year	Nonconformities			
	2018.	2019.	2020	Total
Machines	3	4	4	11
Metal detectors	26	15	31	72
Dogs	123	178	47	348
PPE	11	12	71	94

Table 2: Nonconformities found in the observed period

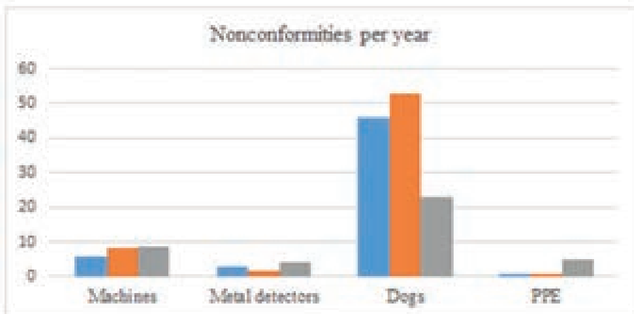
The lowest number of nonconformities related to demining machines, mostly to non-compliance with the prescribed requirements for the soil treatment quality.

There were 72 non-conformities related to metal detectors, mainly due to incompleteness and unreliability of the detection signal.

The highest number of nonconformities related to mine detection dogs, a total of 348, mainly due to not detecting the required number of targets.

Protective equipment includes protective ballistic vests and helmets with visors. The most common nonconformities were incompleteness of protective vests and insufficient visibility through the visors.

Comparing the data on nonconformity, it is noticeable that a number of nonconformities of protective equipment and metal detectors increased significantly in 2020, while that of mine detection dogs was significantly lower.



Graph: Non-conformities per years

Conclusion

The quality and procedures of trials of the mine action equipment and tools make an important part of quality management, i.e., of its most important segment – accreditation. Only functional and reliable equipment guarantees quality of mine action operations and consequently also the trust of end users in the land returned.

The established model of testing and trials of equipment and tools in the Republic of Croatia by an accredited, independent and impartial organization, ensures repeatability and consistency of the process in all its phases.

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(1) IMAS 03.40, Test and evaluation of mine action equipment;

(2) IMAS 07.12, Quality Management in Mine Action;

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Quality Management in Mine Action

MODERN TECHNOLOGIES IN MINE ACTION

Evaluation of the use of unmanned aerial vehicles in-country assessment of suspected hazardous areas in Bosnia and Herzegovina

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Evaluation of the use of unmanned aerial vehicles in-country assessment of suspected hazardous areas in Bosnia and Herzegovina

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Abstract: Bosnia and Herzegovina have submitted an extension request to fulfill the obligation under Article 5 MBT. Through 2017-2018, a project funded by the European Commission was launched, a methodology for country assessment developed and survey teams were trained. Through December 2018 to December 2019, 14 survey teams from BHMAC, Norwegian People's Aid and Bosnia and Herzegovina Armed Forces performed field and other activities under country assessment of SHAs contaminated with mines, cluster munitions and other explosive remnants of war. Survey teams have been used different techniques to collect data and analyze evidence of the presence of explosive threat and the characteristics of existing SHAs. They were equipped with 14 UAVs DJI Phantom 4 PRO V.2 with a color camera. The use of UAVs for assessment at the country level was a novelty which required more careful planning and training of teams to use UAVs. Evaluation of the use of UAVs includes analysis of planned and performed flights, the ability of teams to record, process and analyze data, UAV flight outputs including utilization of photos for mine situation analysis, geocoding, photomosaics and survey with questionnaire among teams. The evaluation results provided a better understanding of the extent to which UAVs contributed to the efficiency and quality of the country assessment of SHAs.

Keywords: unmanned aerial vehicles, country assessment, suspected hazardous areas, Bosnia and Herzegovina, Norwegian People's Aid, AIDSS, Multi-Criteria Analysis

Introduction

Bosnia and Herzegovina (BiH) have submitted an extension request to fulfill the obligation under Article 5 MBT. Through 2016-2017, the Demining Commission in BiH and the BiH Mine Action Centre (BHMAC) developed a national Mine Action Strategy 2018-2025. The work on the operationalization of the Strategy identified some obstacles. (1) There was no updated baseline of mine contamination and its impact in BiH for the Strategy implementation. The previous country assessment of suspected hazardous areas (SHAs) in BiH was based on an outdated methodology from 2001 which was no longer comply with IMAS and its land release concept. (2) Application of IMAS evidence-based decision making was not applied fully into Bosnia and Herzegovina mine action management. It requires an inventory of remaining direct and indirect evidence on mine threats. BiH must complete the development of more efficient land release and planning to accelerate compliance with Article 5 MBT. Both obstacles limited the country's ability to anticipate the extension of the obligation under article 5 MBT supported by an effective mid-term plan for the land release of SHAs. The solution was to implement a new country assessment of SHAs with an improved country assessment of the size and impact of the explosive threat and its impact in BiH. A project funded by the European Commission was launched, a methodology for country assessment developed and survey teams were trained by the end of 2018.

Through December 2018 - December 2019, 14 survey teams from BHMAC, Norwegian People's Aid (NPA) and Bosnia and Herzegovina Armed Forces (BHAF) performed field and other activities under country assessment of SHAs contaminated with mines, cluster munitions and other explosive remnants of war. Survey teams have been used different techniques to collect data and analyze remaining evidences of the presence of explosive threat and the characteristics of existing SHAs, such as desk study, measurements for positioning evidences and SHAs, gathering and analyzing contamination and impact data through observations, interviews, community questionnaires, and unmanned area vehicles (UAVs) use. Survey teams were equipped with 14 UAVs DJI Phantom 4 PRO V.2 with a color camera. Evaluation of the use of UAVs includes analysis of planned and performed flights, the ability of teams to record, process and analyze data, UAV flight outputs including utilization of photos for mine situation analysis, geocoding, photomosaics and survey with questionnaire among teams. The evaluation results provided a better understanding of the extent to which UAVs contributed to the efficiency and quality of the country assessment of SHAs. Besides an analysis of the recorded data, 14 survey teams involved in the country assessment (9 BHMAC, 3 NPA, and 2 BHAF) completed the questionnaire for the evaluation of the use of UAVs during February 2020.

Contribution of UAV flights in filed survey operations

Until 20 February 2020, survey teams planned and used UAV for data collection and assessment on 44% of 427 processed SHAs. An area of 89.42 km2 or 10.4% of the total size of SHAs was covered by UAV flights. Teams performed 384 flights with a duration of 6,761minutes, which is 17.6 minutes per flight on average (Table 1).

Among survey teams, there are different practices in the intensity and the way of the use of drones caused by (1) different levels of training, knowledge, skills, and competences in data collection and processing using UAV; (2) different environmental conditions in which the teams worked (topography, terrain characteristics, vegetation, population, etc.); (3) skepticism towards the use of new technologies in the survey. Survey teams have successfully used the existing SOP provisions on the use of UAVs.

Use of UAV as a tool to strengthen evidence -based decision-making approach

Survey teams have been recorded 10,620 photos or 27.7 photos per flight on average. Out of the total, 2,510 photos or 23.6% have been used for the analysis of mine contamination. It is 6.5 photos per flight on average. About half of the utilized photos are geocoded to locate evidence. Two survey teams used photomosaics as an improved analysis of canceled areas. Teams recorded 187 videos while 23.5% of them are used for the analysis of mine contamination (Table 2).

The survey team processed and recorded 14,513 pieces of evidence using all survey techniques (8,955 direct and 5,558 indirect shreds of evidence). Out of total 1,770 or 12.2%, evidence was processed using results of UAV flights. It is 4.6 evidence per flight and 3.8 flight minutes spent per evidence. They include 156 or 1.74% of all direct evidence recorded and 1,614 or 29% of all indirect evidence recorded). Use of UAVs equally supports UAV's data collection analysis as a first technique to discover new evidence (906 or

From 30 November until 20 February 2019		Total	Per the survey team			
			Average	Median	Min	Max
The period in which the survey teams used UAVs	months	156.89	11.21	10.90	7.13	15.06
All SHAs where field surveys were completed (all techniques)	#	427	30.50	29.50	10	58
	km2	858.02	61.29	66.67	20.03	88.90
SHAs where UAVs were used (size of the area surveyed with UAV only)	#	188	13.43	10.00	1.00	32.00
	km2	89.42	6.39	0.85	0.10	34.34
Number of flights	#	384	27.43	13	1	95
Flights duration	min	6,761	482.93	276	10	2,220

Table 1. Use of UAV by survey teams during a country assessment of suspected hazardous areas in BiH

Evaluation of the use of unmanned aerial vehicles

From 30 November until 20 February 2019	All teams	
	#	%
All photos recorded by UAV and reviewed	10,620	
Photos utilized to analyze mine situation	2,510	23.6%
Photos geocoded	1,309	12.3%
Photomosaics	12	
All videos recorded by UAV and reviewed	187	
Videos utilized to analyze mine situation	44	23.5%

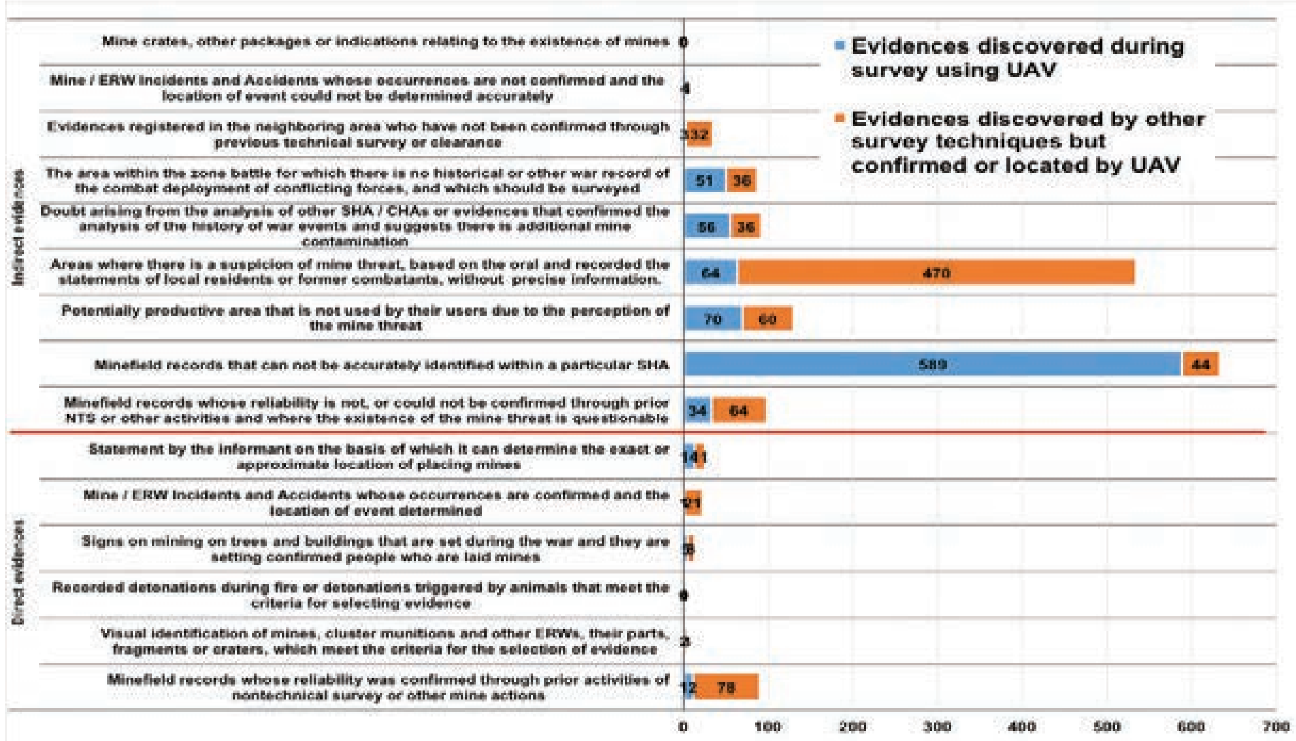
Table 2. UAV flights output

51.2% of evidence) and discovering evidence by other survey techniques and confirmed or located by UAVs (743 or 48.8% of evidence). Considerable variations were observed in the collection and processing of different categories of evidence (Graph 1). UAVs were mostly used to identify and locate data on mine threats, whether it be on record in the database or on the statements of witnesses. This applies to both direct and indirect evidence. The teams also had the opportunity to give their opinion on the usefulness of UAVs for collecting and analyzing data in the survey SHA. They ranked eight purposes for which the most used UAVs for the survey. According to the teams, UAVs are mainly used for the analysis of the spatial characteristics of the SHA, for the application of cancellation criteria and a more accurate location of evidence (Table 3).

Regarding the use of drones, teams were offered six statements where they answered via a Likert scale of agreement. They have a positive opinion (fully agree or agree) for next statements: (1) the use of drones as a data collection technique has enhanced our work in the assessment of environmental conditions (vegetation, land, topography, etc.) (14); (2) we would recommend the use of drones in the future operations of non-technical survey (13); (3) the use of drones as a data collection technique has advanced our work to identify indirect evidences of mining (trenches, bunkers, etc.) (13); (4) the provisions of the chapter "Flight by drone to collect data" from the SOP "Country assessment of SHAs in BiH" are clear and easy to follow (13) and; (5) the

Ranking results by 14 survey teams	Average	Rank
For the assessment of environmental, soil, topography and other environmental characteristics of SHAs	2.57	1
To sub-division, increase, or cancel SHAs	2.57	1
For the more accurate location of evidence	5.64	3
To analyze mine contamination history within an SHA	6.07	4
To confirm evidence of contamination which has been previously identified by other techniques.	6.71	5
To check data on mines and other explosive devices collected from the population or through some other techniques	6.79	6
To detect explosive devices on the ground	8.29	7
To discover new evidence of mine contamination	9.43	8

Table 3. Question: For what purpose was the drone most used in collecting and analyzing data in the Country assessment of SHAs in BiH?



Graph 1. Structure of evidence on the presence of mine threat processed using UAVs by survey teams

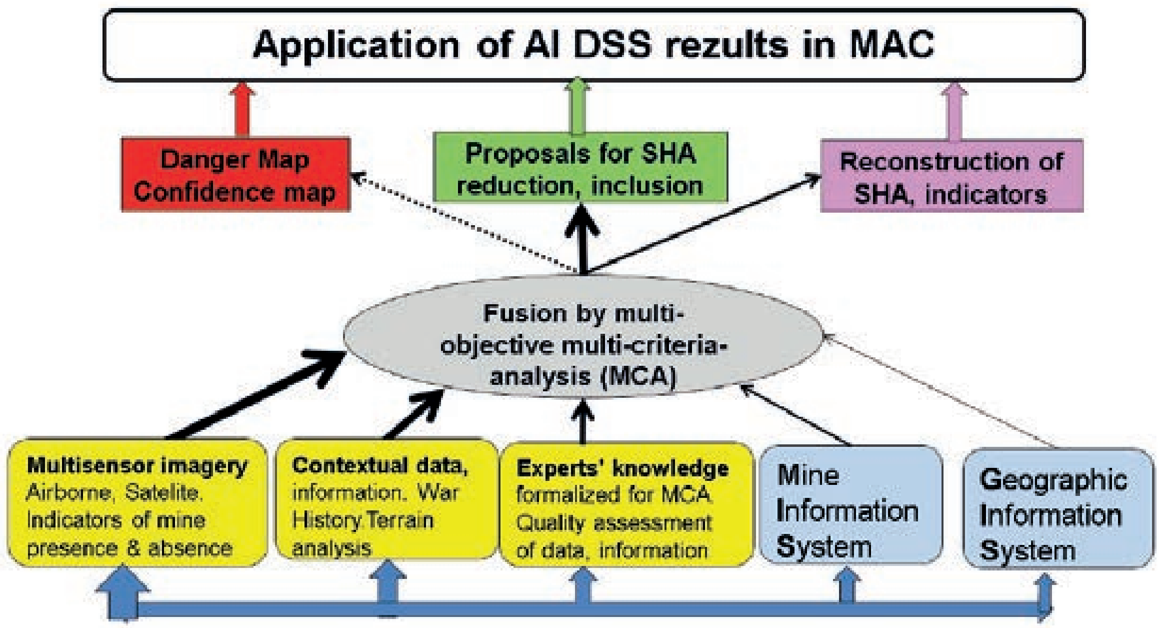


Figure 1. Scheme of AIDSS application in Bosnia and Herzegovina [1].

use of drones as a technique for data collection has full applicability in our work on the non-technical survey. Teams have mainly negative opinions on the statement: (6) the use of drones as a data collection technique has advanced our work to identify direct evidence of mines (visible mines, etc.) (6 disagree, 5 neutral).

Advancing processing and interpretation of collected photographs and videos

The data collected by the use of UAV with a color camera are interpreted subjectively and the results are evaluated in the previous text. Here we briefly consider options for advancing the interpretation outcomes of collected photographs and videos, based on a similar project done in a project "Determination of Mine - Suspected Area near Bihać, Mostar,

	Indirect IMP	B	M	T
1	Trench	30	30	2
2	Bunker	32	9	
3	Pedestrian's shelter	37	109	20
4	Dry stone-wall	3	15	3
5	Destroyed building	1	9	6
6	The road not in use	11	3	
7	Dugout	5		4
8	Shelter	3	10	4
9	Tank shelter	3	1	
10	Artillery shelter	2		
12	Shelter of multiple launch rocket system	1		
13	Mortar shelter	1		
15	Surveillance post		7	6
16	Stone bank		17	

Table 4 Indirect indicators of mine presence IMP, [1].

Trebinje by Advanced Intelligence Decision Support System (AIDSS) Bosnia and Herzegovina", [1]. The relevant methodology and results are presented in [2], [3], [4], [5]. The scheme of the AIDSS, a list of indirect indicators of mine presence (IMP), areas, for three analyzed regions, near Bihać (B), near Mostar (M) and near Tebinje (T), show benefits obtained by AIDSS methodology. In a whole process is applied objective methodology of the fusion of the data, information, knowledge of mine information system (MIS), geographic information system (GIS), experts' knowledge with results of processing the collected imagery. For fusion is applied multi-criteria analysis (MCA) methodology, Fig. 1, Tab.4 reflects differences of IMPs due to the differences in contamination situations and terrains.

The aerial platform for a multisensory system used in [1] was helicopter Mi-8. Although it has many limitations if applied for humanitarian mine action, valuable results are obtained.

The country assessment of SHA in Bosnia and Herzegovina, 2018-2019, is based on the use of 14 UAVs, with color cameras collecting photographs, Fig.2, Fig.3, and color videos. The survey teams also added other kinds of data and information, by conventional non-technical survey methods, Fig. 4.

Figure 2 Trenches and shelters Berkovići.

Figure 3 Separation defense lines Paležnica

Figure 4 Inclusion in SHA, an example of an outcome from NTS based on UAVs.

The survey teams collected very valuable images and videos, several of them made mosaics and final products, maps for cancellation from SHA or for inclusion into SHA. Authors prepared PowerPoint presentations which will include mentioned contributions. The achieved level of processing and interpretation is evaluated in previous sections, while here we propose to apply whole AIDSS methodology and derive outcomes with the highest level of reliability.

Conclusion

The widespread use of UAVs requires careful monitoring and evaluation of activities performed to understand better the benefits and how to improve applied UAV flight techniques. The introduction of UAVs has improved the efficiency, quality, and accuracy of SHA assessment. When it comes to identifying and analyzing a mine threat, the level of participation of UAVs in the identification and analysis of the evidence of 12.2% of all evidence is above expectations, especially considering that it took significantly less time to identify those using UAVs than when using other techniques to detect data collection and analysis.

The use of UAVs for assessment at the country level was a novelty which required more careful planning and training of teams to use UAVs. We propose to apply AIDSS methodology on the whole amount of data collected till 20 February 2020 and derive objective outcomes with the highest level of quality and reliability.

Acknowledgment

Data and evaluation inputs are provided by teams of BHMAC, Norwegian People's Aid and Bosnia and Herzegovina Armed Forces.

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Testing of new imprinting technique for the training of mine detection dogs on a carousel scent discrimination device

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Testing of new imprinting technique for the training of mine detection dogs on a carousel scent discrimination device

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Abstract

The standard imprinting techniques on a carousel or alike scent discrimination devices assume that dogs associate odor of explosives and mines with known odor of the kong toy and after recognizing that odor above the mines buried in the ground. The time required for a dog to associate known odor with the odor coming from a mine depends on several factors such as type and depth of the mine targets, but also on various environmental factors affecting the vaporization and the contamination extent. This means that imprinting process requires longer time when conditions are not optimal. If searching scenarios change, the process often needs to be repeated. Field teams sometimes experience difficulties with imprinting at the locations with different operational conditions, but it is commonly attributed to acclimatization or human (handler) factor.

The aim of developing a new imprinting technique is to provide odor picture closest to the odor of the buried landmines and present it to the dogs at earliest training stage as possible. Following this logic, the new imprinting protocol has been created and tested with 20 dogs from the beginning of their imprinting training over several months in Norwegian People's Aid Global Training Center for Mine Detection Dogs. Analysis of testing results explains influence of factors contributing to detection rates and to the duration of the entire imprinting process exposed during the testing of new techniques. Further development of the techniques may significantly reduce landmine scent imprinting time, as well as needs for extensive re-training due to changes in operating environment.

Keywords: odor detection, mine detection dogs, imprinting, Norwegian People's Aid, Global Training Center, TNT contamination, land mine detection

Introduction

Mine detection dogs (MDD) are widely used in humanitarian demining operations for half of the century. There are still various methods of training and application range, often subject of disputes within the wider community, as well as among dog trainers and operators. Although several research studies were conducted on the applicability of the MDD systems, the training techniques are commonly not explained or supported by scientific evidence. There are several ways and approaches to teach dogs to detect explosive odors and landmines. The most common approach is to assist dogs with associating odor of explosives by presenting it together with an odor that is very familiar to the dog. This familiar odor is usually a toy that is being used to play with a dog. Playing with a toy is actually main rewarding method for the dogs and detection training process begins with searching for the toys. Some dog training schools are reducing amount of familiar odor (a toy) in searching exercises, while some attempting to associate familiar odor directly with the mines.

The standard imprinting techniques on a carousel or alike scent discrimination devices assume that dogs associate odor of explosives and mines with known odor of the kong toy and after recognizing that odor above the mines buried in the ground (Bach & Kelly, 2004). The time required for a dog to associate known odor with the odor coming from a mine depends on several factors such as type and depth of the mine targets, but also on various environmental factors affecting the vaporization and the contamination extent. This means that imprinting process requires longer time if conditions are not optimal, and sometimes the process needs to be repeated when searching scenarios change. It is not uncommon that teams experience difficulties with imprinting at the locations with different operational conditions, but it is often attributed to acclimatization or human (handler) factor.

The aim of developing a new imprinting technique is to provide odor picture closest to the odor of the buried landmines and present it to the dogs at earliest training stage as possible. The initial idea was to contaminate soil with the explosive and use it instead of explosive pieces from the beginning of the imprinting process. The amount of explosive odor in the contaminated soil is far less comparing to the odor of the visible explosive fragments. Furthermore, the odor of the contaminated soil is much closer to the composition and the amount of the odor available above the mine in the ground. Following this logic, the new imprinting protocol has been created and tested using 20 dogs from the beginning of their imprinting training over several months in Norwegian People's Aid (NPA) Global Training Center for Mine Detection Dogs (GTC). The protocol prescribes procedures for detection of the soil samples contaminated by the gradually reduced amounts of TNT. In the first phases samples are presented on the carousel, later on the ground, while in the last phase the samples are being associated with the buried landmines. On each searching session, negative samples and distracting odors were presented beside one to three positive samples. The last testing phase was conducted under unfavorable environmental conditions in unknown test area that hasn't been used before.

Problem

The standard imprinting techniques on a carousel is entirely based on dog's ability to associate smells from the mine location with the samples presented during the training. However, the fact that process has to be repeated when conditions on the ground change, indicates that odors presented during the training and odors above the buried landmines are not necessarily similar and easy to generalize.

The first significant difference is amount of the chemicals found in training samples and above the mines in the ground. It has been argued that that presence of the explosive chemicals do not necessarily meet minimum odor requirements for dog detection (McLean & Sargisson, 2005).

Concentrations of explosive originating chemicals above the buried land mines are usually measured in nanograms per gram of soil (Phelan J. and Webb S., 2003). However, concentration of explosive substance used in samples for detection training are at best measured in milligrams, which is thousands of times bigger concentration of the chemical comparing to those found above the buried mines. These facts lead to the questions if (1) can the imprinting training process be improved to provide more relevant odors on the carousel and similar techniques, and (2) can such training shorten imprinting training and minimize difficulties when searching scenarios are changed?

Designing and the application of a new imprinting technique

In order to make training odors more relevant to landmine searching context, NPA explores alternative ways for creating samples. The proposed idea is to contaminate soil with an explosive substance and use that soil instead of explosive and landmines pieces from the beginning of the imprinting process. The amount of chemicals in the contaminated soil is obviously much closer to the amount of chemicals found around the landmines out in the field. It is not expected that artificial contamination will be much higher comparing to the real conditions, as the soil around landmines reaches equilibrium of saturation at some stage (Phelan J. and Webb S., 2003). The soil contaminated in such way can be used instead of pure explosive pieces even in early imprinting phases. To test the concept, NPA chose to use TNT military grade explosive used in PMA 1 landmine. Samples of the soil are collected at sufficient distance from possibly contaminated area. After collection, the samples are stored in the hermetically closed glass jars together with a piece of TNT (100, 50, and 10 grams). The piece of a white paper has been stuck on the inner side of the jars' lids. As it is known that substances changes color to yellow or red when exposed to TNT, this paper is used as an indicator that soil is saturated with the TNT chemical. The jars are left to soak indoors, at the room temperature, until the indicator paper changed its color. For the control purpose, the dummy soils samples should be prepared. Contaminated soils and dummy soils are stored in separate rooms. Both rooms shall have the same conditions, so temperature and humidity shall be monitored.

The testing protocol prescribes procedures for detection of the soil samples contaminated by the gradually reduced amounts of TNT. In the first stage samples are presented on the carousel, later on the ground, and in the last phase the samples are associated with the buried landmines. On each searching session, negative samples and distracting odors were presented beside one to three positive samples. At the beginning, the carousel work was divided in four phases of detecting contaminated soil samples: (1) Samples of soil contaminated with 100 g TNT presented with known odor ('kong' toy); (2) Samples of soil contaminated with 100 g TNT; (3) Samples of soil contaminated with 50 g TNT; (4) Samples of soil contaminated with 10 g TNT. One sample used in training contains one teaspoon of the soil. The dog transits from one to the next phase after three successful detection sessions. If dog doesn't detect the sample, or make a false indication, it will repeat the previous phase.

Starting position for the dog should be determined randomly. The dog can be rewarded with 'kong' toy, other toy, or food. After the dog indicates, the cup with the positive shall be removed. The session ends when dog runs full circle without indications. After the session is completed by one dog, all cups and carousel shall be clean by acetone.

After all phases on carousel are successfully completed, the samples will be presented for outdoor training on the ground in next three phases: (1) Sample of contaminated soil on the ground; (2) Samples of contaminated soil above the buried mine; (3) Buried mine only. The principal of the progress from phase to phase is the same: after three successful detections.

To prevent dogs cueing other signals, it is important that sufficient soaking time has elapsed that all ground disturbance from digging has disappeared. Besides, surface laid mines must not be used. The last testing phase was conducted under unfavorable environmental conditions in unknown test area that hasn't been used before.

Adjustment of training protocols after analysis of initial results of control tests

To test training protocols, seven dogs were selected. After the first results, more dogs were included in the trial, including operational dogs and dogs that already completed imprinting on TNT and landmine pieces. As expected, most of the dogs were able to detect samples of contaminated soils without major problems. However, the initial test results indicated some problems that required the upgrade of the new imprinting technique: (1)The dogs that were only trained to detected contaminated soils did not detect TNT if presented separately; (2) Some dogs that were detecting landmines in the field, and the TNT on the carousel, were not detecting contaminated soil; (3) Most of the dogs had difficulties detecting soil contaminated with 10 g of TNT. It should be noted that paper indicator in the jars for point 3. didn't change the color even after several months of soaking time. Considering above points, it has been decided to change the testing procedure and remove 10 g contamination until the preparation of the samples is better understood.

Analysis of testing results

Analysis of testing results gained using new imprinting techniques includes: (1) Analysis of the learning phase which included learning new odor (TNT or contaminated soil); (2) Analysis of success during training on carousel device; (3) Analysis of the field testing results.

Analysis of the success rate of the learning phase is conducted to confirm training level of the dogs required for advanced detection tasks. It basically means that in order to proceed with detecting new substances, it had to be confirmed that dogs are trained to search on carousel, indicate, and recognize odor of very small amount of kong toy. Detection success rate for the learning phase for the standard imprinting technique is 98,9 % for the 89 sessions. Such result proves that dogs entering imprinting phase have developed good detection ability on the kong toy and are consistently indicating it regardless of it size and background odors.

Detection rate of the dogs presented with the contaminated soils instead of solid TNT are 82,4 % for 68 sessions. Even though it may look as low total success rate, several dogs completed this phase with 100 % success rate. The total rate is affected due to the fact that some dogs in this group were already imprinted on TNT and did not search for kong pieces for at least several months. These conclusions are confirmed with the analysis of the next phases of carousel work which included more 1300 sessions.

Target	False indication		Missed target		Hit		Total tests
TNT	63	11.4%	61	11.1%	428	77.5%	552
TNT 10 gr	4	17.4%	4	17.4%	15	65.2%	23
TNT 50 gr	31	14.6%	15	7.1%	166	78.3%	212
TNT 100 gr	19	11.6%	10	6.1%	135	82.3%	164
Total tests	117	12.3%	90	9.5%	744	78.2%	951

Table 1. Results of testing on a carousel 2019-2020

The second analyses explore detection work on the carousel. Through 2019 to February 2020, dogs were tested with new imprinting techniques on various TNT and contaminated soil samples: (1) TNT pieces amounting 0,3 to 2 g; (2) Soil contaminated with 100, 50 and 10 g of TNT; (3) Contaminated soils presented together with TNT piece 0,5 to 1 g. This analysis explores influence of dog handlers, individual dogs, presented target substance, room temperature and sample preparation time to the actual result of the detection training session (success of detection, target missing, and false indication). In these phases detection rates of the dogs trained on contaminated soil were even higher than rates of the dogs detecting solid TNT. Lowest detection rate was on the soil expected to be contaminated only with 10 g of TNT. The success level was 65.2% which does not meet the detection criteria set for the initial training phase. Further testing is needed to explore relevance of usability of such samples in imprinting training.

Cross checks of results have shown that several dogs trained on contaminated soil were not automatically detecting solid TNT. While it was expected that dogs trained on solid TNT might be not detecting contaminated soils, missing solid TNT after detection of samples with enormously low concentrations of the same substance, suggests only that dogs do not perceive those two odors as the same.

After the small TNT pieces have also been added in contaminated soil samples, detection rates improved and matched those for solid TNT and contaminated soils. False alarm rates are lowest for this combination (6,7%), while false alarm rates on solid TNT are more than 10 %.

Highest detection rates are observed when samples are prepared and searched during the same day (80.9%). It decreases down to 70.7 % after an overnight, and even down to 46.2 % after 64 hours. As the preparation process is well controlled, soaking time effect proves that odor in the contaminated soils definitely changes over the time, and likely over the mines as well.

The effect of soaking time was analyzed only for contaminated soil samples. The obtained results suggest that detection rates are significantly deteriorating with time elapsed from samples preparation to detection session

Soaking time (h)	False indication		Missed target		Hit		Total
0.5 to 6	108	10.6%	86	8.5%	822	80.9%	1,016
17 to 21	20	17.2%	14	12.1%	82	70.7%	116
64	4	30.8%	3	23.1%	6	46.2%	13
Total tests	132	11.5%	103	9.0%	910	79.5%	1,145

Table 2. Influence of soaking time to results

(soaking time). The other contributing factors are handlers and dogs. While some dogs have consistently high detection rates regardless of training phases and used target substances, some dogs struggle to maintain good detection rate and often falsely indicate. This behavior could be explained also with the handler factor which may contribute in different ways: from disturbing dog during the work, mimicking, to simply affecting the dog with his or her presence. However, the handlers behavior was not subject of this testing and observations in that regards are not recorded. The results obtained indicate the need for the further upgrade of the protocol with the variables that better measure the impact of the handlers, which implies closer supervision of their work.

The last analysis includes 113 tests in the field to explore possible influence of external factors on detection success (handler, type of target, environment parameters - temperature, relative humidity, heat stress index, ground temperature, and the ground level relative humidity). The detection rate was 63%, while false alarm rate was 18 %. The results also show that the dogs trained only trough ground contamination technique detected mines in a same rate as dogs trained following standard technique. The environment and weather data were gathered for statistical analysis. Some weak correlation with the temperature has been identified. There was no correlation found with the depth of the landmine targets. It is noted that the number of collected data is insufficient for reliable conclusions on field stage of testing.

Conclusions

The imprinting on TNT contaminated soil samples is the detection dog training technique that is still being developed. This testing encompassed entire standard and new imprinting techniques on a carousel device with several dogs of different training level and detection experience. During the testing period the procedure has been adjusted several times in order to apply experienced results. The testing in the field has only been conducted during short winter period in quite unfavorable ground conditions. The information gathered during this limited period was not at the level required for correlation analysis. Therefore, the influence of the factors contributing to detection rates is still not fully explained. However, there are indications that further development of the techniques may significantly reduce landmine scent imprinting time, as well as needs for extensive re-training due to changes in operating environment.

Test results so far indicate that dogs can detect odors in samples contaminated with TNT at the same level or with higher contribution of hits as in previous standard training protocols on carousel. Exploring alternatives and testing of the new imprinting technique also exposed some weaknesses in standard training systems, as well as in following training routines and procedures. The questions are raised about the adequacy of the standard imprinting method, in particular: (1) Are the samples used during the training process really relevant? , and (2) Can the whole process with recognizing explosive substances on the carousel be skipped, and imprinting training conducted only with association of familiar odor – for example with a kong toy?

Further development and testing of imprinting techniques should take in account the conclusions of these analysis: (1) Odor of contaminated soils and solid TNT samples are perceived as different by dogs. Training only on solid particles of the landmines might not be always enough. In the other hand, if solid TNT is used for the purpose of developing association for dogs, the process is likely excessive; (2) Imprinting on soil contamination shortened process to the detection of PMA 1 landmine; (3) Dog behavior and dog's previous experience is still the most significant factor determining detection success. Skipping training phases and lack of understanding how dogs are perceiving the odor will affect the detection rates.

The final conclusion of the analyses is that suggested technique should be further developed, and testing expanded to include other soil types, landmine targets, and different climate zones. Besides, focus should be paid on the impact of the handlers and strict adherence to the procedures.

The continuation of activities is justified, as such technique has potential to reduce required time for imprinting on target substance, possibly reduces needs for a training areas and number of targets with relevant soaking time, and improves quality of daily testing in the field operations.

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A thermal infrared video provides the gain to the separability of the target

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A thermal infrared video provides the gain to the separability of the target

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Abstract

We consider the main differences between the survey from the remotely piloted aircraft systems (RPAS) if done by longwave infrared (thermal infrared - TIR), or by sensors in visible wavelengths (color). The color survey is almost always applicable if the light conditions are on average normal. The thermal contrast Tt/Te of the target Tt and the environment Te shows significant daily changes. Due to the described and other critical facts, the TIR survey from RPAS is not simple like the color visible. There is a need to provide the matching parameters of the TIR survey to features of the targets and the environment: landmines (LM), unexploded ordnance (UXO), improvised explosive devices (IED), cluster munition (CM), and provision of needed detecting probability for the considered targets and the environment. The currently used thermal infrared cameras provide recordings in two formats of thermal images, 640x512 pixels, and in video (e.g. MV4) format, with 30 (or 25) frames per second, each frame has 720x480 pixels. We report the outcomes of the testing and analysis of the TIR survey, which shows the increase of separability and thermal contrast if are used TIR video recordings, [1].

Key words: Longwave IR, thermal IR, TIR video frame, TIR image, target, environment, separability

The TIR video provides the gain to the separability of the target

Thermal Imager Zenmuse XT 640 × 512 pixels. Pixel Pitch 17 μm, Sensitivity (NEdT) <50 mK at f/1.0, Photo JPEG (8 bit) / TIFF (14 bit), Video MP4,30 Hz, 720x640 pixels, Lens 9mm, Field of View 69ox56o Software: FLIR tools, MapInfo, Pix4D, [1], [2], Fig.1

Figure 1. Thermal Imager Zenmuse XT.

The TIR video recording can be exported into a sequence of images (frames), every frame has 720x480 pixels, with a frequency of 30 frames per second. When RPAS flies over the target, the received TIR radiation coming from a target increases gradually to a maximum and decreases gradually. In this process exist TIR frames that have stronger recorded data then the data of the TIR image 640x512 pixels, Fig.2.

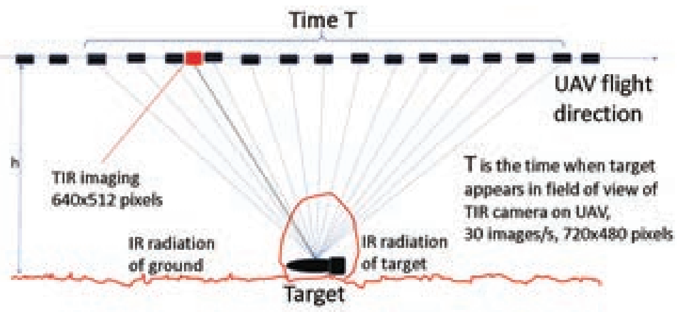


Figure 2. When RPAS flies at height h above the target on the ground, with speed v (m/s), the TIR sensor receives TIR radiation of the target during the time T. In thermal video

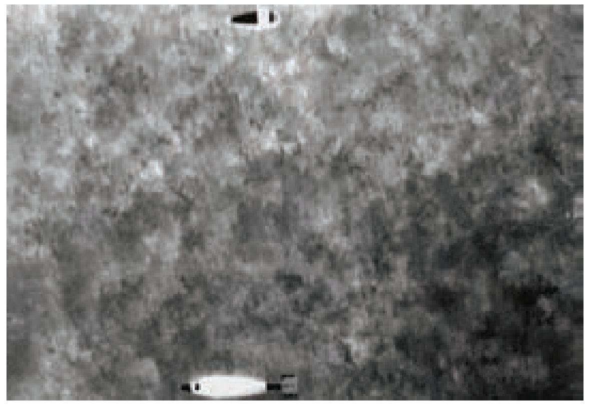
frames (720x480 pixels) this happens more often. The measure of the benefit is the separability S, Fig.3,

$$S = |\mu_t - \mu_e| / [(\sigma_t^2 + \sigma_e^2)^{1/2}] \qquad (1)$$

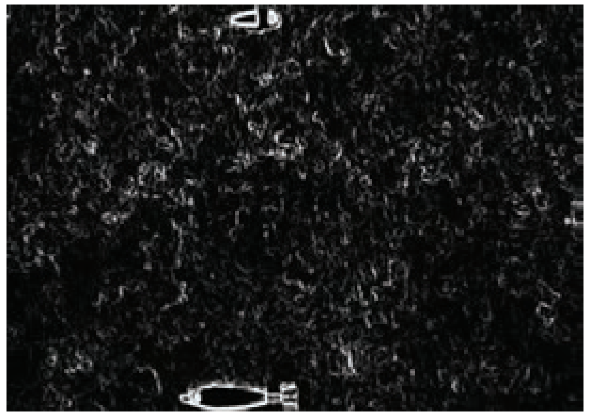
where μ_t, μ_e are mean values, σ_t^2, σ_e^2 variances of target (t) and environment (e).

Figure 3. The definition of a separability S.

Separability obtained from TIR video frames 720x480 pixels shows significant gain if compared to the separability obtained from TIR images 640 × 512 pixels. During time T, when the target is visible from the thermal sensor on an RPAS, its separability obtained from thermal frames is always larger from the separability obtained from the thermal image. The detection of targets in a TIR survey from RPAS in NPA practice is performed: a) by manual search the targets on the collected images or the videos, which are collected by the automatically programmed survey flights; b) by free RPAS flight, when the operator manually guides the RPAS while searching the suspected objects - targets. For search targets in the video is needed real-time processing hardware, but this can be solved by a tool that enhances the edges of the target, in a sequence of TIR frames exported into image format, Fig.4.



a



b

c

Figure 4. Tool for the detection edges of targets in the thermal infrared video recordings. a) Two targets in 720x480 pixels video frame, b) The enhanced edges of targets, c) The clutter suppressed.

The goal of [1] was to analyze the difference between TIR and color visible survey via RPAS and apply outcomes into elements for standard operating procedure. The eleven explosive targets were selected, for this purpose, Fig. 5 and Fig. 6.

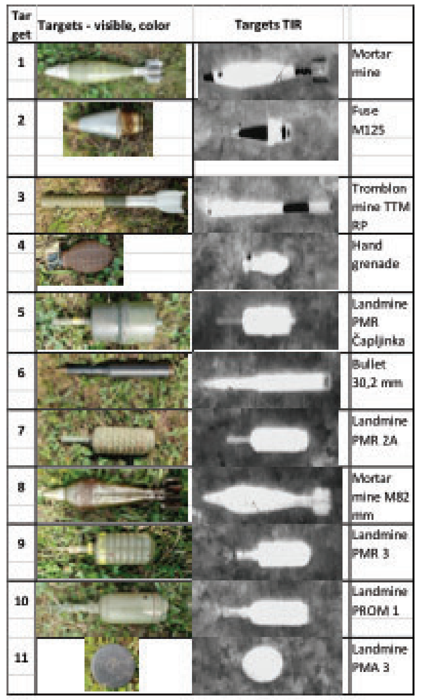


Figure 5. Targets and their TIR images.

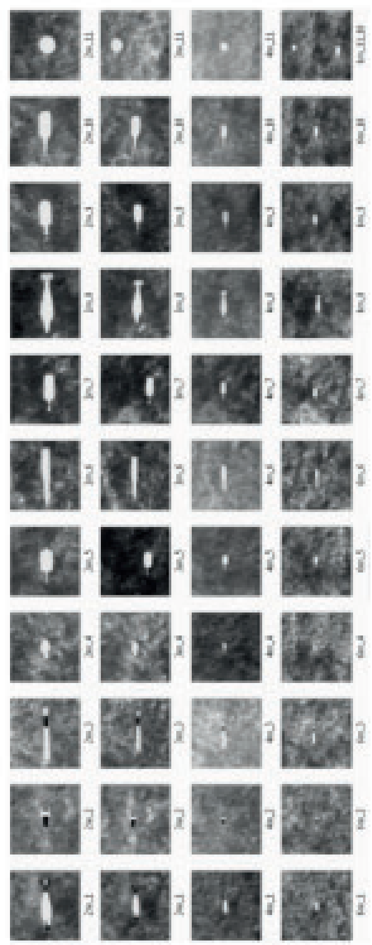


Figure 6. TIR visibility of 11 explosive targets, from RPAS at heights 2 m, 3 m, 4 m, and 6 m.

In Fig.6. is presented the influence of RPAS flight height on TIR visibility of target, while in [1] is derived, full quantitative model. The color visible survey is almost always applicable if the light conditions are average normal. For the TIR reliable survey, and detection of targets, the Sun insolation is obligatory, but this is not enough, the thermal contrast Target/Environment shall be > 1. The TIR survey is additionally limited by the emissivity ε of the target, ε<1. Emissivity, reflection, imaging angle decrease the probability of the target detection & identification via the TIR measurement. The atmosphere attenuation is negligible if RPAS flight heights are lower then 10 m. The thermal contrast of the target and the neighborhood shows significant daily changes, [2]. For the reliable detection of the target, the number of pixels on its area should be high, this is defined by Johnson's criteria, [3]. Due to described facts, the TIR survey from RPAS shall provide the following, [1]:

- Matching parameters of the TIR survey to features of the targets and the environment, landmines (LM), unexploded ordnance (UXO). In future Improvised explosive devices (IED).

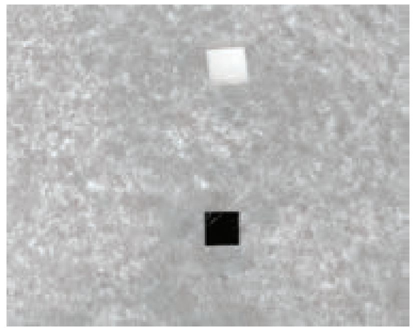
- Provision of needed detecting probability for the considered targets and the environment.

- Optimizing the UAV based TIR acquisition for Land Release, Non-technical and a Technical survey.

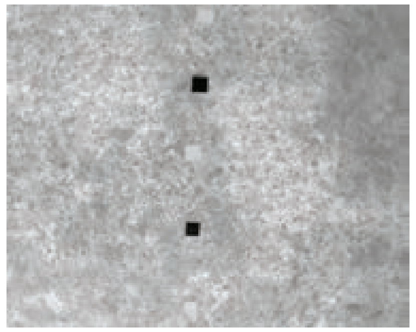
- Evolutionary design of the standard operating procedures (SOP) for the TIR survey, verified in several totally different environments and situations.

Operational calibration of TIR spatial resolution

The probability of a survey mission by a TIR camera on board of RPAS depends on the achieved spatial resolution of the collected images and video frames. While there are numerous causes that decrease obtained spatial TIR resolution, it is mandatory to check achieved spatial thermal resolution. For this task, we applied operational calibration by the use of polished aluminium markers. The aluminum square polished surface appears in the TIR image black and has a large contrast to other parts of the terrain. The use of such markers enables the operational calibration of the spatial TIR resolution. The wooden or paper markers that are painted black, appear in thermal images as white squares.Fig.7.



a



b

Figure 7. TIR image of the calibration markers.

a) h = 2m, markers 15x15 cm,

b) h = 6 m, markers 15x15cm, 10x10 cm.

Knowing the dimensions of the calibrating markers, numbers of pixels in the horizontal axis (M=640), the vertical axis (N=512) one can calculate the dimension of the pixels of the considered survey. The measured TIR resolution is always coarser of theoretical value, due to several causes, e.g. the blurring the images due to movement and the vibrations of the camera on RPAS, weather conditions, thermal conditions. The success of a TIR survey mission by RPAS is often uncertain while the use of dual-sensor (thermal infrared camera and visible color camera integrated into one unit) can overcome this problem, Fig.8.

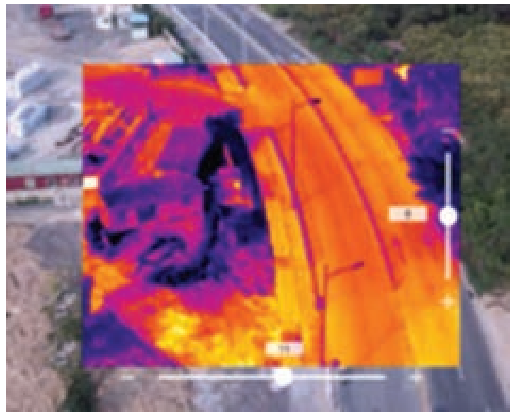


Figure 8. The visible wavelengths image and TIR image are fused in dual-sensor camera.

Acknowledgments

Norwegian People's Aid, Mine Action and Disarmament Programme Bosnia and Herzegovina, provided tests and data for use in [1], [2] and in this conference article.

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A thermal infrared video

Bee4Exp: Biological Method (Bees) for Explosives Detection

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Bee4Exp: Biological Method (Bees) for Explosives Detection

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Light-emitting organic semiconductors are highly sensitive to trace vapours of explosives at ppb concentration levels and below. However, detecting trace amounts of explosives in field conditions is highly challenging, especially under variable environmental conditions. Preconcentration techniques allow the explosives to sorb and accumulate on a material over time, thus a higher concentration can subsequently be thermally desorbed and detected via a loss of emission from the organic semiconductors. To assess optimal preconcentration materials, different polymers were loaded with 2,4-DNT and their retention and desorption characteristics were measured for a wide range of analyte concentrations, and thermal desorption temperatures. Camera-equipped drones were also used with signal-processing algorithms to monitor trained honeybees swarming around vapour plumes. We demonstrate an end-to-end methodology with promising results for humanitarian demining efforts.

Introduction

Novel technologies for trace chemical detection of explosives have been developed in recent years, with an emphasis on optical sensing1-4. The chemical signature emitted from landmines over time has traditionally been detected by dogs, but the drawbacks with dogs including costs of upkeep, animal behaviour, and time allowed on-site per day5. Optical chemical sensing can allow comparable sensitivity to dogs, with the added advantage of low-cost, portable instrumentation with no limits on operational time.

Remote Explosive Scent Tracing (REST) is a common technique for sorbing explosives to a mesh material prior to interrogation via sniffer dog. This method can be used in conjunction with optical sensors, which have drawbacks in field conditions, particularly with windy conditions dispersing trace vapour plumes prior to detection. Preconcentration materials have been characterised with a range of explosives, where the explosive molecules sorb to the surface over time which can then be thermally desorbed to deliver several orders of magnitude higher masses of explosives to the sensor element. Many of the polymers investigated and characterised are however very expensive and not suitable for mass use in humanitarian demining. Some chemically similar materials available off the shelf are promising alternative materials, like fluoropolymer Aflas and PBE.

Finally, the use of honeybees provides a method to survey a wide area without risking human life. Honeybees collect material from the environment electrostatically during natural foraging activity. Explosives present in the environment from landmines can be picked up with pollen and brought back to the hive, which can then be analysed and detected.

A complementary active method involves training bees to fly towards a specific odour in a contaminated area. This is achieved by exposing the bees to TNT, for example, when given a food source like sugar solution. The bees associate the smell of TNT with a food reward, and so when released into the field they hover above a vapour plume. Over distances, the bees are followed by using high-definition cameras and thermal cameras mounted on drones. By using three such drones simultaneously the area can be overlaid for higher reliability. From georeferenced high-resolution video, a map of space-time density of trained bees over the suspected area is generated, which allows the determination of the precise location of an explosive device.

We present recent results from the Bee4Exp project, which aims to use honeybees in a passive method to survey wide areas for landmine contamination, with a subsequent active method where the honeybees are trained and followed by a camera-equipped drone to pinpoint landmines in that area. The aspiration is to provide a new tool for safe humanitarian demining.

Experimental

The methodology for sensor fabrication, preconcentrator preparation, and bee colony preparation is outlined in detail in a previous work6. Briefly, the fluorescent polymer Super Yellow (Merck) was dissolved in toluene and spin-coated onto clean glass slides. To assess the performance of thin-film preconcentrators, the fluoropolymer Aflas was compared with a phenol-based epoxy polymer (PBE). Each was dissolved in Tetrahydrofuran to deposit thin films.

To assess the affinity of the preconcentration polymers to DNT, and the optimum temperature to induce thermal desorption, a thin film of the sorbent material was loaded with a known concentration of DNT and heated using a hot plate for 3 minutes for each of a series of temperatures starting from 40°C in steps of 10°C. After each heating step, an absorption measurement using a UV-Vis spectrometer was performed.

For in-situ placement of the preconcentration material in the hive entrance and exit, sheets of poster canvas were blade-coated with polymer solution and cut into squares before being rolled into tubes and inserted in Standard Lexan plates (1 × 1 cm tube) cut into 10 cm lengths and used as a cartridge with 4 channels and inserted into the entrance of the hives. The cartridges containing the preconcentrators were left in place throughout the day to allow bees to return from foraging and deposit any explosive materials (Figure 1).

Figure 1 - Honey bee in cartridge tunnel containing a preconcentrator.

To test the preconcentrators for explosive residue, the canvas square was placed on a heating element near the sensor in a homemade cell. The sensor was excited with a blue laser diode and its photoluminescence measured over 5 minutes. The photoluminescence at room temperature was measured for 30 s, then the heating element turned on for approximately 100 s to heat the sample to 100°C. The loss in light emission was measured. After measurements had been completed the chamber was flushed again with clean nitrogen to clear the chamber of any residual explosive vapours.

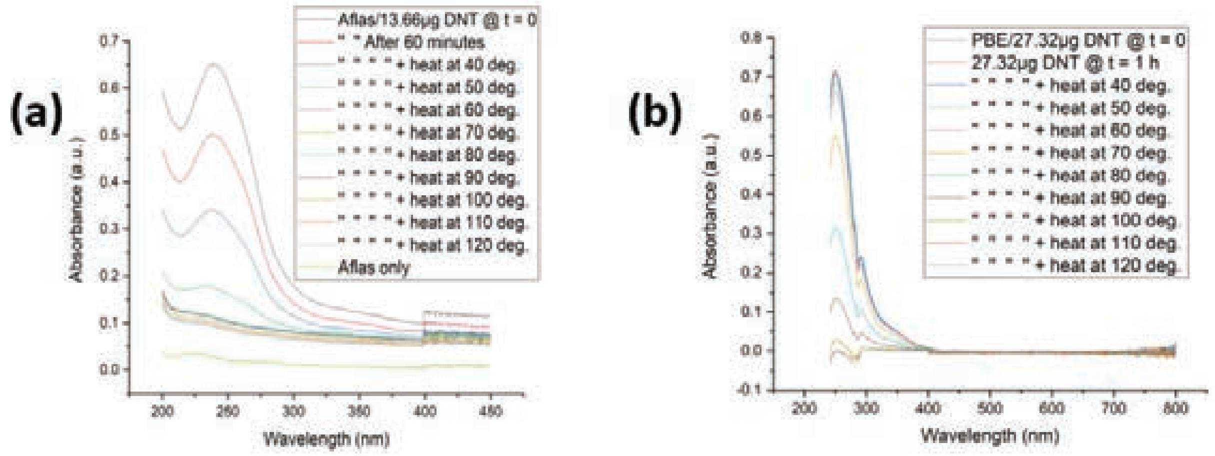

Figure 2 - (a) thermal desorption of DNT from Aflas over 40°C - 120°C ; (b) thermal desorption of DNT from PBE over 40°C - 120°C .

The acquisition hardware consists of video capture using a UAV equipped with an ultra-high definition video (UHD) and a thermal camera (TC). UHD video resolution was chosen to cover the largest possible ground in one frame, so each frame contains more than 8 million pixels. The UAV hovers at around 8 to 10 meters and camera is equipped with a 50 mm lens (equivalent to a 35 mm system), and so each honeybee covers the area of around 20 pixels.

The UAV includes a DYS Saga aluminum gimbal suitable for large DSLRs with a net weight of 1.6 kg and capability to carry more than 3 kg of payload, and a 5.8G video transmitter. This system is compatible with Panasonic GH4 and Sony A7 digital cameras. The camera is enclosed in a steel case with two Li-Ion 18650 batteries and a mount for GoPro RGB camera. The camera has a Ulis Pico 640 image sensor with 17 μm pixel size with a 100 mm lens.

Results

The results from loading the Aflas and PBE films with DNT are shown in Figure 2. The use of Aflas as preconcentrator material has been shown to be effective for adsorbing explosive materials for subsequent thermal desorption and detection, and Figure 2a shows desorption at close to ambient temperatures. Better retention in the polymer allows the samples to remain stable with the original mass of deposited explosive on the surface, leading to more pronounced fluorescence quenching. The polymer PBE shown in Figure 2b exhibits effective loading of DNT, with no desorption noted until heated to 80°C

Figure 3 - Images of honeybees during a free flight. The yellow circles marked automatically detected honeybees.

Results from the camera-equipped drone is shown in Figure 3. The yellow circles show individual bees detected via the algorithm, pointing towards a successful method for identifying honeybees in real time when they swarm above an explosive vapour plume.

Conclusions

Results from a project combining free-flying honeybees for passively sampling explosives materials, and actively trained bees to detect buried explosives with UAV-assisted monitoring, have been presented. Materials Aflas and PBE have been investigated for their affinity to explosives and thermal desorption characteristics. Passive sampling allows for explosives to be collected by foraging honeybees which then deposit the explosives on the surface of a preconcentrator which can then be exposed to an optical sensor for detection; this method is anticipated to be useful for area surveying. The active method is intended to be able to pinpoint individual land mines in an area, with bee swarming over a suspected mine being followed and recorded by a dual camera system mounted on a UAV. Both methods together may provide a robust beginning-to-end procedure for humanitarian demining.

Acknowledgments

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The novel paradigm for a decision support system of the aerial non-technical survey

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The novel paradigm for a decision support system of the aerial non-technical survey

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Abstract:

The industry of sensors and unmanned aerial systems (UAV) enables the advancement of detection of explosive objects (landmines, unexploded ordnance, improvised explosive devices) and the non-technical survey of areas contaminated by explosive threats. In the last ten years, dominates research and development of the direct detection of explosive devices versus detection of indirect indicators of the explosive threats on large areas in frame of civilian Non-Technical Survey (NTS). The impact of the mentioned phenomena is not used to its full potentials in the civilian domain of NTS. Although UAV technology can provide a large amount of data, interpretation of the data and the decision-making as an outcome of the interpretation are not developed yet. Between 1998 and 2020 many research and technology development projects on aerial NTS are realized. Some of them applied Decision Support System (DSS) paradigms: GIS-based DSS paradigm, Multi-Criteria-based DSS paradigm, Automatic Target Recognition (ATR) paradigm. The Scientific Council of HCR Center for testing, development, and training, initiated in December 2019 research and development of the Aerial Non-Technical Survey, based on UAV data acquisition, and a recommender system in its DSS functions. The proposed recommender system utilizes deep learning algorithms and collaborative filtering (CF) that rely on datasets containing selection preferences for different objects. DSS knowledge database will be based on ontologies to facilitate formal description of complex semantic structures, knowledge transfer, and reuse. The objects and preferences will be derived by fusion of features of secondary indicators, ranked by eigenvalues. The novel DSS will be implemented in the new Aerial Non-Technical Survey System which will be realized through projects by several partners. The operational validation will be done by CROMAC in mine suspected areas of Croatia.

Keywords: aerial non-technical survey, DSS, UAV, secondary mine indicators, multi-criteria ranking, deep learning, recommender system, CROMAC

Introduction

The development of Aerial Non-Technical Survey was done by many research, development, and several deployment projects, initialized in operationally validated project SMART, [1]. The Advanced Intelligence Decision Support System uses piloted helicopters and its decision support system (DSS) relies on Multi-Criteria fusion of data, information, experts' knowledge, and the secondary (indirect) indicators of explosive threats, Indicators of Mine Presence, Fig. 1, Fig. 2, [1]. The structure and processes in AIDSS were under continuous development and advancement and the outcomes of AIDSS become reliable and efficient, [2], [3], [4].

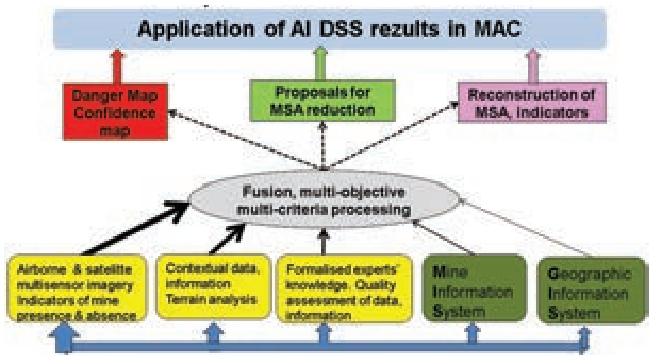

Figure 1 Advanced Intelligence Decision Support System based on Multi-Criteria fusion.

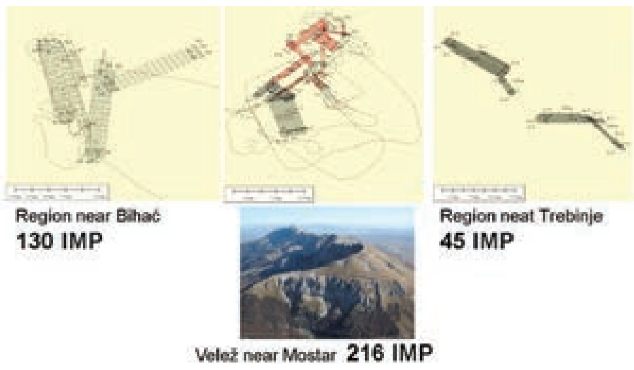

Figure 2 The helicopter flight routes, quantity of Indicators of Mine Presence (IMP) depend on terrain and situation in the former battle area. Besides the spatial data, information, the most important is experts' knowledge and contextual information and data.

Substitution of piloted helicopters with unmanned aerial systems (UAV)

The use of UAV aerial platforms instead of piloted helicopters in humanitarian mine action started approximately around the year 2010 and now UAVs dominates. One of the first applications of UAV in humanitarian mine action was in Bosnia and Herzegovina, [5]. In the last five years, the number and dimension of UAV applications are grown, mainly due to availability of the reliable industrial UAV and sensors matched for application on UAVs. Therefore the new Aerial Non-Technical Survey System shall be based on UAV with increased endurance.

Development phases of the Aerial Non-Technical Survey System

The A-NTS System developed in previous projects is planned to be upgraded in two phases, Fig 3.

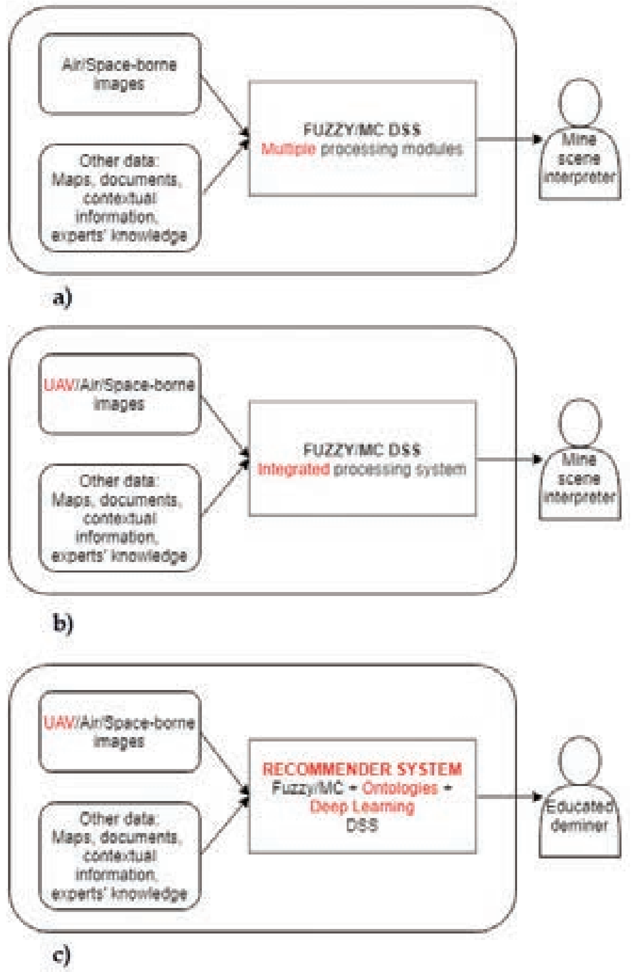

Figure 3 Development phases of the Aerial Non-Technical Survey Decision Support System / Recommender System a) Existing Fuzzy / Multi-Criteria Decision Support System (FUZZY/ MC DSS), b) Integrated DSS enhanced with UAV imagery, c) Integrated DSS extended with ontologies and deep learning.

In the first phase, multiple processing modules used by the mine scene interpreter will be integrated into one complete system. Images obtained from sensors mounted on helicopters and satellites will be complemented with UAV collected images that can be acquired ondemand and with higher resolution. The system will shorten the time of analysis and reconstruction of the mine scene, therefore, increase the productivity of interpretation and support in decision making of further demining actions in the observed explosive threats area. In the second phase implemented a recommender system based on ontologies, symbolic reasoning, and deep learning [6], [7], will enhance the usability of the system and enable its use by the educated deminer.

Ontology-based recommender expert system for non-technical survey

Computer ontologies have been successfully applied for the description of multi-level picture content, concept semantics, object labels, and relationships, especially defined in the upper levels of the picture semantics hierarchy [8] [9]. This top-down approach in document representation and retrieval has three main benefits over the opposite approach (i.e. bottomup) which relies on media features and other low-level image descriptors. Firstly, database users prefer to articulate their search queries in a natural language, or in a constructed language similar to their preferred natural language, which is inherently capable of expression of complex semantics. Secondly, the information one can infer from raw media information cannot be automatically transformed to high-level semantics that the pictures convey. Thirdly, only rich high level full semantic representation of a picture can express the full range of relationships, explicitly observable, implicitly inferable, or with the word as a whole, the variety of supported connotations, actions, and the broader context.

The potential of ontology-based recommender systems in personalized multimedia retrieval has already been well identified [10] [11]. In this context, ontologies provide a list of suggestions presented to the user. The recommendation process considers similarities calculated between ontologies of objects and users, which reflect the descriptive features existing in the system's knowledge database. The researchers have also shown that ontologybased methods enable the interoperability of heterogeneous knowledge representations and results from inaccurate recommendations. The applicability of ontology-based recommender systems in real-life settings has been demonstrated.

However, to the best of our knowledge, the entire benefit of computer ontologies in the representation of expert knowledge for detection of explosive objects and the non-technical survey of areas contaminated by explosive threats has not been recognized and used in practice.

In this regard, we propose a novel model of ontology-based recommender expert system for non-technical survey in decision support system (DSS) functions. The knowledge base for ontological representation of relevant knowledge in the mine scene domain is shown in the next figure. The knowledge base has two main components: 1) the terminological component, and 2) the assertional component. The first component, or the terminological component (TBox), describes the relevant notions of the application domain by stating the properties of concepts and roles and their interrelations. TBox contains an ontological representation of the knowledge in mine-action technical concepts, properties, and relationships expressed in a decidable formal logic.

The second component of the knowledge base is the assertional component (ABox). It contains a formal set of assertions describing specific facts, statements, and observations in terms of terminological knowledge. ABox describes a concrete world by stating individuals and their specific properties and interrelations.

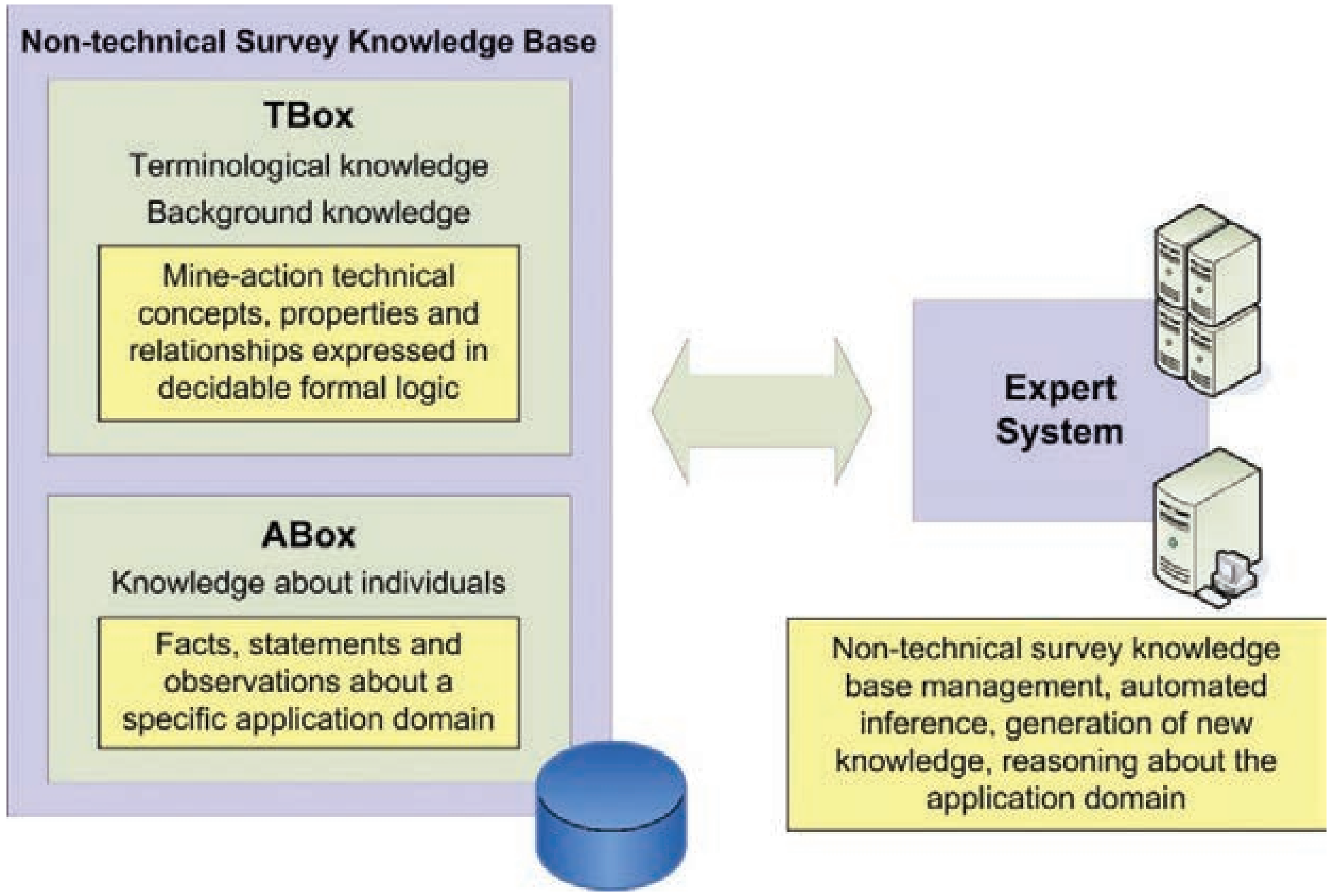

Figure 4. A schematic diagram of the Non-technical Survey Knowledge Base. The extracted information from UAV/Air/Space-born image analysis constitutes the assertional component (ABox) of the knowledge base and the terminological component (TBox) is defined by a selected foundation ontology and the developed non-technical survey mine scene interpretation ontology.

The description logic ontology language OWL 2 DL is the best choice for the construction of the Non-Technical Survey Knowledge Base because it exemplifies the optimum compromise between adequate expressivity and guaranteed decidability [12]. Most importantly for the practical implementation of the proposed system, a variety of tools for knowledge engineering are readily available which allow construction, management, reuse, and reasoning in OWL 2 DL schema [12].

The insertion of UAV/Air/Space-born images, as well as other information acquired by remote sensing in the Non-technical Survey Database, is shown in Figure 5. In this procedure, the knowledge base of the ontology-based recommender system is also being populated. Firstly, concepts in the image content that are deemed important by mine scene interpretation experts are detected and classified. After a concept is recognized, an equivalent concept must also be identified in the representation ontology. TBox must define all concepts that exist in the UAV/Air/Space-born image content. After an equivalent concept has been found a new individual is created, associated with the image, and stored in ABox. This image recognition
and semantic annotation process are repeated for all images that will be stored in the
proposed system.

As can be seen in Figure 5, in our proposal image content recognition and scene interpretation are performed automatically for example by a deep learning (DL) algorithm as an input in the ontology-based recommender expert system database. A group of mine-scene interpreters (i.e. domain experts) further inspect

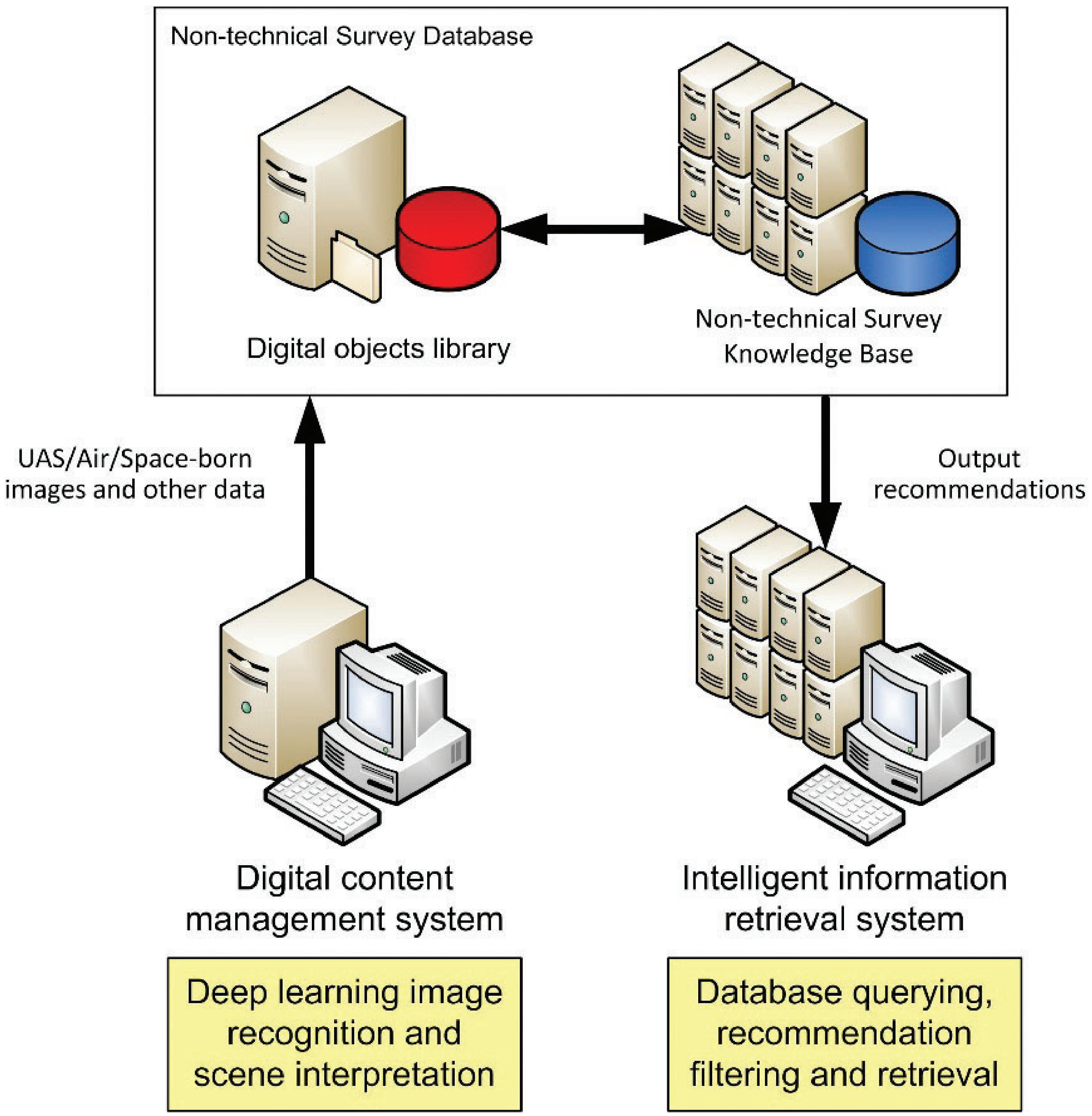

Figure 5. An illustration of the ontology-based recommender expert system structure. Input UAV/Air/Space-born images and other data are processed, for example by deep learning (DL) networks to perform image identification, classification, localization, and pixel-level instance segmentation of a mine scene. Output recommendations are generated by the expert system and the associated Non-technical Survey Knowledge Base.

the picture to verify or correct the intelligent algorithm's output if required. Deep learning algorithms are a class of machine learning (ML) algorithms based on artificial neural networks with representation learning [13]. Their characteristic feature is the use of multiple layers to progressively extract higher-level features from the raw data input. From the aspect of the knowledge base, the image recognition procedure is viewed upon as a black box that yields ground truth object labels and relationships present in pictures and other input data. UAV/Air/Space-born images and other data are permanently stored in the digital objects library.

Finally, the generation of output recommendations is performed by the artificial intelligence expert system at the operator's workstation. Management of the knowledge base, automated reasoning, generation of new knowledge from the existing definitions and facts, as well as all forms of reasoning supported by the OWL 2 DL formalism about the domain of interest is executed at this workstation.

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The novel paradigm for a decision support system of the aerial non-technical survey

MINE ACTION IMPACT ON DEVELOPMENT OF ECONOMIC, ENERGY AND TRANSPORTATION INFRASTRUCTURE

The Journal’s Twenty-Five Years of HMA in Review

Jennifer Risser, Blake Williamson, Suzanne Fiederlein

The Journal's Twenty-Five Years of HMA in Review

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Blake Williamson
Suzanne Fiederlein

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This summer (2021), The Journal[1] celebrates its 25th year with the publication of a double, anniversary issue. While the name has changed over the years, The Journal's mission has not: to act as a conduit through which international practitioners, technical experts, policy advisors, and researchers share information on mainstream topics, evolving standards, and new innovations in service to and for the betterment of those affected by indiscriminate, explosive weapons of war.

For twenty-five years, The Journal has presented a historical narrative and timeline of the evolution of humanitarian mine action (HMA)/conventional weapons destruction (CWD), publishing over 1,700 articles from national authorities, NGOs, academic institutions, and military entities from around the world. Similarly, as familiar HMA personalities over the years contribute their unique perspectives, insights, and experiences, the breadth of HMA knowledge expands, broadening the community of practice's understanding of past and present issues.

Over the past two decades, certain themes have emerged time and again, sometimes falling out of the limelight only to resurface years later. Published articles have often mirrored the events playing out on the global stage, from undulating conflicts to refining community norms and expectations as they transform the field of HMA.

To identify and analyze the main topics and trends, successes and challenges, identified in over two decades of publication is indeed a Herculean task. In the space of this brief paper, we identify and address three topics that—although not holistically representative of the myriad of popular topics in HMA and CWD—have continually emerged as dynamic points of discussion since The Journal's inception: victim assistance and the role of gender; the evolution of HMA standards and metrics; and innovations in HMA technology and methods.

We do not try to contextualize these within the broader framework of HMA or, indeed, even within their own evolutionary sphere of practice but rather offer only brief snapshots of these topics as they are portrayed and have matured over The Journal's existence. These snapshots highlight contributors who have worked within HMA for as long or longer (affectionately referred to as the 'dinosaurs') than this publication's tenure, as well as new contributors to this niche discipline.

Diversity and Inclusion in HMA

The evolution of diversity and inclusion, and the different facets these terms represent within HMA, have gained increasing, consistent recognition within The Journal. At The Journal's inception in 1997, mention of diversity and inclusion, specifically disability and gender, are nonexistent. In the 1998 article, "Humanitarian Demining: Ten Years of Lessons," focus is on clearance, local capacity, funding, and technology, with a brief mention of victim assistance (VA) needing to be part of a future roadmap for humanitarian demining.[2] However, a year later in 1999, an entire issue is dedicated to victim and survivor assistance.[3]

In her article, "Defining the Pillar of Victim Assistance" Sue Eitel from the Landmine Survivors Network notes that in 1995, victim assistance was not on the political agenda, but by publication of her article in 1999,[4] a number of events had occurred to push forward the VA agenda: the United Nations Mine Action Service identified VA as one of the pillars of mine action; the International Campaign to Ban Landmines and its founder, Jody Williams, jointly received the 1997 Nobel Peace Prize; and in the same year, Diana, Princess of Wales's trips to Angola and Bosnia and Herzegovina to visit minefields and landmine survivors brought significant media attention to mine action, specifically VA. In 2002 and again in 2008, issues 6.3 and 12.1 focused entirely on VA, covering legislation, local capacity, policy, prosthetics, terminology, disability rights, data collection, funding, and personal survivor stories.[5,6]

In his 2011 article, Ken Rutherford, landmine survivor, co-founder of the Landmine Survivors Network, and former CISR director, highlights the role of legislation in not only recognizing VA but helping to advocate for the rights and dignity of survivors, specifically noting the roles of Article 6 of the Anti-personnel Mine Ban Convention (APMBC), signed in December 1997; the Convention on the Rights of Persons with Disabilities, entering into force in May 2008; and the 2008 Convention on Cluster Munitions.[7] Moving forth from legislation to standards, DeSantis and Eriksson from the Geneva International Centre for Humanitarian Demining (GICHD) highlight the module on VA in the Information Management System for Mine Action (IMSMA), providing tracking and monitoring of survivors' access to rights as well as accountability in tracking progress.[8]
Within the past ten years, articles addressing VA have focused on the importance of data collection and sharing among different countries to improve the efficiency and effectiveness of services provided,[9] the effects terminology has on the portrayal of survivors,[10] the effects of IEDs on survivors, the importance of integrating VA into local capacity-building initiatives and mine risk education (more recently, explosive ordnance risk education),[11] and so much more.

The connection between VA and gender has been evident in articles throughout the years. As noted in their 2011 article, "Gender-sensitive Victim Assistance," Calza Bini and Massleberg from the Gender and Mine Action Programme (GMAP), founded in 2009, highlight the importance of including gender considerations in VA, to recognize that landmine/ERW contamination affects women, girls, boy, and men differently, and reflect on the importance of gender-sensitive language and the need to examine terms when referring to gender and disability.[12]

While VA gained traction in HMA in the late 1990s, it was not until 2008 when The Journal begins to cover gender with a special focus in volume 12.2 on gender in mine action.[13] In this particular issue, authors from the Zambia Mine Action Center, United Nations Development Programme, International Peace Institute, International Women's Development Agency, Humanity & Inclusion (formerly Handicap International), and others discuss the emerging importance of including gender in HMA planning, prioritization, strategy, risk education, 'gender mainstreaming,' and gender stigma in mine action.

In a 2013 GMAP article "How to Improve Demining Activities Through Gender-sensitive Mine Risk Education," the authors discuss how mine action was widely perceived as a

1 The Journal of Conventional Weapons Destruction is generously funded by the Office of Weapons Removal and Abatement in the U.S. State Department's Bureau of Political-Military Affairs.

2 Consulting Corporation, RONCO (1998) "Humanitarian Demining: Ten Years of Lessons," Journal of Mine Action: Vol. 2: Iss. 2, Article 10, https://commons.lib.jmu.edu/cisr-journal/vol2/iss2/10.

3 Journal of Mine Action: Vol. 3: Iss. 3, https://commons.lib.jmu.edu/cisr-journal/vol3/iss3/.

4 Eitel, Sue (1999) "Defining the Pillar of Victim Assistance," Journal of Mine Action: Vol. 3: Iss. 3, Article 2, https://commons.lib.jmu.edu/cisr-journal/vol3/iss3/2.

5 Journal of Mine Action: Vol. 6: Iss. 3, https://commons.lib.jmu.edu/cisr-journal/vol6/iss3/

6 Journal of Mine Action: Vol. 12: Iss. 1, https://commons.lib.jmu.edu/cisr-journal/vol12/iss1/.

7 Rutherford, Ken (2011) "Victim-Assistance History in International Humanitarian Law: From Somalia to Geneva to Laos," The Journal of ERW and Mine Action: Vol. 15: Iss. 1, Article 14, https://commons.lib.jmu.edu/cisr-journal/vol15/iss1/14.

8 Desantis, Angela and Eriksson, Daniel (2013) "The New IMSMA and Victim Assistance," The Journal of ERW and Mine Action: Vol. 17: Iss. 3, Article 8, https://commons.lib.jmu.edu/cisr-journal/vol17/iss3/8.

9 Desantis, Angela and Eriksson, Daniel (2013) "The New IMSMA and Victim Assistance," The Journal of ERW and Mine Action: Vol. 17: Iss. 3, Article 8, https://commons.lib.jmu.edu/cisr-journal/vol17/iss3/8.

10 Macauley, Cameron (2013) "Landmine Injuries and Human Rights: The Terminology of Victims and Survivors," The Journal of ERW and Mine Action: Vol. 17: Iss. 3, Article 2, https://commons.lib.jmu.edu/cisr-journal/vol17/iss3/2.

11 Franck, Bernard; Koolmees, Donna; and French, Sarah (2020) "Community-Based Inclusive Development: Integrating Survivors into a Broader Victim Assistance System," The Journal of Conventional Weapons Destruction: Vol. 23: Iss. 3, Article 10, https://commons.lib.jmu.edu/cisr-journal/vol23/iss3/10.

12 Calza Bini, Arianna and Massleberg, Asa (2011) "Gender-sensitive Victim Assistance," The Journal of ERW and Mine Action: Vol. 15: Iss. 2, Article 14, https://commons.lib.jmu.edu/cisr-journal/vol15/iss2/14.

13 The Journal of ERW and Mine Action: Vol. 12: Iss. 2, https://commons.lib.jmu.edu/cisr-journal/vol12/iss2/.

military and technical field where an almost exclusively male staff planned and implemented activities, and that there remained significant work to better understand how mine-affected communities could benefit from including gender and age perspectives, to how the different pillars of mine action improve the quality and impact of programs.[14]

More recently, jumping ahead a few years to an interview published in 2019, GMAP director, Arianna Calza Bini, highlights the main areas of mine action that still need improvement within the context of gender and diversity.[15] Noting that working around gender and diversity in mine action was sometimes described as the "soft" side compared to the more technical and operational sides of HMA such as clearance, Calza Bini reflects on her ten-year tenure working in mine action, noting that the main obstacles to the gender component of HMA being taken seriously within the sector was management's lack of commitment to mainstream gender and diversity in programming, a limited ability to mainstream gender and diversity in certain cultural contexts, funding restrictions, and political will. However, Calza Bini notes that in the past ten years, she has witnessed improvement in all of these areas.

Additionally, in December 2020, Biscaglia et al. present achievements in gender and diversity mainstreaming in HMA, both at the individual and organizational levels.[16] They also more explicitly define "diversity" to extend beyond gender to include factors such as disabilities, ethnicities, religions, languages, and education levels. With experiences discussed from the Cambodia Mine Action Authority, Norwegian People's Aid (NPA), and the GICHD's Gender Focal Point Capacity Development Programme, the article looks at the successes of national mine action organizations to mainstream more effective and inclusive operations, which consider the different information, requirements, and preferences of all members of explosive ordnance-affected communities.

By strengthening the capacity to mainstream diversity and gender in mine action operations, organizations positively influence national capabilities, improve the quality of HMA projects and activities, and ensure communities receive more inclusive and effective services. As the global community continues to evolve in its interactions with diversity and inclusion, so too will the HMA community of practice adapt, which we look forward to addressing in our upcoming summer 2021 edition of The Journal.

HMA Standards and Metrics

The International Mine Action Standards (IMAS) represent the community's combined knowledge of best practices and its commitment to achieving safe and efficient operating requirements. Covering every aspect of mine action, the IMAS have both evolved and expanded to mirror the field's widening scope of activities and maturation as a profession. Continually, The Journal captures these changes—be they revisions or expansions—in a way that reflects how far the community has progressed.

Perhaps most notably, The Journal captured the discourse that peaked in 2017 about the systematic use of improvised explosive devices (IEDs) and how these weapons should be integrated into the sphere of HMA activities by way of proprietary IMAS. A number of authors contributed to the discussion, including Robert Keeley,[17, 18] Chris Loughran and Sean Sutton (MAG, Mines Advisory Group),[19] Louise Skilling and Marysia Zapasnik (DanChurchAid),[20] Craig McInally and Hans Risser (NPA),[21] and Guy Rhodes (GICHD),[22] as well as so many others not captured here.

14 Jones, Abigail; Calza Bini, Arianna; and Varó, Stella Salvagni (2013) "How to Improve Demining Activities Through Gender-sensitive Mine Risk Education," The Journal of ERW and Mine Action: Vol. 17: Iss. 1, Article 7, https://commons.lib.jmu.edu/cisr-journal/vol17/iss1/7.

15 Calza Bini, Arianna (2019) "Interviews with HMA Directors: Arianna Calza Bini," The Journal of Conventional Weapons Destruction: Vol. 23: Iss. 1, Article 3, https://commons.lib.jmu.edu/cisr-journal/vol23/iss1/3.

16 Biscaglia, Laura; Sophal, Ros; Sochenda, Khun; and Sabeeh, Lubna (2020) "Strengthening a Sustainable National Capacity for Gender and Diversity Mainstreaming in Mine Action," The Journal of Conventional Weapons Destruction: Vol. 24: Iss. 2, Article 12, https://commons.lib.jmu.edu/cisr-journal/vol24/iss2/12.

17 Keeley, Robert (2017) "Improvised Explosive Devices (IED): A Humanitarian Mine Action Perspective," The Journal of Conventional Weapons Destruction: Vol. 21: Iss. 1, Article 3, https://commons.lib.jmu.edu/cisr-journal/vol21/iss1/3/.

18 Keeley, Robert (2017) "Quality Management and Standards for Humanitarian Improvised Explosive Device (HIED) Response Activities," The Journal of Conventional Weapons Destruction: Vol. 21: Iss. 3, Article 4, https://commons.lib.jmu.edu/cisr-journal/vol21/iss3/4/.

19 Loughran, Chris and Sutton, Sean (2017) "MAG: Clearing Improvised Landmines in Iraq," The Journal of Conventional Weapons Destruction: Vol. 21: Iss. 1, Article 4, https://commons.lib.jmu.edu/cisr-journal/vol21/iss1/4/.

Discussions about the new challenges that IEDs present for the HMA community have been chronicled in The Journal and examine how devices are emplaced, how they are initiated, how programs should create and manage risk education materials, and whether IED disposal (IEDD) might challenge the neutrality of the acting HMA organizations. Moreover, as IEDs have continued to evolve, contributors such as Michael Cardash (Terrogence)[23] and Dr. Mark Wilkinson (UNMAS)[24] have examined their nuanced compositions and application in specific regions, as well as the respective methods used to address IEDs in both the contexts of simple and complex environments.[25]

Nevertheless, as the community of practice evolves, the need to review and revise existing practices becomes increasingly important. From an early focus on clearance measures and personal protective equipment (PPE) quality[26,27], to a focus on the land release process[28] and revised IMAS to support the new thinking in that area,[29] The Journal reflects the concerns of operators and program managers in finding the balance in IMAS to promote safety, effectiveness, and efficiency across the sector. Journal contributors have explored the importance of creating standards for quality management, which has been depicted by Russell Gasser as the need to conduct tasks in accordance with IMAS and to prioritize tasks that will have the greatest impact,[30] as well as the need for metrics or key performance indicators (KPIs), which Roly Evans and David Hewitson suggest will facilitate comparative analysis efforts among donors and partners who could then measure outputs and outcomes as well as improve organizations' abilities to assess the individual performance of its operators.[31] Most recently, The Journal includes articles that re-examine requirements for PPE,[32] training of military forces on IMAS with a focus on residual risk,[33] the idiosyncrasies of achieving IMAS compliance,[34] and a substantial revision of IMAS 10.60 on the investigation and reporting of demining accidents.[35]

Innovations in Methods and Technologies

Funding shortfalls and complex areas of operation—due to either environmental challenges or security concerns—can mean HMA organizations with limited resources are often confronted with the overwhelming task of both accumulating and scrutinizing large amounts of data on possibly-contaminated areas and employing that information effectively or risk misappropriating valuable assets, not to mention time, searching for explosive hazards. However, coupled with increasingly easy-to-use data collection methods and technologies, innovations in data management, and advanced technologies from the private

20 Skilling, Louise and Zapasnik, Marysia (2017) "Addressing the Explosive Hazard Threat in Northern Syria: Risk Education on Landmines, UXO, Booby Traps, and IEDs," The Journal of Conventional Weapons Destruction: Vol. 21: Iss. 2, Article 14, https://commons.lib.jmu.edu/cisr-journal/vol21/iss2/14/

21 McInally, Craig and Risser, Hans (2017) "Humanitarian Mine Action and IEDs," The Journal of Conventional Weapons Destruction: Vol. 21: Iss. 3, Article 10, https://commons.lib.jmu.edu/cisr-journal/vol21/iss3/10/.

22 Rhodes, Guy (2017) "Improvised Explosive Devices and the International Mine Action Standards," The Journal of Conventional Weapons Destruction: Vol. 21: Iss. 3, Article 3, https://commons.lib.jmu.edu/cisr-journal/vol21/iss3/3/.

23 Cardash, Michael (2019) "Booby-traps and Anti-handling Devices: Common Tactics," The Journal of Conventional Weapons Destruction: Vol. 23: Iss. 1, Article 14, https://commons.lib.jmu.edu/cisr-journal/vol23/iss1/14.

24 Wilkinson, Mark Ph.D. (2019) "IED Threat Consistency and Predictability in Fallujah: A 'Simple' Model for Clearance," The Journal of Conventional Weapons Destruction: Vol. 23: Iss. 2, Article 4, https://commons.lib.jmu.edu/cisr-journal/vol23/iss2/4.

25 Wilkinson, Mark Ph.D. (2019) "IEDs and Urban Clearance Variables in Mosul: Defining Complex Environments," The Journal of Conventional Weapons Destruction: Vol. 23: Iss. 2, Article 5, https://commons.lib.jmu.edu/cisr-journal/vol23/iss2/5.

26 Smith, Andy (2003) "IMAS and PPE Requirements," Journal of Mine Action: Vol. 7: Iss. 1, Article 12, https://commons.lib.jmu.edu/cisr-journal/vol7/iss1/12.

27 Wilkinson, Adrian (2003) "International Mine Action Standards: Future Development of PPE Standards," Journal of Mine Action: Vol. 7: Iss. 1, Article 5, https://commons.lib.jmu.edu/cisr-journal/vol7/iss1/5.

28 Gray, Helen (2014) "Amendments to the IMAS Land Release Series," The Journal of ERW and Mine Action: Vol. 18: Iss. 1, Article 3, https://commons.lib.jmu.edu/cisr-journal/vol18/iss1/3.

29 Lodhammar, Pehr (2013) "Legal Aspects of the Land Release Process," The Journal of ERW and Mine Action: Vol. 17: Iss. 1, Article 4, https://commons.lib.jmu.edu/cisr-journal/vol17/iss1/4.

30 Gasser, Russell (2015) "Quality Management in Vietnam: Building a National ISO 9001 System," The Journal of ERW and Mine Action: Vol. 19: Iss. 1, Article 7, https://commons.lib.jmu.edu/cisr-journal/vol19/iss1/7/.

31 Evans, Roly and Hewitson, David (2019) "Key Performance Indicators and HMA: Time to Standardize?" The Journal of Conventional Weapons Destruction: Vol. 23: Iss. 2, Article 10, https://commons.lib.jmu.edu/cisr-journal/vol23/iss2/10/.

32 Smith, Andy (2018) "PPE Development and Needs in HMA," The Journal of Conventional Weapons Destruction: Vol. 22: Iss. 1, Article 2, https://commons.lib.jmu.edu/cisr-journal/vol22/iss1/2.

33 Hewitson, David (2020) "A New Approach to Understanding, Achieving, and Demonstrating IMAS Compliance," The Journal of Conventional Weapons Destruction: Vol. 24: Iss. 1, Article 8, https://commons.lib.jmu.edu/cisr-journal/vol24/iss1/8.

34 Hewitson, David (2020) "A New Approach to Understanding, Achieving, and Demonstrating IMAS Compliance," The Journal of Conventional Weapons Destruction: Vol. 24: Iss. 1, Article 8, https://commons.lib.jmu.edu/cisr-journal/vol24/iss1/8.

35 Yen, Ta Thi Hai (2020) "Game-Based Learning: An Innovative and Scalable Approach to Mine Risk Education," The Journal of Conventional Weapons Destruction: Vol. 23: Iss. 3, Article 8, https://commons.lib.jmu.edu/cisr-journal/vol23/iss3/8.

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sector, organizations are increasingly leveraging these assets to improve prioritization and survey techniques.

Mobile devices and digital forms have transformed how organizations collect real-time data that programs can immediately employ to modify and monitor projects. Catholic Relief Services and similar organizations have repeatedly showcased the efficiency of mobile technologies to both collect data[36] and provide effective risk education.[37] Data management systems like IMSMA developed by UNMAS and GICHD in the late 1990s have evolved significantly over the years through iterations such as IMSMA Next Generation (IMSMANG) and IMSMA Core.[38]

An ever-present topic in HMA, the land release process has been discussed at length throughout the community's history and is regularly discussed in The Journal. In 2009, Håvard Bach noted that "Clearing mines is actually the least difficult aspect of mine action. The real challenge lies in defining the task and determining the location of the mines."[39] Thankfully, methods for delineating boundaries of both suspected (SHAs) and confirmed hazardous areas (CHAs) have since evolved significantly. From the Odyssey2025 Project using drones to identify buried landmines and mapping minefield perimeters in Chad[40] to Binghamton University's work on automated surveying techniques to constrain search areas of 122 mm BM-21 rockets in Ukraine, efforts to pioneer new surveying practices continue to expand HMA's toolkit.

The proliferation of ultralight unpiloted aerial vehicles (UAVs) and the increasing versatility of unpiloted aircraft systems (UAS) have proved immensely useful for various HMA activities over the last decade. As Andy Smith pointed out in 2017, "There has not been a new technology so useful to HMA since the development of ground compensating metal detectors."[41] From the CAMCOPTER, the first UAV mentioned in The Journal in 1999[42] and the Airborne Minefield Area Reduction (ARC) project in the early 2000s, to more modern implementations used by The HALO Trust (HALO) in Sri Lanka[43] and MAG in Cambodia,[44] practical uses for UAS technology within the range of HMA activities have proven beneficial in the use of aerial photography,[45] detection,[46] inspection,[47] identification,[48] and survey.[49]

Moreover, as demonstrated by Golden West Humanitarian Foundation's Advanced Ordnance Training Materials[50] and Augmented Reality Ordnance Learning System,[51] harnessing technologies such as 3D-printing and virtual reality have significant impacts for explosive ordnance disposal enhanced visualization techniques and training purposes. However, innovations are not limited to technology, and a joint article by HALO, MAG, and NPA on their new approach to measuring behavior change illustrates the importance of determining quantifiable metrics and tailoring context-specific explosive ordnance risk education programs while building trust within a community.[52]

36 Phong, Nguyen Tuan and Yen, Ta Thi Hai (2017) "Catholic Relief Services: Information and Communication Technology in Monitoring and Evaluation," The Journal of Conventional Weapons Destruction: Vol. 21: Iss. 2, Article 7, https://commons.lib.jmu.edu/cisr-journal/vol21/iss2/7.

37 Yen, Ta Thi Hai (2020) "Game-Based Learning: An Innovative and Scalable Approach to Mine Risk Education," The Journal of Conventional Weapons Destruction: Vol. 23: Iss. 3, Article 8, https://commons.lib.jmu.edu/cisr-journal/vol23/iss3/8.

38 Vinek, Elizabeth; Mukahhal, Sulaiman; and Cottray, Olivier (2016) "Mobile Data Collection: Interoperability Through New Architecture," The Journal of Conventional Weapons Destruction: Vol. 20: Iss. 2, Article 4.
Available at: https://commons.lib.jmu.edu/cisr-journal/vol20/iss2/4

39 Bach, Håvard (2009) "Clearing Areas Right; Clearing the Right Areas," The Journal of ERW and Mine Action: Vol. 13: Iss. 2, Article 8, https://commons.lib.jmu.edu/cisr-journal/vol13/iss2/8.

40 Fardoulis, John; Depreytere, Xavier; Gallien, Pierre; Djouhri, Kheria; Abdourhmane, Ba; and Sauvage, Emmanuel (2020) "Proof: How Small Drones Can Find Buried Landmines in the Desert Using Airborne IR Thermography," The Journal of Conventional Weapons Destruction: Vol. 24: Iss. 2, Article 15, https://commons.lib.jmu.edu/cisr-journal/vol24/iss2/15.

41 Smith, Andy (2017) "Using Small Unmanned Aircraft (SUA) in HMA," The Journal of Conventional Weapons Destruction: Vol. 21: Iss. 3, Article 13, https://commons.lib.jmu.edu/cisr-journal/vol21/iss3/13.

42 Gendron, Theodore R. (1999) "MECHANICALLY ASSISTED LANDMINE CLEARANCE AND DETECTION," Journal of Mine Action: Vol. 3: Iss. 2, Article 7, https://commons.lib.jmu.edu/cisr-journal/vol3/iss2/7.

43 Gerard-Pearse, Oliver (2018) "Drones Supporting Mine Clearance in Northern Sri Lanka," The Journal of Conventional Weapons Destruction: Vol. 22: Iss. 3, Article 6, https://commons.lib.jmu.edu/cisr-journal/vol22/iss3/6.

44 Fahs, Shathel and Crowther, Greg (2018) "The Added Value of Integrating UAVS Into the HMA Toolkit," The Journal of Conventional Weapons Destruction: Vol. 22: Iss. 3, Article 4, https://commons.lib.jmu.edu/cisr-journal/vol22/iss3/4.

45 Cruz, Inna and Eriksson, Daniel (2013) "Miniature Aerial Photography Planes in Mine Action," The Journal of ERW and Mine Action: Vol. 17: Iss. 3, Article 16, https://commons.lib.jmu.edu/cisr-journal/vol17/iss3/16.

46 Bajic, Milan; Ivelja, Tamara; and Brook, Anna (2017) "Developing a Hyperspectral Non-Technical Survey for Minefields via UAV and Helicopter," The Journal of Conventional Weapons Destruction: Vol. 21: Iss. 1, Article 11, https://commons.lib.jmu.edu/cisr-journal/vol21/iss1/11.

47 Alford, Brad; Curran, Edward; and Cole, Shawn (2018) "Determining the Value of UAVs in Iraq," The Journal of Conventional Weapons Destruction: Vol. 22: Iss. 1, Article 8, https://commons.lib.jmu.edu/cisr-journal/vol22/iss1/8.

48 deSmet, Timothy; Nikulin, Alex; Frazer, William; Baur, Jasper; Abramowitz, Jacob; Finan, Daniel; Denara, Sean; Aglietti, Nicholas; and Campos, Gabriel (2018) "Drones and "Butterflies": A Low-Cost UAV System for Rapid Detection and Identification of Unconventional Minefields," The Journal of Conventional Weapons Destruction: Vol. 22 : Iss. 3, Article 10, https://commons.lib.jmu.edu/cisr-journal/vol22/iss3/10.

49 Fardoulis, John; Depreytere, Xavier; Sauvage, Emmanuel; and Gallien, Pierre (2019) "Drones in the Desert: Augmenting HMA and Socio-Economic Activities in Chad," The Journal of Conventional Weapons Destruction: Vol. 23: Iss. 1, Article 16, https://commons.lib.jmu.edu/cisr-journal/vol23/iss1/16.

50 Tan, Allen D. (2014) "Advanced Ordnance Teaching Materials," The Journal of ERW and Mine Action: Vol. 18: Iss. 2, Article 12, https://commons.lib.jmu.edu/cisr-journal/vol18/iss2/12.

51 Tan, Allen Dodgson (2020) "Augmented and Virtual Reality for HMA EOD Training," The Journal of Conventional Weapons Destruction: Vol. 23: Iss. 3, Article 4, https://commons.lib.jmu.edu/cisr-journal/vol23/iss3/4.

Reflecting to Look Forward

As we look toward the future, it has been beneficial to look back, to see how far our community of practice has come, from originating in Afghanistan in 1988, evolving from a "military problem to a humanitarian one,"[53] the advent of various conventions and treaties, altering contamination landscapes, and more inclusive operations, HMA's evolution has been significant. Yet despite its ever-changing landscape, the community's commitment to rid the world of explosive hazards for the betterment of affected communities has not. Movements such as the Landmine Free 2025 Campaign and the Oslo Action Plan stand in testament to this fact. Despite changing in name, design, and scope throughout its more than two decades of service, The Journal shares in the community's commitment, continuing its role to act as a conduit through which HMA practitioners share information for the betterment of affected communities.

Reflecting the ever-changing landscape of HMA, The Journal's 25th edition issues feature solicitations for Nagorno Karabakh, Syria, Yemen, and Ukraine; the environmental impact of explosives in urban areas; physical security and stockpile management within the context of wars of independence and regional conflicts; and legacy war contamination, to name but a few.[54] Additionally, in our upcoming issues, The Journal will feature articles high-lighting the successful clearance of the Falkland Islands' contamination, the mental health of HMA personnel, and topics focused on multidisciplinary approaches to HMA including conflict pollution, alternative finance, and humanitarian forensic action.

As ever, we are grateful to the Office of Weapons Removal and Abatement in the U.S. State Department's Bureau of Political-Military Affairs for funding The Journal, and to the hundreds of contributors who have helped to make The Journal what it is, as well as those who will help to shape what The Journal becomes. The perspectives and extensive skillsets of the authors represented in The Journal are key to generating context-specific and culturally-sensitive solutions to both help clear the many nuanced minefields and ensure that unique post-conflict communities are able to walk the earth in safety.

52 Boyd, Helaine; Kasack, Sebastian; and Nielsen, Noe Falk (2020) "Measuring Behavior Change Resulting from EORE and the Need for Complementary Risk Reduction Activities," The Journal of Conventional Weapons Destruction: Vol. 24: Iss. 1, Article 6, https://commons.lib.jmu.edu/cisr-journal/vol24/iss1/6.

53 Mansfield, Ian. "Humanitarian Mine Action in Afghanistan: A History." The Journal of Conventional Weapons Destruction: Vol. 19: Iss 3: Article 10. https://commons.lib.jmu.edu/cgi/viewcontent.cgi?article=1659&context=cisr-journal.

54 CISR: The Journal Calls for Papers: https://www.jmu.edu/cisr/journal/cfps.shtml.

Illegal migrants and mine suspected areas

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Illegal migrants and mine suspected areas

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The geographical position of the Republic of Croatia has always favored migration. Both legal and illegal. Given that the route of illegal migrants is from the southeast to the northwest, the countries from which migrants entered Croatia are the Republic of Serbia, Montenegro, and Bosnia and Herzegovina.

The latest wave of illegal migration is seemingly linked to the war in Syria; however, the war in Syria was only the trigger for a wave of migrants. War migrations were followed by economic migrations, which is evident from the fact that the share of migrants from Syria is decreasing, and their number is increasing from Iraq, Iran, Afghanistan, Pakistan, India, Bangladesh, and the whole of North Africa. Given climate change, it is very likely that climate migrants from sub-Saharan Africa will also complete the migrant wave soon.

The routes of movement of illegal migrants from Afro-Asia to the European Union are divided into Mediterranean and land. One of the strongest land migrant routes is the Balkan route, which also includes Croatia (see Figure 1).

The Balkan route was originally directed towards Hungary. With the closure of the Hungarian border, the route moved to the Croatian eastern border. As the Croatian border police at the time were in intensive preparations for joining the Schengen area, they had 120 million euros at their disposal in the Temporary Schengen Instrument.[1] A good portion of that money has been invested in high-efficiency stationary thermal imaging systems deployed across the eastern border. By raising the efficiency of the border police in the area, the route of movement of migrants has changed again. Now it moves through Bosnia and Herzegovina and reaches the Croatian border in the Una-Sana Canton. There are several refugee camps where migrants seek rest and re-supply before continuing their journey. Reception camps in Bihać, Velika Kladuša, and Cazin can take care of up to 2,500 people. At least another 1,500 migrants are outside the camps in makeshift accommodation.[2]

Figure 1 - Balkan route

In Croatia, the pressure of illegal migration doubled in 2019, and in some places even tripled. This trend continued in 2020 and 2021. In 2020 alone, over 20,000 illegal migrants entered the Republic of Croatia.[3]

The destination of migrants are economically strong countries of the European Union, so their movement, if they manage to enter Croatia, is directed further through Slovenia, mainly towards Italy, Germany, Great Britain, and the Scandinavian countries. Despite significant efforts in equipping and training the border police of the Republic of Croatia, its borders remain porous. Over 1,500 migrants were returned from Slovenia to Croatia in the first half of 2020.[4]

The Balkan route was significantly affected by Italy's decision to almost completely abolish rescue missions in the Mediterranean in 2018, which significantly weakened the Cen-

1 https://mup.gov.hr/vijesti-8/zapocela-schengenska-evaluacija-granicne-policije/234235, accessed on May 7, 2021.

2 https://www.klix.ba/vijesti/bih/van-kampova-1-500-migranata-krajiske-vlasti-opet-mole-za-pomoc/210311047, accessed on May 6, 2021.

3 https://www.tportal.hr/vijesti/clanak/unatoc-karanteni-u-ovoj-godini-u-hrvatsku-je-uslo-vise-od-20-000-ilegalnih-migranata-20201001, accessed on May 6, 2021.

4 https://www.jutarnji.hr/vijesti/svijet/kod-brezica-nadeni-migranti-u-vozilu-hrvata-ilegalnih-prijelaza-manje-nego-lani-10343734, accessed on May 6, 2021.

tral Mediterranean route.[5] Consequently, land routes, and thus the Balkan route, have significantly strengthened since that decision. In 2021, Germany, as one of the countries that is the most frequent destination for illegal migrants, claims that the number of migrants is significantly increasing, especially those who arrived via the Balkan route.[6]

It can be seen from the previous text that the weakening of migratory pressure is not likely. That pressure is currently happening on the border between Una-Sana Canton and several opposite Croatian counties. As this whole line also represented the line of demarcation of the warring parties during the 1990s, the area of the mine suspected area (MSE) located there is also large.

As of February 4, 2019 report, the MSE covers 354 km^2 of Croatia. In the area of Sisak-Moslavina, Karlovac, and Lika-Senj counties alone, there are about 250 km2 of MSEs. It is estimated that there are about 31,000 landmines and unexploded ordnance from the Homeland War in mine suspected areas of the Republic of Croatia.[7]

Areas covered by mines in the largest volume are forests with 86.8%, followed by agricultural land with 12.9% and other lands with 0.3%.[8]

The mine suspected area is well marked. Namely, the areas covered by mines are marked with 12,358 warning signs.[9] Given that the borderline often divides mine suspected areas in BiH and the Republic of Croatia, such areas are also marked on the BiH side. At the beginning of the migratory pres

sure, already in the first cases of illegal migrants being found near the mine suspected area, the police asked for additional marking

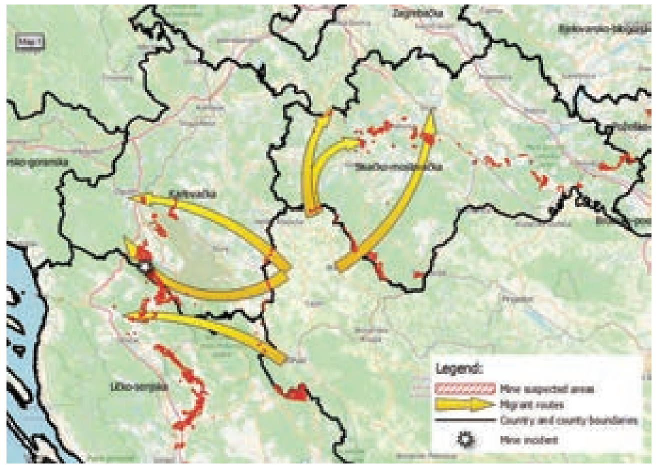

Figure 2 - Transit routes

of such places.

Unlike most places in Bosnia and Herzegovina, illegal migrants cannot move freely through the territory of the Republic of Croatia. Those who manage to enter Croatia illegally move undercover to avoid police patrols in the interior. They mostly move through a wooded area to avoid populated areas as locals cooperate with the police and regularly report the movements of illegal migrants. When forced to pass through populated areas, illegal migrants do so at night hours.

If given the opportunity, illegal migrants seek safety in a mine suspected area as well[10], and their routes often pass through or near them (Figure 2). After years of moving through such areas, a sense of security and belief has developed among illegal migrants that too much time has passed since the mines were planted and they think they are no longer a threat.

They are also informed in advance about the position of the mine suspected area on the territory of the Republic of Croatia. They first received information on the layout of the mine suspected area on Croatia's eastern borders[11], and later for the rest of Croatia[12]. Although this information was provided to them for the reason of avoiding mine suspected areas, they now use such information to navigate through it. This is further confirmed by the case from

5 https://www.dw.com/hr/postaje-li-italija-ponovno-sigurna-luka-za-migrante/a-50406222, accessed on May 9, 2021.

6 https://www.index.hr/vijesti/clanak/njemacki-ministar-povecava-se-broj-migranata-koji-dolaze-preko-balkanske-rute/2275244.aspx, accessed on May 12, 2021.

7 https://web.archive.org/web/20181024063607/ http://www.hcr.hr/en/minSituacDetaljna.asp, accessed on May 7, 2021.

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10 https://www.tportal.hr/vijesti/clanak/policija-u-lici-uhitila-35-migranata-koji-su-u-sumi-podigli-satore-na-miniranom-podrucju-foto-20181106, accessed on May 9, 2021.

11 https://www.tportal.hr/vijesti/clanak/evo-gdje-izbjeglicama-prijete-mine-20150916, accessed on May 9, 2021.

12 https://welcome.cms.hr/index.php/karta-minskih-polja/, accessed on May 9, 2021.

March this year[13] when a group of illegal migrants were seriously injured, and one died in a mine suspected area near Saborski.[14]

The mere existence of signs about the proximity of a mine suspected area will generally deter anyone from entering the same. Such locations are protected from unauthorized entry and through legal provisions.[15] However, migrants do not respect these written and unwritten rules. As we mentioned before, by frequent use of routes passing through the mine suspected area, migrants have lost the fear of possible casualties, and they do not pay attention to legal provisions because their very presence in the territory of the Republic of Croatia is illegal. As a rule, illegal migrants are undocumented and with a hidden identity who only transit through Croatia, which encourages them to commit illegal acts that they would not otherwise commit. They are convinced that they will leave the country very soon, and if they are caught, they believe that their false identity will protect them from criminal liability and readmission to the countries from which they left or from which they entered Croatia.

Given that these are persons who cannot be deterred from entering a mine suspected area by existing measures, it is necessary to introduce more concrete measures to protect such an area. Measures should be implemented selectively, depending on exposure to migrant routes. The protection of a mine suspected area can be twofold. One option is to physically disable entry into the area by setting up barriers. This is special prevention and this option should be applied in the most endangered locations. Another option is to set up a sensor grid that will indicate that someone has entered the area. The sensor network should be connected to the nearest organizational unit of the police, which will intercept illegal migrants when leaving the mine suspected area. This is a general prevention, because information would spread very quickly among the migrant population that such areas are monitored and that they are no longer protected there, but exposed. In this way, we would be ensured that illegal migrants avoid mine suspected areas and thus do not endanger themselves and the services that rescue them.

13 The location is shown by an asterisk in Figure 2.

14 https://www.jutarnji.hr/video/news/migranta-ubila-mina-kod-saborskog-policija-potom-satima-izvlacila-10-osoba-iz-minskog-polja-15055624, accessed on May 9, 2021.

15 In Art. 140 of the Mine Action Act (OG 110/15, 118/18, 98/19) defines a fine of HRK 2,000 to 10,000 for unauthorized entry into a mine suspected area.

Sharing Knowledge and Increasing Transparency with Social Media

David Gertiser, Branislav Jovanovic

Sharing Knowledge and Increasing Transparency with Social Media

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Abstract:

Covid 19 global pandemic put the focus on social networks and online platform for meetings and sharing the knowledge. On this article we are explaining our experience with EOKHUB. Certainly not all in-person events, training or education can be moved online, but distance learning can be an excellent addition to these as well.

Beginning

EOK HUB (Explosive Ordnance Knowledge Hub) launched our social network campaign on June 1st, 2019, and our web page went live on September 9th, 2019. But our thinking about the HUB began several years before that. We noticed that even experts from different explosive ordnance spheres often do not understand what is happening in other parts. For example, experts from humanitarian mine action do not know or don't understand demilitarization details. Cost-saving experience (and potentially lifesaving) from one side of the world remains unknown to the others. Most new technology or methodology is not well-accepted by decision-makers, or expectations are very high ("silver bullet" solution). In all of this, we recognized a need for independent information exchange. Other "problems" present include the sheer volume of information we get every day. It's not possible to follow everything and assess it from all sides, which is important for professionals who wish to stay up to date. These discussions were initially just among friends but began to engage the overall explosive ordnance sector. The result is EOKHUB. EOK HUB is an independent, transparent platform for information exchange on topics varying from machines to policy, dogs to unmanned aerial systems.

Challenges

For us, the COVID 19 global pandemic and lockdown reinforced that we were on the right track from beginning. For more than a year now many in the sector have witnessed traditional activities moving online.

From the early beginning we had a clear vision, namely that online platforms are the future of knowledge sharing, visibility and transparency in the explosive ordnance sector. Reasons are various. Online platforms provide the possibility to reach almost everyone on this planet in a few seconds. Followers can read at a time and location which is suitable for them. It's time wisely spent as well. What can be very important, sharing information online is free or very cheap.

Photo 1: First webinar with European Specialist Group

Certainly not all in-person events, training or education can be moved online, but distance learning can be an excellent addition to these as well. Up until the Covid 19 pandemic, social networks were mainly used for publishing news and making your program and its donors more visible. Remote working brought an emphasis to online meetings and placed webinars in the first row. This leads us to the situation that most people have online meetings all day from sunrise till the sunset, and preparations do at night. Even so, we have noted that many offices are beginning to find an equilibrium between the online and the in-person.

For our part, we noticed a distinct uptick not in website hits and article reads, but social media likes. It is the way people have been able to engage despite the distance. It speaks to the reality of home-office work. Attention is still at a premium, even if we might have more time on our hands due to staying at home.

Photo 2. Medium-term testing of MagDrone R4 before launch

Those were interesting facts and presented new challenges. If you decide, as we did, to not to grow your audience with paid ads it means you have to do much more leg work for each platform. Each social network has his own internal "rules". Different platforms have different length requirements or optimum length. Users of different platforms generally have a different time focus, different audience and maybe most importantly, a different style of writing.

What seemed innocuous at first sight proved a surprising challenge for us. Network anonymity gives users the possibility to comment on your posts/tweets with inappropriate language or to insult someone and for sure no one wants that. Curating a respectful place for knowledge exchange is an important part of our mission. Even though we only focus on technical aspects in the explosive ordnance sector and check information from several sources, it sometimes happens that some followers become very agitated or stop following you. This is why it is fundamental for EOK HUB to always ensure the impartiality, transparency, and accuracy of the information we share.

Most of our followers see the post and finish reading it in a couple minutes maximum, but behind the good article or the post is days and days of hard work. What is most important is good infrastructure.

Certainly, COVID has complicated every aspect of daily life, including our plans at EOK HUB. But we can say that we still have a lot of ideas. We are just finishing our test ground. This will allow us to spend more time with equipment and better know and understand the equipment. We are working to make our testing be more comprehensive and more versatile. There are many heroes in the field we would like to honor and to present to our followers. For sure, our main challenge will be state-of-the-art technology. Due to numerous reasons, it is not tested enough. Our members do not experience that. Indeed, our main goal is to promote the explosive ordnance sector and the quality independently by sharing knowledge where we find it.

Produces of equipment believing us that we will perform honest long-term testing. We can build different scenarios for testing trying to put out the best or the worst from equipment. EOK HUB's main advantage is that we have the support of experts from different fields and from different parts of the world.

As we mentioned above, in the early beginning we decided to grow our base from scratch and not by paid ads. This path is slower but we are grateful to our followers on all our social networks. Why. Most of them are active and giving us contact feedback where we are standing. They are sending us information from the field and facts. We were lucky to meet good people who want to support and help us.

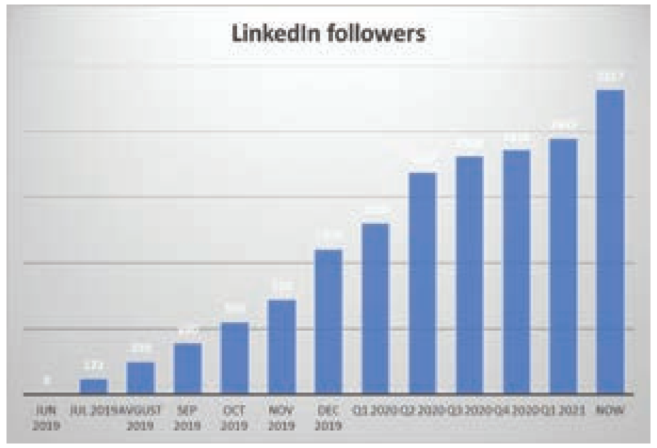

Photo 3: Distribution of LinkedIn followers with time

Conclusion

The past several years has shown us that online platforms, particularly social media, allow for three main opportunities. We are able to share compelling stories, generate conversations, and connect professionals to improve the strength and quality of the EO network. We hope you'll join the conversation!

Sharing Knowledge and Increasing Transparency with Social Media

Linking Mine Action and Infrastructural Development in the Republic of Serbia

Bojan Glamočlija

Linking Mine Action and Infrastructural Development in the Republic of Serbia

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Abstract

This paper deals with the interaction of mine action and infrastructural development in the context of the current expansion of construction and the need to create conditions for safe execution of infrastructural projects that is a prerequisite for future investments in the Republic of Serbia. Requests for clearing the terrain from explosive remnants of war are numerous. The assumption is that there will be more and more requests, given the reform and European integrations processes. Taking into account the fact that armed conflicts of different intensities took place in the territory of the Republic of Serbia during the two World Wars, as well as the 1999 bombing, we can reasonably assume that the land and facilities in the war affected areas have been significantly contaminated with different types of explosive remnants of war, such as artillery ammunition, air bombs of various caliber 50-1000 kg. The role of the Mine Action Center as a national mine action coordinating authority, as well as the role of all other relevant stakeholders, is of vital importance. There is a need for a strictly regulated system, compliance of deadlines, accomplishment of tasks and creation of a sense of security for investors to further invest in infrastructural projects. Prerequisites for this are, among other things, reliable contractors - mine action organizations with qualified staff and technically equipped to carry out demining/clearance operations on such projects. Furthermore, a higher level of awareness on risks of explosive remnants of war is needed and taking appropriate measures prior to carrying out excavation related works.

Keywords: mine action, infrastructural development, explosive remnants of war, Decree on protection against explosive remnants of war, raising awareness on risks of explosive remnants of war

Introduction

In addition to systematically land contaminated areas with cluster munitions, air bombs - rockets and underwater contamination originating from the 1999 bombing, by groups of mines originating from 2000-2001 conflicts along the administrative line with Kosovo and Metohija, in the territory of the Republic of Serbia, there is still a huge contamination with explosive remnants of war from the First and Second World War, as well as the ERW contamination due to explosions and fires in military depots, etc.

For coordination of humanitarian demining operations, in 2002, the Serbian Mine Action Center (SMAC) was established as an independent state body, which focused its activity firstly on what was at that time urgent and important, and those were the areas contaminated with mines, cluster munitions and air bombs - rockets, given that these are explosive ordnance that directly threaten people's lives and prevent their movement and work. Clearance of the areas contaminated with cluster munitions, mines, air bombs-rockets and other UXO has contributed to safety of local population, creation of conditions for safe construction of infrastructure facilities, safe exploitation of forests, development of agriculture and tourism. Also, environmental and fire protection have been improved significantly. Considering that the areas in question have been mostly located in underdeveloped municipalities, in order to develop them and stop population from emigrating for economic reasons, demining/clearance of contaminated areas enables implementation of infrastructural projects, such as construction of solar power plants, development of wood industry, i.e. exploitation and processing of wood.

On the other hand, the areas systematically contaminated with ERW during the two world wars have been treated sporadically.

It is known that the territory of the Republic of Serbia was bombed and destroyed during the First World War in 1914 and 1915 by Austria-Hungary and Germany, in the Second World War in 1941 and 1944 by Germany and Allies. During the bombings, heavy weighted air bombs and artillery shells of various calibers were used. There is a large probability that some of them have failed to explode, but are in the ground, thus posing a real hazard in case of earthworks or the use of other modalities of ground disturbance.

Role of SMAC and other relevant stakeholders

SMAC does not carry out demining/clearance, but, among other things, conducts specialized tasks in the area of mine action, which include survey of areas suspected to be contaminated with cluster munitions, mines and other ERW, develops demining projects, follows the implementation, controls the quality of demining, educates the population about the dangers of mines and other unexploded ordnance, participates in the training of staff for performing general and technical survey and demining.

In Serbia, demining is carried out by specialized companies and other organizations that are accredited, technically equipped and with staff qualified to perform these tasks.

There are more and more infrastructural projects of public interest that include clearing of terrain and construction, relocation or reconstruction of infrastructure facilities, construction of business - residential and other facilities, which implies construction works with excavation of soil.

Last year, SMAC developed an ERW clearance project that comprised a site in Niš, which, during the 1999 bombing, as a site within military barracks, was repeatedly targeted by cluster munitions and air bombs. It has been planned to build apartments for members of security forces on this site.

Furthermore, SMAC developed a project that included a site in Kragujevac where search and excavation of ERW was conducted, and now the construction of the Secondary Government Data Center/Disaster Recovery Centre is in progress on this site.

Fig 1: Armored excavator used on ERW clearance project in Niš

Special attention is drawn to Project for demining and technical survey (UXO risk reduction) in the areas of construction of the main gas pipeline route from the border with Bulgaria (in the vicinity of Zaječar) to the border with Hungary (in the vicinity of Horgoš). Implementation of humanitarian demining operations on this project has provided conditions for safe engineering-geological and geotechnical exploration of soil and construction works on the main gas pipeline route from the border with Bulgaria to the border with Hungary, so called Turk Stream.

In the coming period, SMAC is expected to develop an ERW clearance project involving a complex inside the Smederevo Fortress, which was shot with the 42 cm cannons and badly damaged during the First World War and the crossing of the Danube by the Austrians. In the Second World War, it was devastated by a large explosion of ammunition that was stored there. Towards the end of the war, it was also destroyed by Allied bombers. In order to create conditions for the safe conduct of systematic archaeological investigations in the Smederevo Fortress, as well as to maintain and use this cultural and historical complex to the fullest, it is necessary to search and remove ERW first.

ERW clearance project of areas in the zone of the bridge at Sremska Rača and along planned route of Belgrade - Sarajevo highway, Sremska Rača - Kuzmin section, is in progress. Upon clearance of ERW from these areas, the danger they pose for the construction of the highway to Sarajevo, Sremska Rača - Kuzmin section will be removed and safe implementation of the road infrastructure project, which is for our country of an extreme importance since it will contribute to regional connectivity, will be enabled.

Contractors

In order to best respond to an increasing number of requests for ERW clearance of terrain, contractors have to be mine action organizations with a serious approach to the task, fully committed and above all, with the state of the art technology equipment. Such equipment can enable them to work more efficiently and accurately than ever before. In Serbia, devices developed for the detection of ferromagnetic objects buried underground at a depth of about 6 m have been used on several projects. The devices are equipped with data loggers having software that is used to analyze data recorded in the field.

Photo 2: Use of devices that allow the application of a passive and active method on ERW clearance project related to Data Center construction site in Kragujevac

Analysis of data in the field determines whether there are ERW or anomalies indicating the existence of an object of a mass within the limits of the critical error established by an ERW clearance project.

Photo 3: Transfer and analysis of data acquired by data logger on an ERW clearance project in Kragujevac

Such is, for example, a MAGNEX 120LW device with a recording width of 2.5 m or an UPEX 740 M device with a recording width of 2m.

Photo 4: Use of MAGNEX 120LW and UPEX 740 M on ERW clearance project in Novi Sad

Depending on the terrain to be searched, MAGNEX 120LW device can be hooked up as a quad trailer for faster and easier search of the area to be cleared. The maximum speed of the vehicle for which the detector is attached is 10 km / h.

Photo 5: Use of MAGNEX 120LW device on Demining and Technical Survey Project (UXO risk reduction) in the areas of construction of the main gas pipeline from the border with Bulgaria (near Zaječar) to the border with Hungary (near Horgoš).

New Decree on Protection against ERW

New Decree on Protection against ERW is in its final phase if being adopted by the Government.

It has been developed by representatives of SMAC and Ministry of Interior. In relation to the previous Decree, the amendment will incorporate or revise the following additional components:

- Introduce land release concept, not defined in the former decree;
- Streamline and improve accreditation, monitoring and evaluation;
- Prohibit previous practice of independent ammunition technicians being hired by infrastructure companies, this shall now be done through tasking and coordination from SMAC;
- Introduce the need for development of national standards

Training and Testing Centre within SMAC

In 2020, SMAC has established the Training and Testing Center, namely it expanded its business capacities, with teaching premises with a training ground and site for deminers, within the SMAC, in order to conduct specialized training and issue certificates of competence in the field of protection against ERW, as well as education on dangers of ERW, based on the standards of professional development.

In March 2021, SMAC acquired the status of a publicly recognized organizer of activities for the program - Training of Educators on the dangers of ERW, which was verified by the Ministry of Education.

In the period 21.09.2020.-10.10.2020, SMAC, with the support of the French Embassy in Belgrade and the participation of French instructors, organized, for the first time in the Republic of Serbia, training on Explosive Ordnance Disposal - Level 1 (EOD Level 1), which was fully conducted in accordance with IMAS.

Raising awareness

In connection with this issue, SMAC intends to invest considerable resources in raising awareness with various mine action actors, and international organizations, as well as in the country, in particular with employees of institutions responsible for construction and communal operations, members of the Ministry of Interior, firefighters, hunting associations, mountain societies, entities of importance for protection and rescue and other interested parties. The intention is to carry out ERW risk education and training activities connecting theory and practice.

Conclusion

It is necessary to strengthen the influence of mine action institutions and instruments with a focus on the regulation of the system. In addition, continuing education and training, keeping track of the state of the art technology, but also the establishment of an effective communication platform and networking of mine action actors are needed.

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