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Tel +385 1 650 0020

NOTE:

The material submitted by the authors has not been revised.

All terms, definitions and texts are the original constructions of the authors.

ISSN 1849-3718

Ključni naslov: Book of Papers (International Symposium “Mine Action”)

Skraćeni ključni naslov: Book pap. (Int. symp. “Mine Action ”)

2nd to 4th May 2022, Vodice, Croatia

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18th International Symposium Mine Action 2022

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Standardisation of training in the field of mine action

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Introduction

In the field of Mine Action, training is one of the most important elements, and is an integral part of the continual improvement and staff development, to allow organisations to adapt to a complex and everchanging working environment. It is an extensive topic, and it can be subject to interpretation. Mine Action is guided by the set of International Mine Action Standards (IMAS) and their supporting documents. This year we are celebrating 20 years of IMAS, and these are perhaps some of the most applied sets of standards globally. There is an international standard in place which provides general guidance on the management of training in Mine Action - *IMAS 06.10, Management of Training*[1]. Whilst this guiding document is developed by the sector, for the sector, and is providing the basic framework for all the stakeholders to operate within, it does not provide answers to everything related to training in Mine Action. As the title suggests, it is focusing on the management side of training. However, it is a useful document which helps in understanding the sector`s approach to training, and principles set in this standard (or similar principles), can be applied across the sector. This article will refer to some of the principles set in IMAS 06.10. We are also witnessing recent efforts in standardising competences for some of the key functions across the sector. Notably, Explosive Ordnance Disposal (EOD) and Improvised Explosive Devices Disposal (IEDD) competences are already defined and codified in Test and Evaluation Protocols (T&EP), *T&EP 09.30 and T&EP 09.31*. Other T&EP are being developed too. This article will be focusing on the technical or operational level of training management, as it is, arguably, the most discussed segment in Mine Action. However, it recognises that there are other training requirements which are equally important to keep the programme running (e.g., training for managers, training in support of administration, logistic or finance etc) as well as those which are cross-cutting and should be incorporated in all training, including technical (e.g., gender and diversity).

This article will focus on the competences and competence-based training, the benefits of standardisation and how this can be related to training and identifying some of the potential challenges.

Background

The Geneva International Centre for Humanitarian Demining (GICHD) is an international organisation which, provides training and advisory services to mine action organisations and other national authorities and other institutions involved in mine action (NGOs, operators, and donors), either on the ground or in Geneva[2]. Recently, the GICHD has also developed the e-learning platform, which allows for greater outreach, more flexibility and easier access to courses and course materials. Main recipients of the GICHD training are national capacities, but also the international operators and other relevant stakeholders in the sector. Through years of implementation of global and regional projects, the GICHD has witnessed the lack of a harmonised approach to training and the different levels of knowledge, skills, and attitudes, sometimes even between peers within the same programmes and organisations.

1 Note: This chapter is currently under the review by the Technical Working Group.
2 GICHD webpage, https://training.gichd.org/

As one of the leading institutions in providing training related to Mine Action, the GICHD attempts in synchronising the knowledge across the sector, through sharing experience, good practice and lessons learnt. Training provided by the GICHD aims to develop the same base-knowledge, skills, and attitudes across the sector, so that principles of safety, operational efficiency and effectiveness are based on the same understanding. Additionally, the GICHD has suggested starting a review process of the IMAS 06.10, now approved by the IMAS review board. A Technical Working Group has been created to review this IMAS chapter.

Competences and competence-based training

There are many different definitions of competence, but in short, it is the ability to do something well[3]. IMAS definition sees competence as a specification of knowledge and skill and the application of that knowledge and skill to the standard of performance required in the workplace[4]. As such, competences can be assessed. What the current set of IMAS provides, is the minimum required set of competences, required to perform certain functions, in a defined context and in line with the performance criteria. However, it allows for organisations and programmes to set additional requirements beyond the required minimum. As the competences are closely linked with knowledge and skills, adequate training to achieve a desired competence level is crucial.

Training that emphasises what a person is capable of performing, or should be able to do in a workplace due to completing a training, is termed Competence-based training[5]. The aim of competence-based training and assessment is to produce a competent workforce by providing focused training. It does so by identifying key competences that need to be achieved, determining the most effective way of achieving them and establishing valid and reliable assessment tools to evaluate their achievement.[6]

A defined minimum set of required competences can be used to help to design training programmes that will focus on the required knowledge and development of skills needed. Competences can be put in the category of the learning objectives or learning outcomes that define what students will be able to do when they complete a learning experience, what knowledge will be acquired, and what skill can be applied. For an organisation, it is more likely that competences will be perceived as an output, whereas for an individual learner, having a specific competence may be an outcome. Qualifying for a certain competence can also be a precondition for further career progression.

For example, to move to EOD level 2 training, a learner must be already EOD 1 qualified and must be able to demonstrate his or her knowledge and skills against the defined performance criteria. This could involve the written tests, practical exercises, assessed simulated tasks, or procedures for assessment of actual performance during live operations[7].

However, defining and agreeing on what the minimum required competences should be for different functions and different job roles can be a stumbling point. Organisations and programmes may have varying opinions based on diverse experience, criteria, and standards. Resolving these variances and finding a commonly acceptable approach can be challenging.

Benefits of standardisation in relation to competence-based training

IMAS definition of a standard is "A standard is a documented agreement containing technical specifications or other precise criteria to be used consistently as rules, guidelines, or definitions of characteristics to ensure that materials, products, processes and services are fit for their purpose"[8]. Another definition that can be related to competences can be borrowed from `Investopedia`, which says that the goal of standardisation is to enforce a

3 Oxford Dictionary online, https://www.oxfordlearnersdictionaries.com/definition/american_english/competence
4 IMAS T&EP 09.30 (2022), pg2 - https://www.mineactionstandards.org/fileadmin/user_upload/TEP_09.30.01.2022_Ed.2_02.pdf; another definition can be found in IMAS 07.12, Quality Management in Mine action: "Competence is the ability to apply knowledge and skills to achieve intended results" and this definition is in line with the ISO 9000:2015.
5 UNESCO UNEVOC - International Centre for Technical and Vocational Education and Training, https://unevoc.unesco.org/home/Competency-Based+Training&context=
6 IATA, https://www.iata.org/en/publications/newsletters/iata-knowledge-hub/what-you-need-to-know-about-the-competency-based-approach-to-dangerous-goods-training-and-assessment/
7 IMAS T&EP 09.30 (2022), pg5 - https://www.mineactionstandards.org/fileadmin/user_upload/TEP_09.30.01.2022_Ed.2_02.pdf
8 IMAS 01.10 - Guide for the application and development of International Mine Action Standards (IMAS), https://www.mineactionstandards.org/fileadmin/user_upload/IMAS_01.10_Ed2_Amd10.pdf

level of consistency or uniformity to certain practices or operations within the selected environment[9]. If we link these definitions to competences and competence-based training, we can infer that the standardised competences in the field of Mine Action could increase interoperability on organisational, national, regional, and international level. We can also infer that it would ultimately contribute to mutual confidence amongst interested parties that mine action operations will meet the required level of performance. Therefore, training should be included into strategic planning[10], on both programme and organisational levels, based on the Training Needs Analysis[11] (TNA).

Standardisation also provides a foundation on which innovation can build[12]. It does so by providing structured methods and reliable data that save time in the innovation process and makes it easier to disseminate ideas and knowledge[13]. Standardisation also allows for the programme to source the training from various entities and not to be dependant only on few. Finally, standardisation of competence can ease the changes in the programmes and organisations, by ensuring that there is no loss of quality between the incoming and outgoing staff. It also allows for a certain level of predictability, so the planning can be somewhat easier.

Potential challenges

Some of the challenges that the standardisation may bring can be identified as potential loss of creativity, or potential loss of responsiveness. When an organisation accepts certain standards, it may be difficult to change them, to adapt to new challenges, new solutions and new operational contexts. But perhaps the most obvious challenge related to training, in general, is the long-term monitoring of the outcomes and impact of training. While the outputs can be assessed immediately, long term monitoring of the impact can be complex. Having standardised competences and assessment criteria could arguably provide a better possibility to monitor performance, which would consequently lead to an assessment of training outcome and impact in the organisation or a programme.

Without these assessment tools and standardised criteria, outcome monitoring may still be possible for the organisation who received the training, but for the external training provider, it can be quite aspirational. One could argue that the external training course provider is responsible only for the outcomes on the learner's level, but entities providing training courses should, and often do, monitor the impact of their activities, so they can be improved and become more effective.

Finally, standardising competences across the sector can be time consuming and costly, on the level of standards, and on the level of implementation in the field.

Conclusion

The sector recognises the importance of standardising competencies, and the first steps in this direction are already made. On the level of training, what would further transform the sector is a shift towards appropriate competence-based training, linked to actual functions, rather than the job title[14]. To allow the Mine Action sector to progress further on this track, we must consider adequate time and resources. Developing norms and implementing them in the field will require good planning and commitment of all stakeholders, including national authorities and donors. Standards should focus on defining minimum requirements, allowing to national authorities and organisations to refine them further, to be more relevant and appropriate in the given national context. However, standards should also help with raising confidence that the staff have received the right training, especially when receiving it from an external provider.

9 Investopedia, https://www.investopedia.com/terms/s/standardization.asp
10 IMAS 06.10 – Management of Training, pg2, https://www.mineactionstandards.org/fileadmin/MAS/documents/standards/IMAS-06-10-Ed1-Am3.pdf
11 Ibid.
12 Open Source - https://opensource.com/open-organization/20/2/standardization-versus-innovation
13 Bureau de Normalisation de Québec, https://www.bnq.qc.ca/en/the-importance-of-standardization.html
14 IATA - https://www.iata.org/en/publications/newsletters/iata-knowledge-hub/what-you-need-to-know-about-the-competency-based-approach-to-dangerous-goods-training-and-assessment/

Standards of EOD and other deminers' trainings in the Republic of Croatia

Dražen Šimunović, mag.ing.mech

Abstract HCR-CTRO Ltd. Zagreb, EOD trainings levels 1-3+ in the period from 2008 to 2022, Project of the first EOD 1 training in the Republic of Croatia, Conclusion of the 18th SEEMACC meeting held on 18.03.2008 in Bohinj, Republic of Slovenia, CEN Workshop Agreement CWA 15464 - Humanitarian Mine Action, EOD Competency Standards, UN mine action standards IMAS 09.30 Explosive Ordnance Disposal, ISO Standards, Curricula, Goals, Tasks, Users, Content and Implementation of EOD Training Level (1 ÷ 3+) in the Republic of Croatia, Teachers of EOD Training courses, Other Trainings of Professionals in the Republic of Croatia during the period 1992 -2022.

INTRODUCTION

The aim of this paper is to present the EOD training in the Republic of Croatia in the period from 2008 to 2022 and other training courses for deminers during the course of thirty years, from 1992 to 2022 provided by state and scientific institutions and their compliance with UN standards of mine action, ISO standards and all relevant legal regulations and standards in the Republic of Croatia.

Beginnings of EOD trainings in the Republic of Croatia

The beginning of EOD trainings in the Republic of Croatia dates back to **06.10.2008, when the first EOD level 1 training began in Topusko near Zagreb.** It was part of the Project developed in 2008 by the Croatian Mine Action Centre – Centre for Testing, Development and Training (HCR-CTRO), based on the **conclusions of the 18th SEEMACC** meeting held on 18th March 2008 in Bohinj, Republic of Slovenia in accordance with the CEN Workshop Agreement CWA 15464 - Humanitarian Mine Action: EOD Competency Standards, **UN Mine Action Standards IMAS 09.30 EOD and ISO Standards.** This project covered four levels of training, from EOD 1 to EOD 4 (EOD3+).

For all levels of EOD trainings, curricula (with elaborated thematic units) were developed. The first EOD training courses were implemented by HCR-CTRO in cooperation with international entities in humanitarian demining for candidates from the countries of Southeast Europe.

Aim of EOD trainings

The aim of EOD trainings (stated in the Project) is to provide the EOD trainees with high quality education in order for them to acquire the expertise and skills necessary for independent, professional and efficient performance of tasks in the process of locating, detecting, identifying, removing, destroying and disposing of unexploded ordnance in contaminated areas and/or buildings, and in this regard the acquisition of the knowledge necessary for the implementation of other EOD processes and supervision of these processes and its application in real conditions. The aim of EOD trainings is also for candidates to apply and fully adopt standard operating procedures (SOP), in accordance with international mine action standards (IMAS).

Tasks of EOD trainings

The tasks of EOD trainings are to educate on explosive substances, ignition devices, mines, missiles, mortar shells, hand grenades, rocket launcher grenades, rifle grenades, hand launcher ammunition, guided missiles, rockets, air bombs, cluster munition, naval mines, special fuses and other explosive devices; to educate on deminers' safety measures, safety distances calculation, net mass of pure explosives, operational procedures, locating, remediation, risk assessment, equipment and devices for detection of mines and UXO, identification of CBRT agents, protective means and equipment, radiological, chemical and biological decontamination, disposal of CBRN weapons systems, remediation of the place of discovery of the CBRN agents, post-disposal activities; legal regulations and international standards related to EOD, quality control, organization of work at the worksite, storage, transportation and maintenance of UXO, medical assistance and stress prevention; identifying and solving problems, causes of problems, exchanging of experience in the field of UXO and the methods and ways of solving them, using the EOD-ERW-UXO-mines database, analysis and application of data in practice and to provide all other necessary knowledge and skills in accordance with the Curriculum.

EOD training beneficiaries

The beneficiaries of the trainings are employees of National Mine Action Centres (in the first trainings they were experienced deminers from individual members of the South East Europe Mine Action Coordination Council - SEEMACC). In addition to them, the beneficiaries are employees of certain ministries, in particular: defence, interior, civil protection as well as authorized legal entities (companies) in humanitarian demining/mine action that perform EOD activities.

Figure 1: EOD training at HCR-CTRO

EOD training content

The contents of EOD trainings are made in accordance with the criteria prescribed by the documents IMAS 09.30, Test and Evaluation Protocol 09.30/01/2014, IMAS 09.31/01/2019. Currently, the development and harmonization of the EOD trainings contents with the Test and Evaluation Protocol 09.30/01/2022 is in the process.

EOD 1 training included the following thematic units: safety measures when working with UXO, explosive substances, mines, unexploded ordnance, destruction of UXO and mines, detection tools and equipment, organization of the EOD work sites, legal regulations and first aid. A total of 98 classes (60 theory classes, 34 practical classes and 4 hours of exams). By 2010, EOD 1 training course had 117 classes. EOD Level 1 training is intended for persons without or with minor formal knowledge of explosives and explosive remnants of war as well as for persons who have previously worked with explosives.

EOD 2 training included the following thematic units: knowledge base, equipment, UXO risk management, location and safe access, transport of explosive devices, final disposal, remediation, post-disposal activities and first aid, 73 classes in total (49 of theory, 26 of exercises and 4 hours of exam). EOD level 2 training is intended for persons who have successfully completed a level 1 EOD course or who have previous relevant experience in working with explosives, ERW and mines and have completed a basic course for deminers, which they confirm by taking the EOD level 1 examination.

EOD 3 training included the following thematic units: knowledge base (UXO identification and marking, land munitions and fuses, UXO destruction), UXO risk management, location and safe access. A total of 28 classes (3 theoretical, 21 practical and 4 hours of exams). **This level of EOD training is implemented through the strategy of mentoring the participants through cooperative (constructive) project tasks solving.** EOD level 3 training is intended for persons who have successfully completed the EOD level 2 course and who have performed EOD level 2 tasks for a minimum duration of one year, as evidenced by the certificate of the relevant authority.

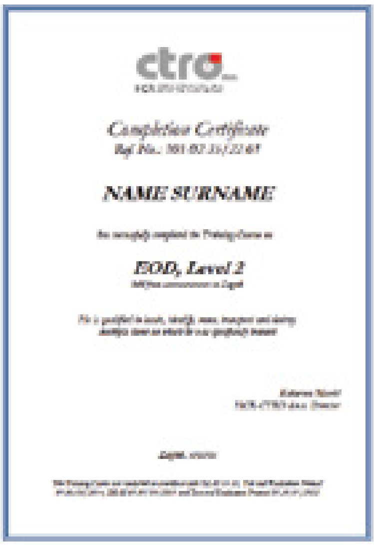
EOD 3+ training included the following thematic units: knowledge base, detection and identification of CBRT agents, protective means and equipment, radiological, chemical and biological decontamination, CBRN weapons systems in Southeast Europe, disposal of CBRN weapons systems, remediation of the location of CBRN ordnance, post-disposal activities. A total of 48 classes (38 theoretical classes, 6 practical classes and 4 hours of exams). EOD level 3+ training is intended for persons who have successfully completed the EOD level 3 course and who have performed EOD level 3 tasks for a minimum duration of one year, as evidenced by the certificate of the relevant authority.

The first EOD-1 training course was held in 2008 in Topusko, Croatia, for participants from the countries of the former Yugoslavia (Southeast Europe) region. In total, from 2008 until 2022, HCR-CTRO trained and tested more than 200 candidates for EOD levels from EOD 1 to EOD 3+.

Figure 2: Cerovac test site

Completion Certificate

At the end of the training course, after passing the examination for a certain level of EOD training, HCR-CTRO issues a Completion Certificate.



ctro

Completion Certificate

NAME SURNAME

EOD, Level 2

Figure 3. Completion Certificate

Teachers and instructors of EOD trainings

EOD trainings have been conducted by recognized explosives experts with many years of scientific, teaching, military technical engineering experience as well as experiences in war and post-war EOD activities in both military and humanitarian demining. The teaching team of scientists and highly educated experts consists of the personnel from CROMAC, HCR-CTRO, Croatian Defence Academy, Police Academy, Faculty of Mining, Geology and Petroleum Engineering, University of Applied Sciences Velika Gorica, Croatian Ministry of the Interior, Croatian Red Cross, ITF, NPA, SEEMACC members (Bosnia and Herzegovina, Montenegro and Serbia) and other institutions.

Figure 4. Practical training at the Cerovac Training site

Other deminers' trainings in the Republic of Croatia

It is important to note that the curriculum of the EOD Level 1 training for the Project, which in 2008 was developed by HCR-CTRO based on the conclusions of the 18th SEEMACC meeting held on March 18, 2008, was based on the curriculum of the six-month training of military deminers/bomb squad specialists from 1992 conducted at the Croatian Defence Academy Petar Zrinski in Zagreb. This Curriculum covered all topics and content related to the EOD expert requirements, both in terms of teaching content and the number of classes. At the same time, the Police Academy of the Ministry of the Interior organized and implemented a six-month course for police officers of the Bomb Squad of the Ministry of the Interior with similar curriculum. In January 1995, Civil Protection, in cooperation with the Firefighters' School in Zagreb, organized the first training course for deminers in humanitarian demining for the purpose of demining minefields in the territories of the Republic of Croatia where the war activities had ceased. Training for deminers at the Firefighters' School was carried out for 6 years between 1995 and 2001, 560 deminers were trained per seven-week curriculum comprising 270 classes, of which 112 theoretical, 154 practical and 4 hours of exam.

Bearing in mind that the Republic of Croatia has had a huge problem with suspected hazardous areas, large numbers of UXO and ERW in the period from the beginning of the Homeland War in 1991 to the present day, training of personnel in the field of demining and EOD was a strategic goal for solving these problems. Since 1992, over 3000 (three thousand) deminers and other professional staff have been trained in the Republic of Croatia through the following institutions and teaching facilities:

<u>Police Academy of the Ministry of the Interior</u>

a) Specialization course in explosive protection. According to the Curriculum, the course has 649 classes, of which 380 of theoretical and 269 of practical lessons. The curriculum covers the areas of terrorism, explosive substances, mines, ammunition, artillery, aviation and naval ordnance, basics of CBRN weapons, special fuses and booby traps, improvised explosive devices, anti-explosion equipment and devices, protective measures against ionizing radiation, first aid, communication culture and stress management, topography, storage and transport of explosive devices and explosion investigations.

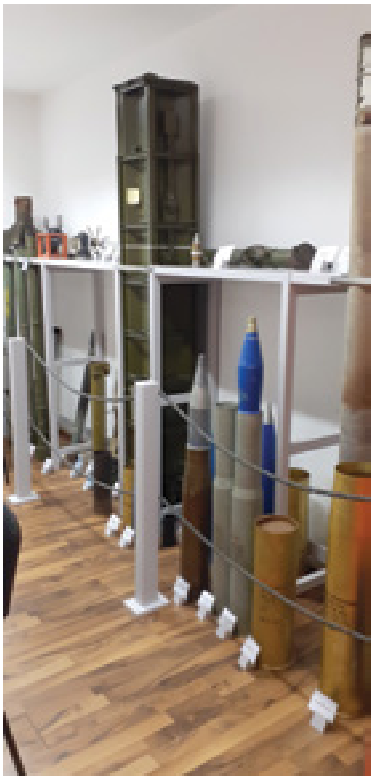
b) A basic training course for deminers. According to the Curriculum, the six-week course has 273 classes, of which 133 theoretical and 140 practical. The curriculum covers all topics in the field of demining and UXO destruction as presented in the Rules and Regulations on the training and training conditions for auxiliary staff, deminers, work site managers and quality control officers (National Gazette 49/2018). The Rules and Regulations also presents a curriculum for the training of an auxiliary workers, site managers and quality control officers.

<u>Croatian Ministry of the Interior</u>

Professional training courses for auxiliary workers, deminers, site managers, quality control officers and quality control supervisors are conducted for the Ministry of Defence by the engineering unit of the Croatian Armed Forces. The deminers' course has a total of 263 classes of which 131 theoretical and 132 hours practical. The Rules and Regulations is harmonised under Article 143(2) of the Law on Mine Action (Official Gazette Nos. 110/15, 118/18 and 98/19).

<u>University of Applied Sciences Velika Gorica</u>

At the University of Applied Sciences in Velika Gorica from 2003 to 2007, an academic course of pyrotechnics and humanitarian demining was conducted, where for the first time experts were educated according to the Bologna process for the duration of 6 semesters for the titles of bachelor of. pyrotechnics and bachelor of humanitarian demining. The curriculum of these courses is aligned with all topics related to demining, EOD and ERW issues.



An approach to defining mine action training in the Republic of Serbia

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Abstract: The territory of the Republic of Serbia was the scene of numerous conflicts, which conseqences of expresse were in large number of explosives remnants of war. The level of industrial development and the geospatial position of the state imposed the need for the existence of a defence industry and a large number depots of ammunition. The consequences of accident situations in production facilites and depots have been shown with large number of unexploded ordnance in cntaminated areas. The imposed danger conditioned the necesity of a systematic approach to the removal of found residual explosive devices. The legal framework in force needs to be constantly innovated. The existing capacities for mine action operations need to be modernized and developed in accordance with identified and anticipated needs. The main authority of mine action operations is the Serbian Mine Action Centre. Recognizing contemporary directions of development of mine action capabilities, the paper presents an approach to defining necessary capacities to achieve certain capabilities. Capability development needs to be designed through staff training in several segments: for engagement in demining tasks; for engagement in tasks of organizing work in preparation and demining; for engagement in implementation of quality control of conducted works. The paper presents an approach to defining a model of staff training for demining purposes.

Key words: mine action, demining, training, organization, quality control.

INTRODUCTION

The geospace of the Republic of Serbia has been confirmed as important through history. Conflicts of conquest have resulted in large numbers of explosive remnants of war that hamper the country's industrial progress in peacetime. The method of eliminating hazards is based on the existence of legislation and the development of capacities which would deal with demining of hazardous areas. The holder of demining tasks is the Mine Action Centre of the Republic of Serbia, which develops and improves its own capacities through cooperating with relevant elements of the defense system. Capacity development is based on different types of education.

THE POSITION AND CONSEQUENCES OF THE POSITION OF THE STATE

The geopolitical space of the Republic of Serbia has always been interesting for various invaders, which has resulted in a large number of conflicts. Their consequences are expressed in human losses and material damage. Subsequent consequences are expressed through consequences coused by the remaining combat mines, air bombs and other ammunition of all calibers.Large number of unexploded ordnance UXO[1] и explosives remnants of war (ERW)[2] conditions security threats, which directly affect on social and economic development.

1 UXO (unexploded ordnance explosive ordnance that has been primed, fuzed, armed or otherwise prepared for use or used. It may have been fired, dropped, launched or projected yet remains unexploded either through malfunction or design or for any other reason),https://www.mineactionstandards.org/en/standards/document-detail/?tx_imas_document%5Bdocument%5D=264&tx_imas_document%5Baction%5D=show&tx_imas_document%5Bcontroller%5D=Document&cHash=611e82a6d46b2fe28da138e248a187ab, приступљено 06.04.2022. године.

2 ERW - UXO and AXO (explosive ordnance that has not been used during an armed conflict, that has been left behind or dumped by a party to an armed conflict, and which is no longer under control of the party that left it behind or dumped it. Abandoned explosive ordnance may or may not have been primed, fuzed, armed or otherwise prepared for use) https://www.mineactionstandards.org/en/standards/document-detail/?tx_imas_document%5Bdocument%5D=264&tx_imas_document%5Baction%5D=show&tx_imas_document%5Bcontroller%5D=Document&cHash=611e82a6d46b2fe28da138e248a187ab, accessed 06.04.2022.

There are many examples where are UXO and ERW, or slowed down the works [1] or took the lives both of civilians and people who carrying their removals[2].

The dangers which cause by UXO and ERW, require existence of institutions which will deal with this issue, and also cooperate with other relevant institutions in the country and abroad on operation of clearence polluted areas.

CAPACITIES FOR MINE ACTION

An institution has been formed at the level of the Republic of Serbia „Mine Action Centre"[3], whose basic task is the coordination and control of mine action on entire territory of the Republic of Serbia. In additional to the above, was recognized cooperation with other structures in the country and abroad, in order to comprehensively improve mine action. Organization of scientific and professional gatherings and training for mine action and building capacity, are one of the basic directions of the center's development in order to improve mine action at state level. Based on the achieved cooperation, the center is recognized as a perspective factor in mine action in the region.

Mine action in the Republic of Serbia is reguleted by „Decree on protection of unexploded ordnance".[3][4]. Mine action is system which evolves and improves over the time, in accordance with International mine action standard. IMAS - International Mine Action Standards are successfully implemented in work Mine Action Centre of Serbia.

The Republic of Serbia is recognized as the center of the region that is interesting for investments by domestic and foreign investitors. The construction of the infrastucture requires ensuring safety during the realization of works as one of the crucial requirements. One of the important documents for the construction of new facilities is certificate of safety works on the locations, e.g. there is no contaminated areas. The only competent authority that issues certificate is Mine Action Centre, in which jurisdiction are organization and quality control demining work.

In the context of the current expansion of the construction industry, the number of requests for issuance of certificate of clearence is growing. Accordingly, recognizing the need for the development, it is necessary to work on strengthening the capacity for training, which creates the conditions for monitoring the growth trends of the construction industry.

3 [3] " RS Official Gazette", No. 70/13

CAPACITY DEVELOPMENT FOR MINE ACTION

Strengthening the capacity of mine action in the Republic of Serbia is reflected in the development and improvement of the capabilities of the Mine Action Centre, in personnel and infrastructure development.

Providing the necessary personnel and infrastructure resources to enhance the state capabilities would greatly contribute to the protection from unexploded ordnance in two ways:

- Indirectly, by providing personnel for demining and destruction of unexploded ordnance, through establishing and enhancing capabilities, primarily trainers, for continuous training demining staff;
- Directly, by developing a plan for faster demining of sites contaminated with unexploded ordnance, which would improve the safety of people and property and create conditions for faster and safer implementation of infrastructure projects, as a prerequisite for future investments in the Republic of Serbia.

With successfully strengthening the capacity for mine action, the Republic of Serbia remains commited to its strategic goal, to membership in EU. In accordance with above, our state continued to achieves results in the implementation of obligations from Stabilization and Association Agreement (SAA).

Continuing the practice of cooperation with domestic and foreign institutions, the realization of the project has begun „Improving the capabilities of the Republic of Serbia in the field of demining and destruction of unexploded ordnance".

The subject project included providing training for instructors and equipping them with modern equipment, in accordance with international standards, which together realize Ministry of defence Republic of Serbia and Mine Action Centre of Republic of Serbia. This project implied establish pool of skilled EOD trainers certified in accordance with the International Mine Action Standards (IMAS) and European Union EOD competency standards, so the trainers are now able to train personnel to conduct Unexploded Ordinance (UXO), Explosive Remnants of War (ERW) and landmines disposal actions, level EOD 1 and EOD 2. With this model of working and achieved cooperation with Army of Serbia, Mine Action Centre can successfully train and keep skills on high level for the realization work , at the mentioned level. A further direction of the Center's development during capacity building would be to provide training for instructors for the next levels of mine action[4]. The mentioned development of training, conditions the improvement of the infrastructure and training base, which would be in the service of quality and safety in training. The European Union has an active participation in the imlementation of the standards through the financing of the mentioned capacity building project[7], as well as organizations of cooperation with relevant actors in mine action.

Considering that a part of improving the capabilities of the Republic of Serbia has already been realized, the next goal is the purposeful use of acquired knowledge through the organization of training. One of the possible directions of development skills, needs to be conceived through staff training in diferent segments, such as:

- To engage in demining tasks;
- To engage in the tasks of work organization in the preparation and implementation of demining;
- To engage in quality control in demining.

Training plans and programs for levels EOD-1 and EOD-2 aare currently being prepared, which would include training of new staff and keep skills of already traind staff. On this way, by strengthening human and infrastructural possibilities, new directions of international cooperation are opened, in the field of exchange gained experiences or training the staff of demining operators. In cooperations with Geneva international center for humanitarian demining (GICHD), successfully implementing training in quality management in the area of mine action[5]. Given this perspective of development and possibilites, Mine action centre in the further cominig tima will have the tasks of clearence floating way in the river Danube. Considering the specifics of the realization of the mentioned task, the experiences that will be gathered can be very useful for improving the training, improving capacites and improving international cooperation.

CONCLUSION

The obvious consequences of the conflict in the country indicate the need to develop and improve the capacity for mine action. The holders of developing is the Mine Action Centre of Republic of Serbia. As a responsibles institution, Као одговорна институција, recognized the need to integrate all available capacities of the defense system in the service of mine action with the aim of creating the necessary conditions for economic growth. Growth reflected in various capital construction projects. Capacity development is reflected in the training of staff to engage in tasks: demining, work organization in the preparation and implementation of demining; quality control in demining.

The set goals are realized in cooperation with relevant authorities in the country, institutions in the world and partner countries.

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Demining process in the function of state border surveillance

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Statistical indicators show that the number of illegal crossings of the state border of the European Union in 2021 increased by 57% compared to the previous year [1]. Given the war in Ukraine, which is the world's leading exporter of sunflower oil, rapeseed, barley, corn, wheat, and poultry, the global food crisis is deepening. This food crisis will impact African countries, some of which depend entirely on grain from Ukraine and Russia. All this could lead to a new wave of migrants from Africa to Europe [2].

The influx of illegal migrants along the Western Balkan route, on which the Republic of Croatia is also on, increased by 125% last year [1]. Due to the new political situation, an increased arrival of migrants from Afghanistan is expected, and due to the war in Ukraine, a reduction in migratory pressure on the Belarusian route is expected, which could further strengthen the Western Balkan route. Within the Republic of Croatia, the greatest pressure of illegal migration is still in the area of the police administrations of Sisak-Moslavina, Karlovac, and Lika-Senj.

Migrants entering Croatia illegally do not avoid mine suspected areas (MSA) [4]. Such areas cover 249.4 km2 of Croatia. In the area of Sisak-Moslavina, Karlovac, and Lika-Senj counties alone, is the majority of MSAs [5]. A large part is along the state border.

State border surveillance should be carried out at the borderline [6]. In cases where there is a mine suspected area along the borderline, the border is monitored on the line of state border surveillance (which is the first safe place from the state border).

Border surveillance largely depends on the possibility to detect migrants as soon as possible. That line where migrants were spotted is called the line of detection. It is desirable that this line be as far as possible from the borderline in the direction of the neighboring country to have more time to react. For the detection line to be as far away as possible, measures should be taken to increase the visibility and range of observation systems.

To establish a line of detection, it is necessary to have a clearly defined state borderline. The state border must be identified, determined, delimited, and demarcated. After the first condition is met, it is necessary to build patrol roads as close as possible to the borderline. Roads are used to install and service the sensor system that should be located in the vicinity of the borderline (long, medium, and short-range cameras and other types of sensors). Ideally, when migrants are spotted long before the border, such routes will also be used for the response.

Sensors must provide detection data to the response forces. For this to be possible, the data transmission system must be placed in a position that can be within the range of both sensors and reaction forces. When the terrain allows, the base stations of the Tetra system and the GSM operator can be several kilometers away from the state border. When it comes to an area with hills, base stations must be in a narrower belt along the state border. An alternative may be the establishment of mesh networks [7] whose parts must be in the range from GSM signals to the border.

The reaction force consists of police officers who are responsible for preventing the crossing of the state border, or for capturing those who have crossed it. They need to be close enough to complete their assignment. The time for their reaction should not exceed 15 minutes. At that time, illegal migrants who move an average of 5 kilometers per hour usually cross a little more than 1 km. If this time is longer, there is a danger that the secondary detection, which precedes the reaction, will not be realized because, with time, the area where the migrant could be located increases exponentially.

Secondary detection is necessary when primary detection systems cannot track the target until reaction forces arrive. For secondary detection, a second set of cameras parallel to the first set, drones, or, ultimately, police officers representing the reaction force, are used.

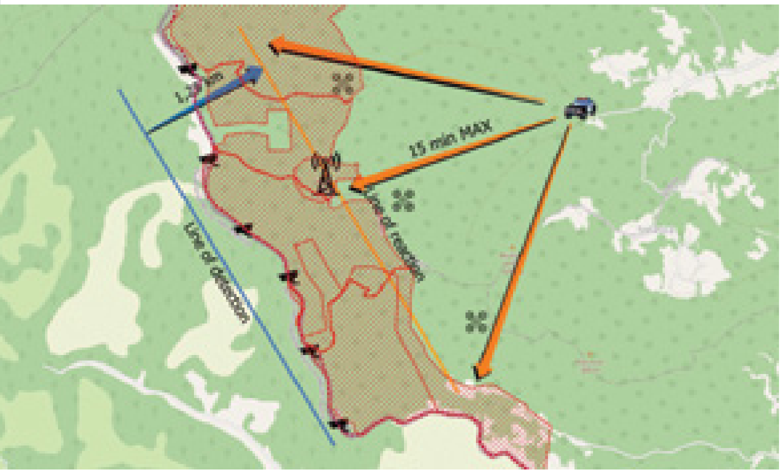

Figure 1 - Border surveillance system obstructed by MSA

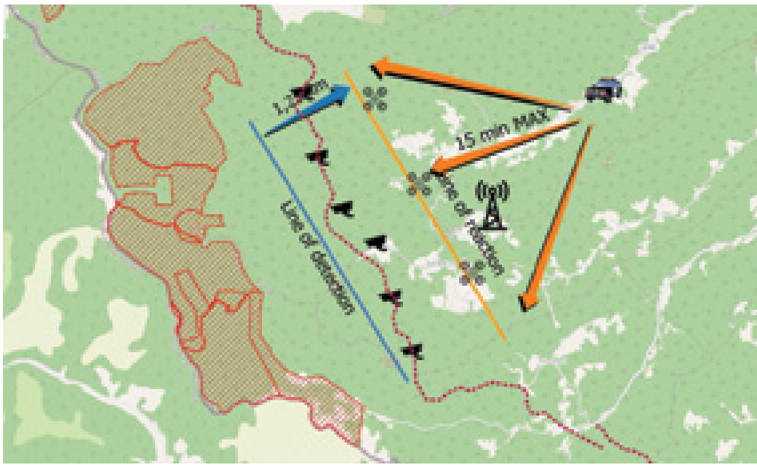

Figure 2 - Withdrawing the line of detection behind the MSA

This whole system has been called into question when a mine suspected area stretches along the state border. Sometimes the mine suspected area extends from the borderline to several kilometers in the depth of the territory of the Republic of Croatia and thus creates an area in which, in terms of state border surveillance, a security gap appears. Namely, persons from the neighboring state enter the territory of the Republic of Croatia and are beyond the reach of the border police of that state, and since this is a mined area, they are also inaccessible to the border police of the Republic of Croatia.

The state border cannot be marked, and therefore is unrecognizable. Necessary roads along the state border cannot be built. The sensor network cannot detect illegal migrants before they enter the Republic of Croatia. The communication system cannot be set up in such a way as to cover the state border. Secondary detection and reaction cannot be performed in a mine suspected area.

There are several options to solve this problem. The first and worst option is to draw the detection line to the edge of the mine suspected area. In that case, illegal migrants will be free to enter the MSA. The reaction area will be in a populated area, located behind the MSA, which makes it easier for migrants to escape or hide, and leads to the possibility of endangering the safety of the local population. Finally, after the construction of the entire infrastructure for the surveillance of the state border outside the MSA, ultimately, the same infrastructure will have to be built along the state border after demining which is economically unacceptable.

Another option is to approach partial demining of only those parts of the MSA that are necessary for the installation of surveillance infrastructure on the state border. This requires the following:

- Demining of a 50-meter buffer along patrol roads (we need space to find the optimal location for the installation of sensors and possible treatment of illegal migrants at the border),
- Demining the buffer area 100 meters around the communication tower,
- Demining a 10-meter buffer area along the road leading to the communication tower.

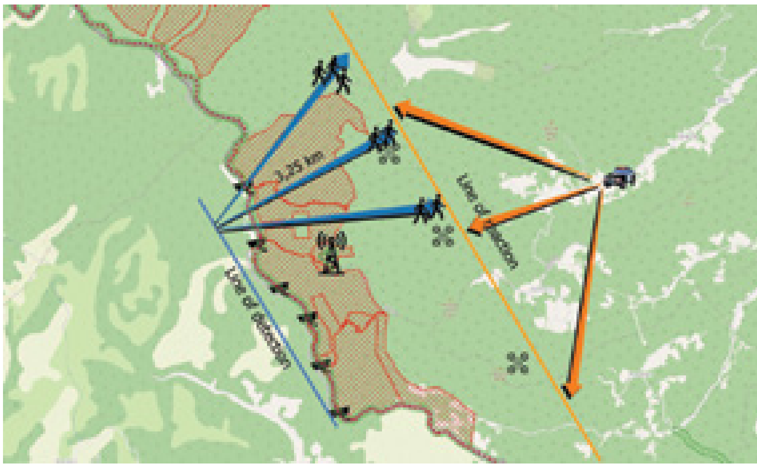

Figure 3 – The line of reaction is too far

This is a much better option than the first, however, it also has certain drawbacks. First of all, migrants that the police fail to find at the state border will still be able to enter the mine suspected area. As in the previous case, there is a possibility that they will reach the inhabited area. Due to the mine suspected area, the reaction line is further away from the detection line than recommended, and the likelihood of a successful secondary detection will be questionable.

Complete demining of the wider area along the state border is the best option. In order to achieve this, taking into account the impossibility of demining the entire mine suspected area at once, the Border Administration of the Police Directorate, in agreement with the Demining Sector of the Civil Protection Directorate, defines demining priorities. As already mentioned, the access roads and the road along the state border are being demined first. After that, the wider area of the state border and the area necessary for the installation of the communication infrastructure is demined. Ultimately, it is necessary to clear all mine suspected areas in the area 5 km from the borderline. Once the above requirements are met, the border police will have the basic precondition for implementing state border surveillance in full.

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Lessons learned from the implementation of Norwegian People's Aid Monitoring, Evaluation, Accountability and Learning in the Management of Mine Action

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Abstract: It is timely to consider the Monitoring, Evaluation, Accountability and Learning (MEAL) architecture and processes in mine action. Since 2019, Norwegian People's Aid (NPA) has been working on developing a more systematic approach to MEAL for its mine action and disarmament programmes and entire global portfolio. In the two-year development of methodology, testing and application of the MEAL system in NPA mine action and disarmament valuable lessons have been learned. They serve to further develop MEAL and to improve the ability of NPA programs to implement their interventions in an effective, efficient, high-quality and safe manner.

Key words: Norwegian People's Aid, NPA, monitoring, evaluation, accountability, learning, theory of change, lessons learned

Introduction

The Development of the NPA Mine Action Monitoring, Evaluation, Accountability and Learning (MEAL) has been started in 2004 when Norwegian People's Aid (NPA) Mine Action Unit released a document entitled Monitoring Concept. At that time, management indicated: "As of today, there are no systematic programme follow-up and limited external input to the programme. The result has been a lack of technical development, streamlining of processes, and uniformity throughout the NPA mine action portfolio. The monitoring concept outlined in this document aims at addressing this challenge" (NPA, 2004: 4). During 2004-2018, monitoring and evaluation in the NPA was based on periodic internal missions to monitor country mine action programs. Thematic or programmatic evaluations were less frequent, usually at the request of donors.

Since 2019, the NPA has been working on developing a more systematic approach to MEAL for its mine action and disarmament programmes and entire global portfolio. Through 2019-2021, development of MEAL was on the design and application of the monitoring and evaluation component. In 2022, the NPA continues work on accountability framework and learning and sharing to complete work on developing the MEAL concept and methodology.

NPA MEAL Policy

In December 2020, the NPA adopted joint MEAL Policy for its international work. The Policy statement highlighted the NPA's commitment to developing its MEAL architecture to enhance "NPA values of unity, solidarity, human worth and rights for all (irrespective of gender, ethnicity, religion, sexual orientation, disability and social status), promote wider learning and improve performances" (NPA, 2020a: 4).

The key purpose of implementing the NPA MEAL is to promote organizational learning and continuously improve interventions. To achieve this purpose, MEAL has been integrated to operationalization of policies and strategies at the global level of the NPA through its international departments (Mine Action and Disarmament, Development and Humanitarian Cooperation) and at the levels of their country programmes. An important element in improving the NPA MEAL architecture is working on the developments of tools and guidelines. This work should enable better implementation of MEAL activities in compliance with international standards and improve ability of NPA staff and partners to understand and use the MEAL mechanisms to enhance organizational performance.

The conceptual framework of the MEAL in NPA Mine Action and Disarmament

In addition to being based on a common policy, the conceptual framework for MEAL in NPA Mine Action and Disarmament has some specific principles as follows:

(1) MEAL should cover all pillars of NPA country programmes (mine action, arms management and destruction, conflict preparedness and protection and nuclear disarmament) and programme's working methods, as well as finance, logistic, HR, administration and other support services.

(2) MEAL shall be in compliance with the requirements as in the IMAS family, particularly with IMAS 14.10 Guide for the evaluation of mine action interventions, IMAS 07.40 Monitoring of mine action organizations and IMAS 07.42 Monitoring of stockpile destruction programmes.

(3) MEAL should take in account OECD evaluation criteria and other criteria related to mine action and disarmament, NPA policies and values.

(4) MEAL should be in line with the requirements of international conventions (MBT, CCM, CCW, TPNW and other conventions). The Oslo Action Plan and its identified good practices, actions and indicators should be incorporated in the MEAL system. Global NPA performance indicators should be closely linked with the Oslo Action Plan.

(5) MEAL uses standardized language, monitoring and evaluation methodologies and tools.

In addition to these key principles, the design of the conceptual framework (Figure 1) should ensure continuity with previous best practices and be in line with the lessons learned from the past monitoring and evaluation. Current NPA monitoring consists of Programme and Performance Monitoring, which are two complementary tools for progress tracking. Programme Monitoring is the NPA's original tool for improving performance and quality as periodic insight into programme and project results and overall status through in-country missions. Performance Monitoring is the continuous measurement of key performance and other indicators at project, programmatic and global levels. Programme and Performance Monitoring share the measurement and analysis of key performance and other indicators, while Programme Monitoring and Evaluation share extended OECD evaluation criteria and similarities in the applied methodology. In such relationships Programme Monitoring is a "bridge" between Performance Monitoring and Evaluation. Accountability is based on NPA's organizational values, policies, rules and regulations and is embedded in all elements of the MEAL.

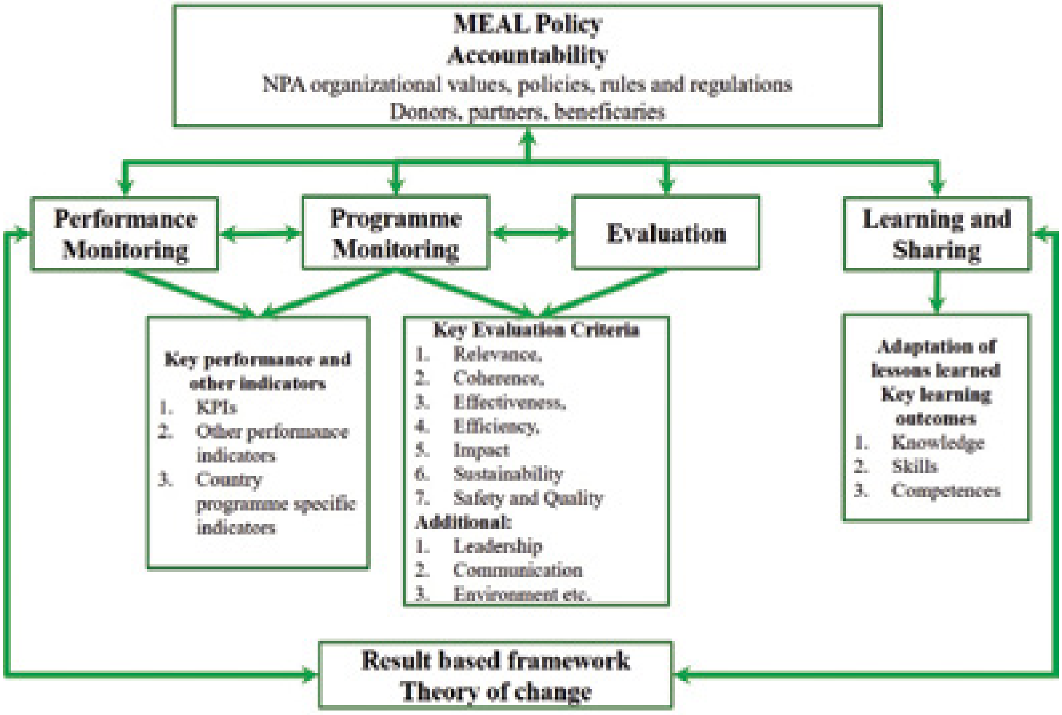

Figure 1. Model of the MEAL for NPA Mine Action and Disarmament

Learning and sharing of knowledge and practice should enable adaptation and continual improvement in a given project or programme context. Evaluation findings and lessons learned should provide guidance, priorities, planning and implementation of learning activities. Theory of Change and Result Based Framework are used for two basic purposes: (1) for planning at the strategic, programmatic and project levels within Department for Mine Action and Disarmament at NPA Head Office (DMAD) and its programmes; (2) to carry out monitoring and evaluation of ongoing or completed interventions to better understand the changes achieved and to share lessons learned for future work.

Lessons learned through testing and application of Performance Monitoring

In January 2021, the NPA adopted new Performance Monitoring Guidelines. During 2021, the Guidelines was tested as a joint effort of DMAD and its country programmes which, resulting in the final version of the Guidelines in force since January 2022. “Performance monitoring refers to the permanent monitoring of inputs, progress on the implemented interventions, outputs and outcomes of the Programmes through defined set of global key performance indicators (KPIs) and other performance indicators (PIs) (Performance Monitoring” (NPA 2022a: 5).

Performance monitoring includes nine sets of global PIs as follows: (1) Finance; (2) Governance and Compliance; (3) Logistics; (4) Administration and Human Resources; (5) Operations and Quality; Framework; (6) Relevance and Impact; (7) Information Management; and (8) External Communication and Public Relationships indicators. A total of 69 global quantitative and qualitative indicators measured quarterly (Table 1). The ninth set of indicators consists of specific indicators related to the global framework agreement between the NPA and the Norwegian Ministry of Foreign Affairs. As a large number of indicators are difficult to measure frequently, 11 global KPIs were selected from all to be monitored monthly (one Financial KPI, one Governance and Compliance KPI, one Admin/HR KPI, five Operations and Quality KPIs; three Relevance and Impact KPIs). Primarily, the measurement of KPIs and PIs serves to strengthen the continuous improvement of the processes and results of NPA interventions, at the global, programmatic and project levels. This measurement should further address positive and negative trends in NPA performance, their early identification and timely response to take advantage of positive trends or reduce the effects of negative trends.

Performance indicator: Average ratio between clearance techniques and area searched through TS in last three months							
2022	Clearance techniques	Searched area	Clearance techniques	Searched area	Clearance techniques	Searched area	Quarterly average
Quarter	01_January		02_February		03_March		
01_2022	m^2	m^2	m^2	m^2	m^2	m^2	%
Angola	2,933	17,933	7,180	27,180	13,951	72,433	20%
Bosnia and Herzegovina	1,111	7,935	17,499	124,992	14,473	99,378	14%

Table 1. An example of quantitative operational performance indicator (source: NPA database)

The NPA Performance Monitoring uses a series of dashboards and forms organized to measure indicators. Each dashboard allows users to visualize performance and focus on it within the programme or globally.

Measuring performance indicators does not mean that the management and key staff of the programme or project possesses or do not possess the necessary qualities and capabilities. In addition to internal factors, the performance of a programme or project is influenced by the entire NPA, and many factors from the external environment of the programme or project (political, security, economic, environmental and others) are beyond the control of the NPA. All of these factors need to be taken into account when prioritizing performance improvement activities. Indicators can be quantitative or qualitative. A three-color traffic light system was adopted for all indicators. The traffic light system is about the need for improvement. Green means according to plans or expectations or policies. Amber requires attention, control or corrective measures. Red indicates the need to analyze and develop an action plan to improve Programme performance and the need for DMAD to assist in the implementation of the plan. The traffic light criteria are still being tested in which extent are oriented on continual improvement and will be revised later this year.

Lessons learned through testing and application of Programme Monitoring

Since 2004, NPA Head Office has implemented a Programme Monitoring concept to ensure the highest quality in the programmes and capturing lessons learned on best practice. Through 2004-2019, the concept has evolved to be one of the key tools for the strategic review of programme performance. The concept is also part of the NPA’s systematic efforts to ensure greater uniformity and high quality in the implementation of activities, with fan emphasis on cross-fertilization and best practice exchange between programmes and DMAD. Programme Monitoring differs from traditional understanding of monitoring as a permanent activity. Programme Monitoring is periodical insight to programme through in-country missions every three to four years, or even more often. From a methodological point of view, it is a semi-evaluation approach, a simplified internal formative evaluation.

The review of the Programme Monitoring in 2019 indicates the need to improve its methodology. Analysis of monitoring missions 2004-2018 confirmed that the following data collection and analysis techniques dominated as follows: desk study, informal interviews, field visits and observations. It can be assumed that monitoring teams used more than these three techniques (such as check lists, descriptive statistics, structure interviews) but this was not evident in the analyzed monitoring terms of references and reports. The lack of qualitative and quantitative standardized indicators, especially in the early phase of monitoring missions 2004-2009, indicated that findings were mainly based on "expert opinion" which always carries a certain level of subjectivity.

programme monitoring missions; application of evaluation criteria; data collection and analysis tools and techniques; use of programme monitoring matrix and follow-up plan.

In addition to the OECD evaluation criteria on relevance, coherence, effectiveness, efficiency, impact and sustainability; also, safety and quality, leadership and management and environmental impact serve as specific criteria related to interventions in humanitarian mine action and disarmament. In total, nine criteria were applied in the Programme Monitoring.

Programme monitoring matrix is similar to the evaluation matrix but has been simplified. The matrix, as a logical approach, connects monitoring questions with indicators and various means of verification. In the matrix, specific objectives are transformed to questions, sub-questions and measurable indicators. The number of data collection and analysis tools and techniques has been increased and described (Table 2). The use of data

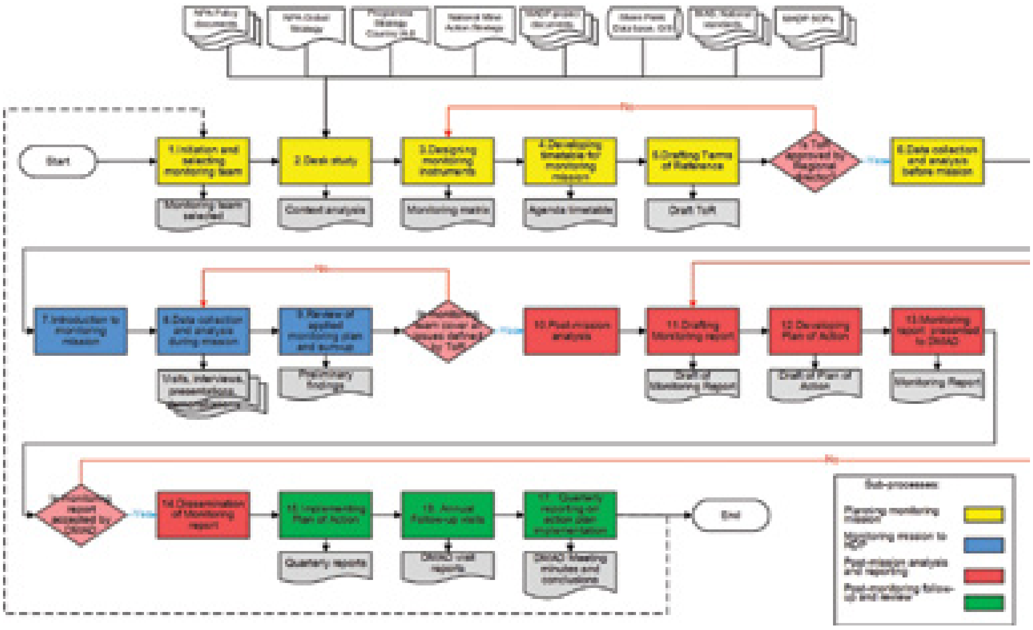

Figure 2. Process of NPA Programme Monitoring

At the beginning of 2019, DMAD adopted new Programme Monitoring Guidelines. Through implementing the Annual Programme Monitoring Plans for 2019, 2020 and 2021, the applied process and techniques were tested and served as an input for the validation of the programme monitoring methodology. The revised methodology includes: a process-oriented approach (Figure 2), general programme monitoring objectives; the procedure for defining the specific objectives for the in-country

collection and analysis tools and techniques and indicators strengthened evidence-based approach in defining the findings, conclusions and recommendations of the monitoring teams.

Table 2. Data collection and analysis tools and techniques

1.	Desk study
2.	SWOT
3.	PESTLE
4.	Stakeholder Analysis
5.	Brainstorming
6.	Structured/ semi-structured interviews
7.	Check-lists
8.	Cause-and-effect analysis
9.	Statistical analysis
10.	Visit and observing
11.	Small scale survey
12.	Case study
13.	Expert opinion
14.	Review of the Theory of Change

Post-monitoring follow-up is a joint effort of DMAD and the monitored Programme to apply the recommended measures to improve Programme performance, share lessons learned and strengthen the implementation of monitoring objectives.

Conclusions

During 2019-2021, Programme Monitoring was a kind of substitute for internal evaluation. However, the application of a significant number of criteria was complex and a serious challenge for internal monitoring teams, monitored programmes and DMAD.

In January 2022, the NPA adopted Evaluation Guidelines and launched the implementation of an evaluation plan for the use of external evaluators for programmatic and thematic evaluations. The introduction of Evaluation has opened up space for simplifying the Programme Monitoring methodology. The number of criteria in Programme Monitoring Guidelines will be reduced from the current nine to four related to the strategic and operational issues of the NPA programmes. The focus will be on the criteria of relevance, impact, efficacy and quality and safety.

The development of an accountability policy framework and its mechanisms is needed at the NPA organizational and programme levels. In addition to focusing on accountability to the public, beneficiaries, donors and partners, internal accountability for results and success in achieving the NPA mission should be strengthened.

Lessons learned from MEAL may indicate competence development needs and related training activities. Promoting 'cross-fertilization' initiatives whereby staff conduct visits or are involved in relevant activities to share and develop working knowledge.

Finally, the introduction of MEAL has helped to better understand phenomena and processes within the NPA. It raised awareness of accountability for organizational performance and strengthened the results-based approach.

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Norwegian People's Aid Mine Action and Disarmament Programme, Bosnia and Herzegovina - Land Release approaches and good practices

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Norwegian People's Aid in Bosnia and Herzegovina

Norwegian People's Aid (NPA) commenced demining operations in Bosnia and Herzegovina in 1996 and has operated across the length and breadth of the country. Since 1996, NPA has released more than one thousand hectares of land contaminated by landmines, cluster munition remnants (CMR) and other explosive remnants of war (ERW) in Bosnia and Herzegovina. In the course of the operations, more than 12,000 landmines, 3,000 CMR and 50,000 ERW have been removed and destroyed by NPA. The impact of the work has been broad: first and foremost humanitarian in that lives and limbs have been saved, but positive outcomes have also been identified in terms of development and peace implementation. NPA is accredited by the national Demining Commission (which reports to the Ministry of Civil Affairs) and is coordinated by the Bosnia and Herzegovina Mine Action Centre (BHMAC).

Land release requirement

According to the Mine Action Review, and at the close of 2020, there were some 956 square kilometers of suspected anti-personnel mine-contaminated area and two square kilometers of CMR-contaminated area. The scale of the contamination means that Bosnia and Herzegovina is classified as having a 'heavy' level of contamination, alongside the countries of Angola, Thailand, Turkey and Yemen (*Mine Action Review, 'Clearing the landmines 2021'*). Efficient and effective land release is therefore essential.

The mine action programme in Bosnia and Herzegovina, at the national level, is more than twenty-five years old. It is therefore inevitable that the work has become more technically demanding; very often deminers are deployed to difficult terrain, typically steep and hilly, with varying degrees of vegetation, and routinely affected by heavy rainfall and flooding. It is very rare not to have findings of landmines and CMR at a task and this reflects very well on the planning of the BHMAC.

NPA BiH searchers working in steep terrain, Gradačac municipality, March 2022

Working closely with the BHMAC, NPA takes every opportunity to re-survey tasks before and during task implementation, including with the application of drones, in order to increase efficiencies. The NPA BiH comprehensive land release process involves the application of all reasonable efforts to identify the suspected and confirmed hazardous areas where less than 1% is subjected for clearance, less than 6% reduced through technical survey (period 2016 to 2020). The remaining area is cancelled.

In terms of assets, manual deminers account for sixty percent of the clearance outputs; mine detection dogs (MDD) - used in both single and double search method - account for forty percent of the clearance outputs. The application of MDD can be particularly effective in forested areas. Mechanical ground preparation remains a key tool for NPA BiH although access is increasingly challenging.

NPA BiH MDD engaged on technical survey (long leash method), November 2020

Bosnia and Herzegovina has a deadline of 01 March 2027 for completion against the Anti-personnel Mine Ban Convention. To that end, a number of smaller-scale completion initiatives are ongoing such as the Brčko District mine-free initiative which aims for completion of all remaining land release tasks by the end of 2024. The impacts of the work are multiple ranging from life-saving humanitarian outcomes through to contributions to large-scale infrastructure projects that are planned for Brčko District (highway routes are planned to strengthen internal and cross-border transportation). Many of the NPA deminers come from Brčko District and NPA takes pride in contributing to the social cohesion of the district.

Community Engagement

NPA BiH gives priority to community liaison and community engagement, before, during and after land is released. In doing so, the quality of information improves, making for increased efficiencies and effectiveness of operations, and, most importantly, good relations are maintained in the areas where NPA works.

When NPA first started mine action operations nearly 30 years ago, all of the deminers were men. NPA BiH worked hard to make sure this is no longer the case. Today NPA BiH prioritises empowering women across all aspects of the organization - from operators to programme management. At the local level, female members of the community will often relate quickly to the NPA BiH female deminers.

Environmental management

In recent years, NPA BiH has given increased focus to environmental management practices, at operational sites and in the course of community engagement. NPA BiH is devoted to adhering to the humanitarian principle of «do no harm,» and is aware of, and taking steps to prevent, possible harm to the environment that may occur during land release activities.

NPA BiH Community Liaison Manager with members of the Gluha Bukovica community, July 2021

2030 Agenda for Sustainable Development

NPA BiH evaluates the links between mine action and the Sustainable Development Goals (SDGs) in the course of its work, identifying progress across relevant targets and gaining an understanding of mine action's contribution and impact on achieving the the 2030 Sustainable Development Agenda in Bosnia and Herzegovina.

In the 2018 Voluntary National Review of progress against the 2030 Agenda for Sustainable Development, Bosnia and Herzegovina highlighted a number of the SDGs in relation to demining; NPA BiH can provide clear examples for each: re. SDG 1, 'No Poverty', the clearance of the "Brcko Notrh 1" task in the coutry's north has allowed the local population to use previously landmine-contaminated land for agriculture, which has improved food security and reduced poverty; re. SDG 2, 'Zero Hunger', at the Kruševo Brdo task in Kotor Varoš municipality, the land returned to local communities through land release efforts is used for agricultural purposes, either as pastures or cropland; re. SDG 5, 'Gender Equality', NPA female deminers operate alongside male deminers, removing landmines and other explosive ordnance of war (ERW) in the same manner as their male counterparts, jobs that were traditionally designated for males; the NPA BiH Community Liaison team is a mixed gender team, facilitating better access to women, children, and minority groups; re. SDG 8, 'Decent work and economic growth', NPA BiH programme directly employs 141 people, often recruiting from affected communities; NPA BiH staff receive relevant trainings, including Non-Technical Survey, Technical Survey, Explosive Ordnance Risk Education and leadership courses which promotes professional growth and enhances employability; re. SDG 11, 'Sustainable cities and communities', NPA BiH land release efforts contribute directly by ensuring safe access and safe public spaces for returnees, both former refugees and internally displaced people (IDP); the ongoing returns to Brčko District is a good example.

Future perspective

Norwegian People's Aid remains fully committed to contributing to the successful implementation of the Anti-personnel Mine Ban Convention and the Convention on Cluster Munitions, in close cooperation with national partners. With continued efforts to improve land release efficiencies, completion will be possible. Norwegian People's Aid conveys sincere thanks to its core donors, namely Norway, Germany and Switzerland.

Land release operations in Tajikistan

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Along with many other countries, the Republic of Tajikistan is the State Party to the Ottawa Convention since 2000. Thus, its obligations under the Convention include the following:

- Clearance of the lands from landmines;
- Mine risk education;
- Victim Assistance;
- Advocacy of the ban of the use of the antipersonnel landmines;
- Destruction of the UXOs and the stockpiles,

and all these activities are performed under direct coordination and supervision of the Government Institution "Tajikistan National Mine Action Centre" (TNMAC).

In 2014 the Tajikistan Mine Action Programme was nationalized and the TNMAC was established in the country as the national entity to ensure the implementation of the Ottawa Convention in the national capacity building, material and technical base, strengthening the planning capacity, coordination, and resource mobilization, in accordance with national and international standards, as well as training of local experts on land release.

After the nationalization it became possible to develop and adopt national legislative, normative and regulatory documents, such as the Law of the Republic of Tajikistan "On humanitarian mine action", the National strategy of the Republic of Tajikistan on humanitarian mine action, National mine action standards (NMAS). In addition, the Training Centre of TNMAC, where all demining operators conduct trainings for the demining staff, was established and equipped.

Since the beginning of the national humanitarian demining operations in the country, the Ministry of Defense of the Republic of Tajikistan (MoD RT) and the Swiss Foundation for Mine Action (FSD) were the only demining operators in Tajikistan. Later on, the Norwegian People's Aid (NPA) and the Union of Sappers of Tajikistan (UST) joined the demining activities in the country. These demining agencies continue land release operations in the country. The exception is FSD which do not have sufficient funding for land release operations for about three years already; but they have one Weapons and ammunition disposal (WAD) team.

The land release operations in the country begin with the non-technical survey (NTS) activities performed by professional NTS staff. NTS activities include collection of relevant information through communication with local communities, visual identification of potential hazard areas, installation of warning signs (Pictures 1 and 2).

Picture 1

Picture 2

In cases when the information and/or evidence received during NTS is not sufficient, then we proceed with technical intervention. Technical intervention was introduced in Tajikistan mine action programme in 2015 and is still being used in order to detect signs of contamination and more accurately determine the location of the minefields. The main reason to combine the NTS with technical intervention is to detect the actual evidence directly on the suspected hazard area until the first hazard sign is identified (Pictures 3 and 4). Such method has demonstrated its effectiveness and efficiency and significantly contributes to saving time and costs.

Picture 3

Picture 4

Mainly, in Tajikistan technical intervention is conducted due to the following reasons:

- Minefield records are not available;
- No communities reside in the area;
- Occurrence of natural disasters (causing migration of mines and UXO).

As known, 93% of Tajikistan territory is covered with mountains and the majority of minefields are located in mountainous and hard-to-reach areas. Taking this fact into account, manual clearance is currently the main type of demining in Tajikistan, despite the fact that the majority of minefields are located in high altitude hard-to-reach areas (Picture 5).

Picture 5

Only limited mined areas, located in plains, can be processed by mechanical demining machine and mine detection dogs. In past there were attempts to use mechanical demining machines and mine detection dogs in mountainous mined areas (Pictures 6 and 7).

Picture 6

Picture 7

But unfortunately, because of high altitude the engine of the mechanical demining machine could not work adequately. Currently we use mechanical demining method of land clearance in plains. As for the dogs, sharp vegetation hurt their noses and they lost the sense of smell. Thus, mine detection dogs are no longer used.

It is worth to note, that the demining operations in Tajikistan may be performed only 60 days per year, due to the accessibility of the hazard areas caused by difficult terrain and the weather conditions.

In accordance with the NMAS and the SOP, the cleared land is mapped and checked during the Quality Control operations by TNMAC Officers and then, in case if nonconformities are not identified, the relevant data is included into IMSMA database and the cleared land is handed over to local authorities for further safe use. Based on the national mine action standards, TNMAC officially hands over the cleared land to the local authorities with the handover certificate and the map of the cleared area (Picture 8).

Picture 8

According to TNMAC statistics and post-clearance impact assessments, government and local population are using a cleared land for road construction/reconstruction, disaster mitigation activities, water supply, cross-border trade, fishery, construction of transmission/communication lines, coal/gold mining activities and maintenance of dams along the rivers. Almost half of the cleared area used as a pasture land and for crop production.

Demining of agricultural areas is also a priority from the viewpoint of a sustainable return of war-affected people. As land is cleared, it can be returned to productive use, feeding families and contributing to post-conflict reconstruction and economic development.

The impacts of the landmine threat were severe. Zones of risks are usually in hills and mountains where most villages are located. Mostly, women and children go close to hazardous areas where they collect firewood and wild fruits, grazing livestock. That is why 28% from total victims are children (25% - boys and 3% - girls). Due to the unconventional shape of some mines and sub-munition, they can be attractive to younger children, presenting an added layer of risk to civilian communities living near contaminated areas.

As the statistics shows, from 2004 to 2013, the annual results of land clearance increased, and from 2014 to 2016, they decreased. The main reasons are the reduction in the number of demining teams, the impossibility to use mechanical demining machines in all areas and mine detection dogs, and the decrease in funding from donor community.

Another issue causing obstacles in land release in Tajikistan is that during the rain/ natural disasters in the mountainous areas mines move and fall down causing problems to local population and expanding the suspected hazard areas.

The female teams of deminers were introduced in Tajikistan in 2014 by NPA, to ensure that both men and women have equal access to participate in demining operations. Currently there two teams of female deminers operating in the country and they significantly contribute to the effectiveness and efficiency of the humanitarian land release in Tajikistan.

R

RESEARCH AND DEVELOPMENT WITHIN MINE ACTION

Aerial survey of UXO in/on ground

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Abstract: A simplified but crucial question regarding the aerial survey of landmines, unexploded ordnance, abandoned ordnance, explosive remnants of war, improvised explosive devices (targets) is: could available sensor techniques and aerial platforms do it for targets buried in the ground and not only for targets on the ground surface? And, are these sensors in use in mine action operations? The number of scientific references and number of references about operations of the aerial survey show the dominance of scientific references and a low percentage of operations cases. The first civilian attempt to develop and apply the aerial minefield survey was in 1998. in the European „Airborne Minefield Detection Pilot Project". It was followed by several similar R&TD aerial minefields survey projects ARC, SMART, AIDSS Croatia, AIDSS Bosnia & Herzegovina, and TIRAMISU. In all of them, the aim was to detect secondary indicators of mines, former battle zone. Only ARC considered the possibility to detect landmines in the ground by LWIR. Around 2010. demining companies started the application of unmanned aerial vehicles (UAV) and they applied cameras in visible wavelengths, even with LWIR, multispectral cameras, again for targets on the surface. The continuous trend of R&D considers ground-penetrating radars (GPR), Synthetic Antenna Radar (SAR), while new trend introduces magnetometers and electromagnetic field detectors for the detection of explosive objects buried in the ground. The availability of cheap and reliable, industrial UAVs, enables automated aerial surveys. The positive consequence is the implementation of new sensors, among them, magnetometers seem to be the first winners and will enter into operations.

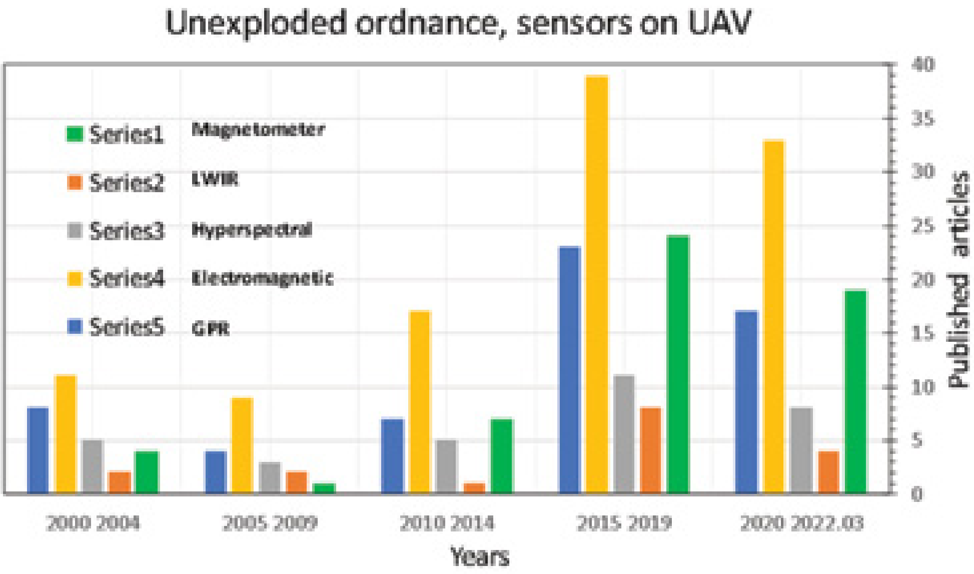
Keywords: UXO, UAV, ferromagnetic, survey, magnetometer, GPR, LWIR, hyperspectral

Introduction

The aerial survey for humanitarian mine action started in the year 1997., by „Airborne minefield detection: pilot Project" of several European countries, [1], [2], [3]. It was focused to estimate minefields, indeed suspected hazardous areas (SHA), mainly via detection of the secondary indicators, introduced by Ben Maathuis, [1], [2]. This approach, based on the remote sensing of SHA, mainly with electro-optical sensors, and synthetic antenna radars, aerial and spaceborne, continued and resulted in significant benefits for humanitarian mine action, [4], [5], [6], [7], [8]. The aerial platforms have been aircrafts and helicopters while the first civilian unmanned aircraft system used in 2001 was CAMCOPTER in project ARC, [6]. In ARC was researched the possibility to detected subsurface landmines using longwave infrared (LWIR) sensors onboard of UAV. From 2012. increased participation of UAVs in aerial non-technical survey, [9], [10], [11]. Again increased interest in LWIR sensors [10], [11] and the possibility to detect landmines. Hyperspectral remote sensing of the plants' stress due to landmines was reported in [12], and the probability of hyperspectral detection of the unexploded ordnance (UXO) partially obscured by soil was reported in [13]. The application of the ground-penetrating radar (GPR) on UAV is reported in several references, e.g. [14], but there are no reports about the operational application in humanitarian mine action. A similar situation is with aerial electromagnetic sensors and magnetometers which are available for humanitarian mine action onboard UAVs for detection of subsurface targets. Instead of a comprehensive review of references, we made a bibliographic analysis of the number of published articles, without patents, and reported in the following sections.

Sensors on UAVs and targets

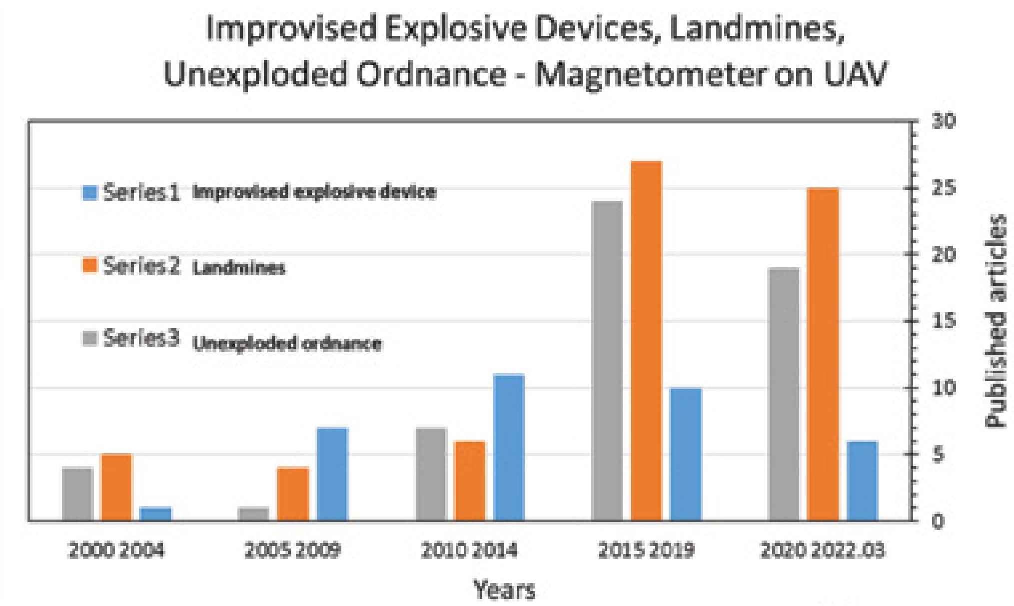
The bibliographic analysis for the last twenty-two years using keywords UAV, unexploded ordnance, subsurface, and keywords of sensors (magnetometer, LWIR, hyperspectral, electromagnetic, GPR), applied on Google Scholar provided results in Fig.1.



◀ Figure 1. The number of published articles about the detection UXO with five considered sensors on UAVs increased after the year 2010.

Targets of aerial survey UXO, IED, Landmines

The number of published articles about detection from UAVs, with Magnetometer, of three kinds of targets (Improvised Explosive Devices, Landmines, and Unexploded Ordnance) shows an increase after the year 2015, Fig. 2.



◀ Figure 2. Number of published articles about the detection of three kinds of targets, with magnetometers on UAV

The magnetometers detect ferromagnetic objects by analyzing their influence on the magnetic field of Earth, [15], [16], [17]. The operational potential of the survey with a magnetometer onboard a UAV, for one example, is shown in Fig.3. The most interesting and very actual information is presented in [16].

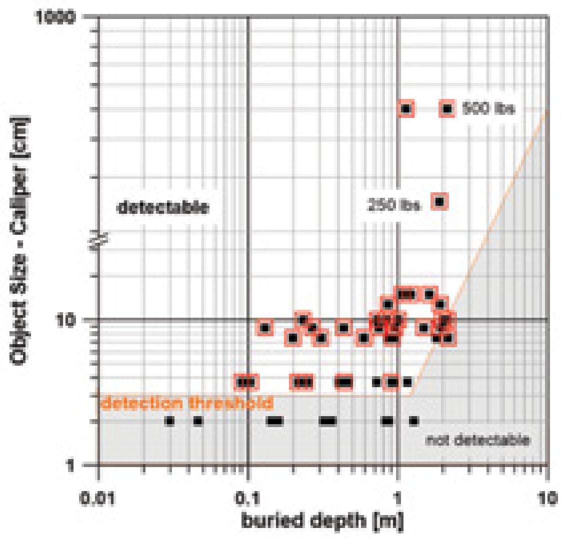


Figure 3. Survey potential of PentaMag System, onboard UAV. Source [14, slide 10].▶

Conclusions

Among the considered sensors, used on UAVs, for the detection of subsurface targets, the GPR has a natural advantage (detection of plastic and not only metal mines and UXO). Due to the technical complexity of GPR, the magnetometers on UAVs have a chance to first enter into operations, despite their limitations on ferromagnetic targets. LWIR sensors, despite simple technology, are the last in this race.

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Advanced techniques for landmine detection using bistatic radar

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Abstract: This paper presents a bistatic ground penetration radar study with different transceiver and receiver antennas configurations. It is based on a design of air-coupled, miniature, low-power pulsed time-of-flight radar with TEM antennas. The goal was to develop a fully polarimetric bistatic radar attached to 2 separated drones flying in an optimal formation for target detection. The work introduces several experiments in the laboratory environment, where the flight formation with spatial positions of a transmitter and receiver antenna was observed. Achieved results show the optimal position of transmitting and receiving bistatic radars antennas. The goal is to detect small targets with an approximate surface of 0.01cm^2, like anti-personal land mines. The bandwidth of the radar was 2 GHz. The goal is to enable tomography using drone-based GPR.

Keywords: bistatic radar GPR, pulsed time-of-flight radar, TEM antennas, antenna positioning configuration

Introduction

The deadly legacy of modern warfare and low-intensity conflicts that lasted for decades after the peace agreement are Explosive Remnants of War (ERW) and Unexploded Bombs (UXB)[1]. ERW is an explosive weapon that did not explode after employment. ERWs are the remains of Land Mines (LD) and other improvised explosive devices (IED), which are mostly hidden or covered with earth [2],[3]. All the not exploded devices in the civil areas present a death threat for all living beings during and after the conflict ends.

The non-invasive detection of the ERW has attracted and increased interest due to its applicability, operation safety, and its low-cost operation. An unavoidable fact is that newly designed LDs are constructed to trick out classic metal detectors using plastic, wood, glass or contain the barest minimum of ferrous or nonferrous metal. To increase recognition and avoid false alarms from classic detectors, the use of radars signatures can improve the efficiency of detection and discrimination among the hidden object [5].

Ground Penetration Radar system (GPR) is used for subsurface and hidden object imaging applications [6]-[8]. GPR variations use different radar operation structures, antenna designs, and beamforming sources. The GPR system is a monostatic radar where TX and RX antennas are colocated, and surveys are collected in common offset mode [9], where the TX and RX antennas are moving together along the surface. Regarding monostatic structure, the bistatic structure introduces a system where RX and TX antennas are managed separety[10],[11]. Such structure has key benefits in contrast to the monostatic structure [12]. The benefits of such a configuration will be discussed below in the paper.

This paper focuses on analyzing different bistatic configurations to detect a small object. The pulsed time-of-flight radar with a bandwidth of 3 GHz is used in the experiment. The experiments demonstrates different antenna positioning and polarization configurations. The presented results were obtained from the laboratory environment and are a preliminary experiment for Unmanned Aerial Vehicle (UAV) bistatic radar system. Bistatic UAV radar can employ multiple Tx-UAV and Rx-UAV carriers, which can significantly increase the detectability regarding the structure, shape, and used material.

Bistatic Radar Configuration

The bistatic radar structure and geometrical layout are presented in Fig. 1. The basic principle of the operation is equal to the monostatic structure, whereby the Rx and Tx are independently managed. The structure has higher sensitivity for targets with low SNR values [3],[13]. An object with irregular shapes or rough surfaces can reflect the incident waves in particular directions. Such reflections have higher backscatter, which lowers the detection efficiency for monostatic structures. The view from different angles enables higher detectability and easily distinguishes clutter futures.

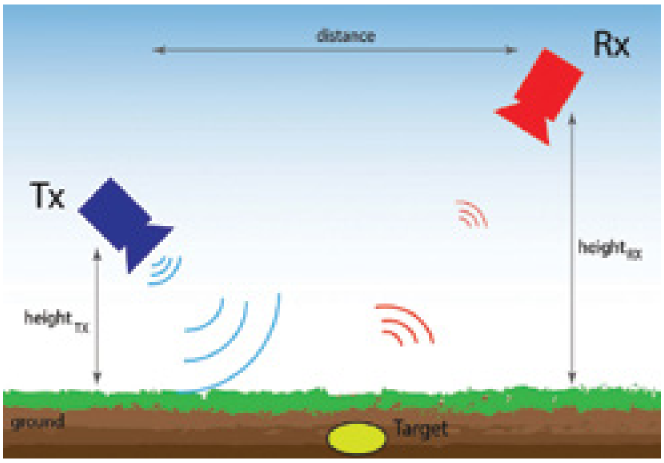

Figure 1. Bistatic radar configuration.

Additional control of the distance, angle of Tx, Rx, and height of antennas can improve the detectability of the target with different assemblies structures and layers.

In the case of bistatic radars the transmitter and receivers are synchronized in time, spatial and phase. The phase should be very stable to obtain bistatic radar image. In this study, we designed a system that uses GPS signal to generate PPS and the local oscillator can be synchronized using a direct digital synthesizer DDS. The local 10MHz clock is fed to double balanced mixer followed by a filter. The 10MHz ouput is divided to obtain the 1s pulse, which is synchronized with GPS PSS using using DSS driven PPL. The timing conditions can be measured and signals can be aligned within the sub ns accuracy [14].

Experiment Description

The bistatic radar experiment has conducted in the laboratory environment. Two TEM Rx and Tx antennas were used. The measurement data were analyzed and stored with Keysight Vector Network Analyzer (VNA) N5063A with a bandwidth of 18GHz and a time pulse duration of 300ps. The measurements are carried out in azimuth and range direction, as shown in Fig. 2.

Figure 2. Experimental setup, with adjustable bistatic Rx and Tx antenna configuration, VNA and PC-Matlab .

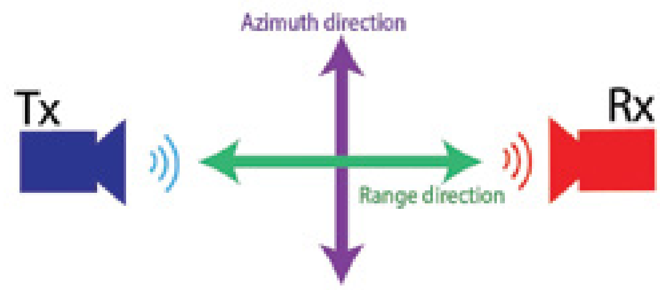

Figure 3. Azimuth and range scanning direction.

For each direction, a different configuration of the antennas positions was used. The antennas configuration is divided into six different modes, as shown in Table 1.

Table 1: Measurement configurations

Mode	Tx_{height} [m]	Rx_{height} [m]	*Distance [m]*	*Pol* $(^0)$
M1	1.2	1.2	2.5	HH
M2	1.2	2.1	2.5	HH
M3	2.1	1.2	2.5	HH
M4	1.2	1.2	2.5	HV
M5	1.2	2.1	2.5	HV
M6	2.1	1.2	2.5	HV

Table 1 present the height of the Tx and Rx antennas, distance between the antennas, and polarization. The first and second sets of experiments were performed in a range and azimuth directions, respectively, as shown in Fig. 3. For both directions, the target velocity is constant and maintains approx. at 1.5m/s. Maximal target velocity determined the VNA data acquisition time, which is limited to 9ms by 201 samples. The scanning resolution is 2.5 10^{-2} m/trace. Bistatic radar structure is compared with monostatic structure, where the antenna's offset is set to 20cm and the scanning height of 1.2m, equal to the bistatic configuration in *M1*. All results are presented in the paper below.

Experimental results

The B-SCANs performed in the range direction are shown in Figs. 4-6.

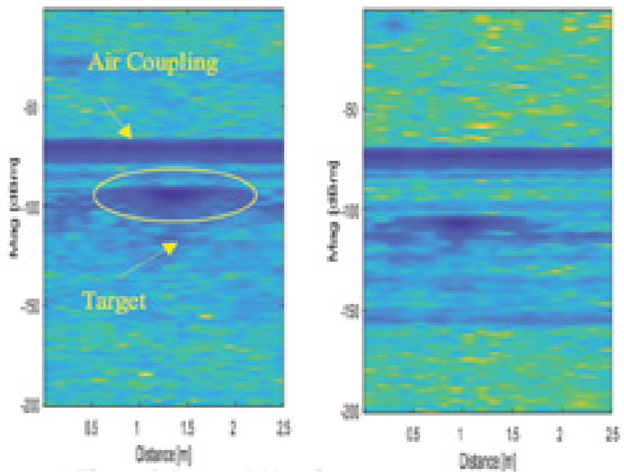

Figure 4. B-scan M1 and M2 in range direction.

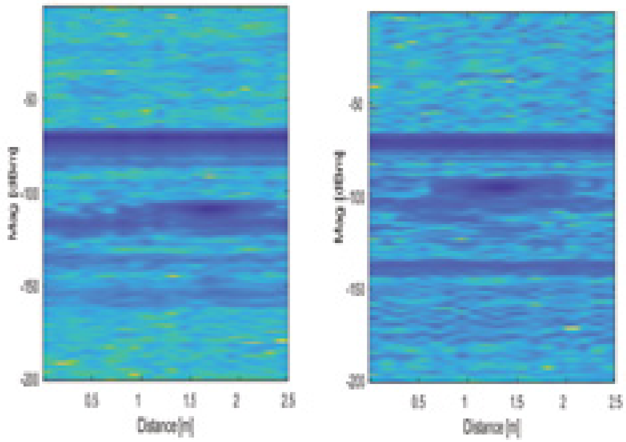

Figure 5. B-scan M3 and M4 in range direction.

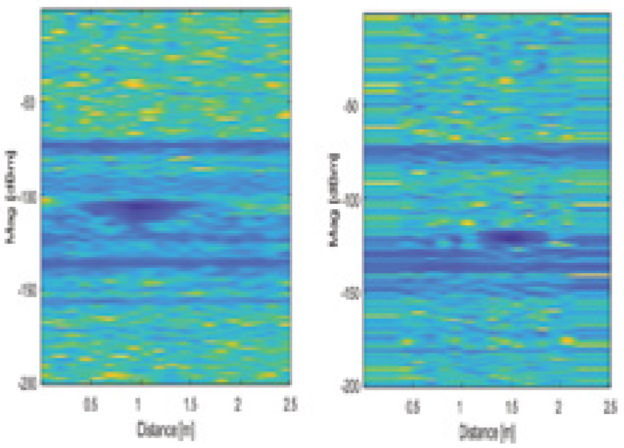

Figure 6. B-scan M5 and M6 in range direction.

B-Scans obtained by moving target in the azimuth directions are shown in Figs. 7-9.

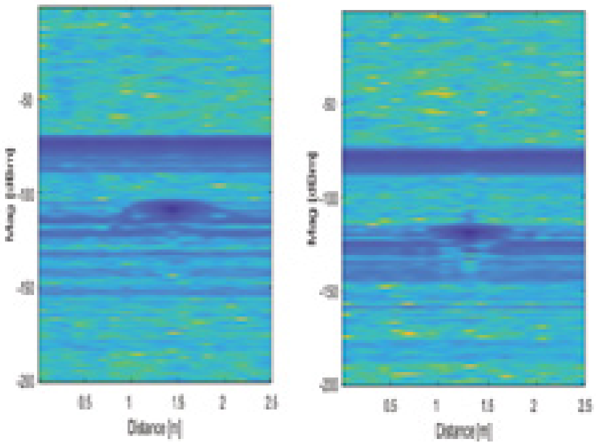

Figure 7. B-scans M1 and M2 in azimuth direction.

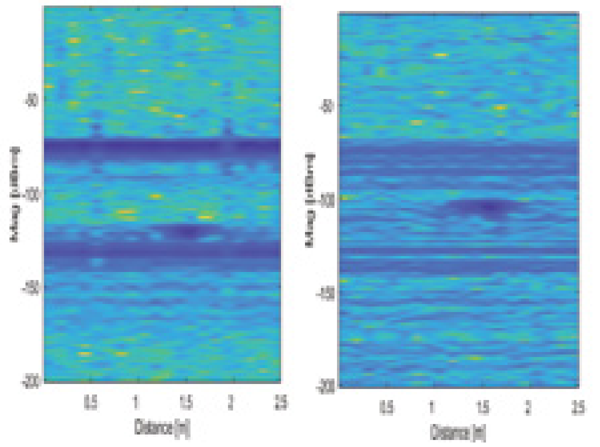

Figure 8. B-scans M3 and M4 in azimuth direction.

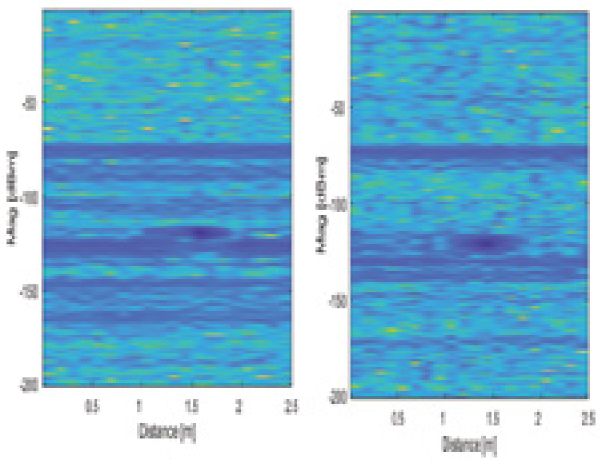

Figure 9. B-scans M5 and M6 in azimuth direction.

Fig.10 presents the scan with a monostatic structure in both directions.

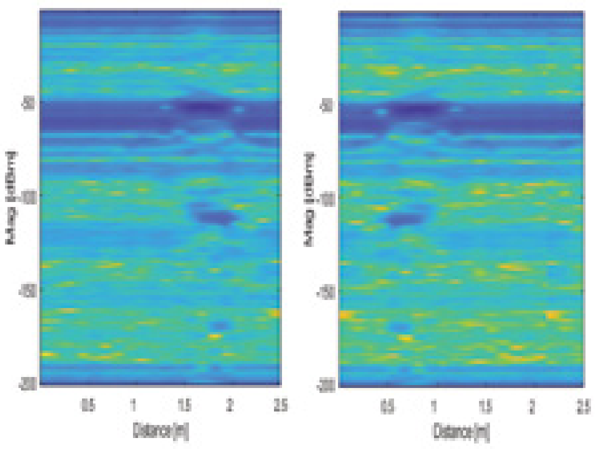

Figure 10. B-scans obtained with monostatic configuration.

From the given results, the structure of the bistatic radar with the same Tx source has higher target discrimination regarding the monostatic structure; as shown in Figs. 1-9 and 10. In the monostatic constalation, the target is hidden in direct ground reflection. Direct ground reflection is very high in B-scans reported. Only direct air coupling can be seen and is distinctly detached from the target reflection. Direct air coupling is less significant when the Tx and Rx antennas are not leveled, figures 4 and 7 (left and right). In the polarization signatures, figures 5(right), 6, 8(right), and 9 can be noticed that direct air coupling is notably suppressed, and the target has a high SNR value. The constalation M5, where Tx radar is positioned below Rx is recommended.

Conclusion

The paper presents a preliminary experiment of a bistatic radar structure for landmine detection. The structure offers higher target discrimination than monostatic radar and can be used for ground and underground landmine detection systems. The experiment is the basis for further development and research of the UAV bistatic rada system for landmine detection. Such an approach also offers a MIMO radars system, which can improve target recognition and classification.

Acknowledge: This work is supported by NATO Science for Peace and Security program with a grant number: G5953

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Biological Method (Bees) for Explosives Detection: a summary

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Abstract: The NATO Science for Peace and Security project Bee4Exp: Biological Method (Bees) for Explosives Detection was a multidisciplinary work spanning organic optoelectronics, materials science, Unmanned Aerial Vehicle (UAV) engineering, image processing software development, and apiology. The project created an end-to-end landmine detection tool consisting of two processes: the Passive Survey and the Active Search. In the former, honeybees foraged in an area contaminated with mines, with the colony entrance containing a preconcentration material to sorb any explosives, carried by the bees, onto the surface for subsequent analysis and confirmation. In the latter, bees were trained to sniff out TNT and exposed to the suspected area; camera-equipped UAVs followed the bees to monitor any swarming at a specific point, indicating the presence of an explosive vapour plume, and thus an individual mine. This paper describes an overview of the project's results and looks to the future of this innovative new strategy.

Motivation

Over the past few decades, honeybees have been used to passively collect a variety of environmental contaminants including explosives, pesticides, and SARS-CoV-2 [1, 2], and sniffer bees have been trained in the past [3]. Both attributes were identified as potential routes towards an end-to-end technology that could complement existing deminer's techniques including sniffer dogs, metal detectors, and the more advanced scientific methods being developed [4, 5]. Bees offer several advantages in demining, particularly their large numbers for bioaccumulation and the lack of human presence on the field. The vision for deploying the Bee4Exp system was to first survey an area suspected to be contaminated with mines. Once the area of concern was confirmed to be mined, the bees would be trained in a tent containing TNT with a sugar reward for the purpose of pinpointing individual mines. However, this is not possible to observe from ground level where the bees may be several kilometres away. The Active method was conceived to solve this problem. Honeybees can be tracked in the field by camera-equipped UAVs, and subsequent image processing is used to strip out other objects in the frame including grass and stones, creating a heatmap of bees where an individual mine is buried. These passive and active methods together form a biohybrid system to detect landmines and the aspiration was to make demining faster and safer for those in the field.

The Passive Survey

A class of polymer known as organic semiconductors are light emitting and have been used to detect explosive vapour since explosives decrease the amount of light emitted from the polymer on contact [6]. This loss of emission, shown in Figure 1, occurs within a few seconds of exposure and can be easily monitored by photodiode or spectrometer.

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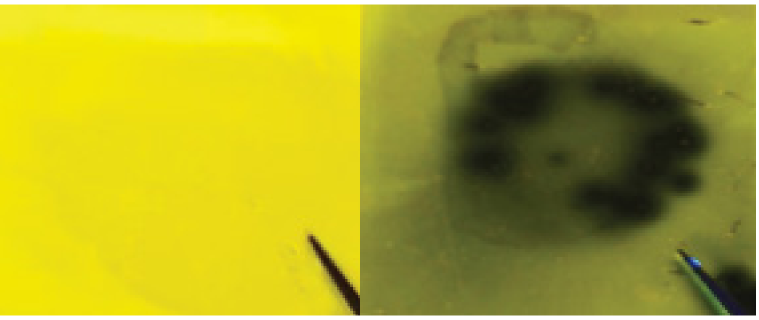

Figure 1 - Organic semiconductor film. Pristine (left), and exposed to DNT (right)

Early field work with a prototype landmine detector (developed under the FP7 project TIRAMISU) showed that in real-world environments it can be extremely challenging to detect a few nanograms of explosive emitted in a vapour plume outdoors. The work then focused on using preconcentrators, a common technique in environmental sampling where trace amounts of chemicals are collected over time for analysis – for example, instead of detecting a few nanograms in a few seconds, the nanograms build up on the surface over several hours to give micrograms, which are easily detectable. This technique has been used previously in demining with REST sampling [7].

Figure 2 - Preconcentrators in hive entrance

We used a commercially available polymer and inserted "tunnels" into the colony, separated into "Entrance" and "Exit" as shown in Figure 2 to ensure returning bees carrying explosives residue entered the same tunnels each time. This procedure was refined over several field work trips, where placement of the colonies and feeder solution jars helped increase the area of land the bees flew over, collecting more explosives for analysis. Our limit of detection was found to be less than 5 ng, and we estimate that a single colony may collect over 1,000,000 times that over a day's placement. Benkovac test site, near Zadar, was used for field work and has 1,000 mines of different composition, giving confidence the technique is suitable for a wide range of mines.

The sensors themselves were also improved and adapted to screen out false positives, like pesticides, by using a form of chemical filtering layer over the sensor film. Heating the films for greater reversibility allowing re-use after a detection event has been investigated, which would reduce cost and waste in the field [8], and a spin-out company has been formed to commercialise the sensors in the near future.

The Active Search

To train the bees, colonies were placed in a tent with a sugar solution in the centre of a TNT source. By flying over the TNT to reach the sugar, the bees are conditioned to find explosives in the field. Once suspected minefields were confirmed by the Passive Survey, trained bees were released into the environment and tracked by ultra-high-definition video and a thermal camera attached to a UAV. The parameters of acquisition were tuned to give 15-20 pixels for each bee. To locate honeybees flying or hovering over a patch of the field, we pre-processed the video to stabilise the image, split it into smaller spatial segments and performed background subtraction. The pre-processed video was fed to a convolutional neural network for detection of small moving objects. The detections were aggregated and a heatmap generated as shown in Figure 3.

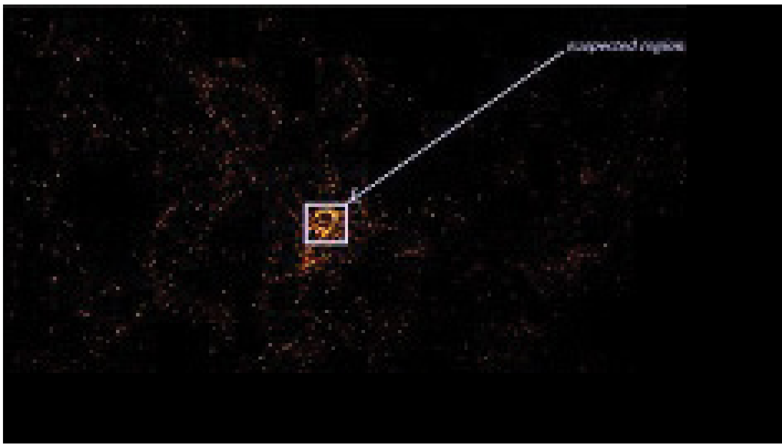

Figure 3 - Example of a bee heatmap

Using a combination of camera-equipped UAVs and advanced image processing, the Active Search method showed increased counts of honeybee detections at locations corresponding to the actual locations of the landmines.

Impact

This research project led to several high-impact journal articles [9-12], invited lectures at international conferences, and a large amount of international press coverage across TV, radio, and print. The articles alone are estimated to have reached over 113 million people globally. The project partners frequently participated in public engagement activities and national impact events, where the project was broadly promoted, and awareness about landmines in general was raised. Of note was a ZDF documentary broadcast in Germany and Austria featuring the project as well as interviews with team members on BBC Scotland and RTRS in Bosnia & Herzegovina.

Looking forward

The Bee4Exp project ended on the cusp of moving to a higher Technology Readiness Level and thus closer to deploying the technology in areas with mine contamination. All components of the full system have areas that can be improved including sensitivity, selectivity, and coverage. For instance, the team developing sensors continue to improve the sensor films to better screen out false positives, fine-tune the best preconcentrator materials for explosives retention, and move towards on-site detection with instrumentation developed in a spin-out company. The Active Search method can be improved by making it more robust to environmental conditions and imaging artifacts. This can be achieved via formation flying multiple UAVs, and the fusion of the bee detections in the visible spectrum with other sensor data, such as sounds from a microphone array and images from infrared spectra. Altogether, these improvements will lead in the future to a new and complementary tool for landmine detection.

Conclusions

Bee4Exp was a multidisciplinary and multinational project that made significant and promising results for end-to-end mine detection. Advances in sensor material science, optical instrumentation, colony preparation, UAV engineering and image software engineering resulted in high-impact, world-first outputs. Extensive field trials were crucial in developing the full system, and we have identified areas for improvement with the technologies. In future the aspiration is to help deminers with area surveying, identification of specific landmines, and in post-clearance Quality Assurance.

Acknowledgements

The authors acknowledge funding from NATO Science for Peace & Security under grant agreement MYP G5355.

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MINEONT: A proposal for a core ontology in the aerial non-technical survey domain

Marko Horvat*[1], Andrija Krtalić[2], Milan Bajić[3], Mario Muštra[4], Davor Laura[5], Hrvoje Gold[6]

Abstract: Logical representation of knowledge enables reasoning based on formal logic, integration of heterogeneous data sources, augmentation of existing knowledge, and discovery of hidden knowledge that is hidden or unknown even to experienced professionals. Moreover, many high-performance software tools and services for logical reasoning are readily available in the academic community. Computational ontologies, or ontologies for short, are a comprehensive, formal, scalable, and adaptable methods for knowledge representation and automated reasoning. They have been successfully used in many diverse application domains, from medicine and natural sciences to engineering and applied sciences. However, the use of ontologies in the context of demining is novel and has not been exploited to the full advantage. In this context, a new core ontology called MINEONT (an acronym for "MINE-action ONTology") has been proposed. The MINEONT is written in the OWL-DL 2 formalism and allows an expressive and formal representation of concepts in mine action, high-level semantics, geospatial metadata, and information obtained through method of remote sensing, non-technical surveys, and other mine action survey types. The vocabulary of this ontology supports, among others, the following corpora: multisensory aerial and satellite imagery, derived indicators of mine presence and absence, contextual data, terrain analysis information, formalized knowledge of the humanitarian demining specialists in the form of declarations and procedures. The designed ontology has many advantages in describing data for non-technical surveys. However, it is also relevant for building a specialized recommender artificial intelligence (AI) expert system. Such an ontology-based decision support system (DSS) would integrate a large amount of collected data and facilitate interpretation and decision-making processes. In the paper, details about the Web Ontology Language (OWL) are given and its advantages for application in the aerial non-technical survey for humanitarian demining are explained. The MINEONT model is introduced and described in detail. The advantages of MINEONT compared to other existing methods in the aerial non-technical survey system are planned to be tested and demonstrated as part of scientific projects in which domestic and foreign partners, including CROMAC, will participate.

Keywords: aerial non-technical survey, ontology, knowledge database, machine learning, recommender system, secondary mine indicators, DSS, CROMAC

1. Introduction

Mine action is a complex, multi-faceted process that combines humanitarian assistance and development studies aimed at eliminating landmines and reducing the social, economic, and environmental impact of landmines and explosive remnants of war (ERW). The goal of mine action is to identify and reduce the effects and risks of explosive hazards to a level where people are safe. Demining involves more than just removing landmines from the ground. It also includes effective actions aimed at protecting people from danger, helping victims become self-sufficient and active members of their communities, and creating opportunities for stability and sustainable development. Humanitarian demining, such as mine and ERW surveys, land release, mapping, marking, and clearance, is a specific group of activities and a type of mine action [1].

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In our paper the mine action dataset is a high-level generic term that jointly describes all available digital documents relevant for detection of explosive objects in the context of non-technical survey and humanitarian demining.

The benefits of an Advanced Intelligence Decision Support System (AIDSS) using piloted helicopters and a decision support system (DSS) relying on multi-criteria fusion of data, information, experts' knowledge, and secondary (indirect) indicators of explosive threats and mine presence have already been presented and experimentally verified [2] [3]. However, existing document databases used for this purpose suffer from at least three sets of important drawbacks that have an adverse and far-reaching effect on their construction, utilization and proliferation:

1. Construction. Creation of an integrated mine action dataset is a large and complicated task involving many different specialists from various domains. Individual records must be first selected and approved by the demining specialists. Then the approved records must be manually acquired and processed.

2. Utilization. Since no dedicated tools for automated content retrieval and extraction of datafiles used in humanitarian demining exist, the construction of mine action databases must be carried out manually by scrutinizing all available records stored in different formats. This is a time-consuming process and requires experts highly trained in mine-scene interpretation.

3. Maintenance and propagation. Databases containing semi-structured or differently structured also difficult to maintain and upgrade with new content because the laborious and time-consuming steps in the construction phase have to be repeated. Repositories of non-technical survey inputs are proprietary and have different architectures. As a consequence, their reuse and integration are severely restricted.

The potential of ontology-based recommender systems in personalized document retrieval has already been well identified [4]. In this context, computer ontologies integrate all available document information and present a list of suggestions 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 ontology-based methods enable the interoperability of heterogeneous knowledge representations and results from inaccurate recommendations [4]. The applicability of ontology-based recommender systems in real-life settings has been successfully demonstrated in practice (per example [5]).

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

The aforementioned problems motivate research into the tools and methods for improving annotation of documents produced in non-technical surveys. Formal knowledge representation and automated reasoning techniques can be successfully applied to impair deficiencies of existing mine record repositories and represent the best option for their upgrade. To address these issues, we propose MINEONT (MINE-action ONTology) for a formal and comprehensive description of information for detection of explosive objects in the context of non-technical survey and humanitarian demining. The proposal of the MINEONT follows our previous work on the ontology-based recommender expert system for non-technical survey in decision support system functions [6].

2. Construction of the MINEONT knowledge database

The first step in utilizing computer ontologies in any domain is the construction of the knowledge database with a specific model optimized for the selected domain. The construction of the intelligent expert system's knowledge database involves acquisition, processing and preparation of all data required to obtain an integrated understanding of the minefield. The construction process can be split in two phases: 1) data acquisition and 2) data processing.

As shown in Figure 1 the inputs for construction of a mine action knowledge database may be many: minefield records, mine accidents maps, reconstructed minefields, interviews, surveyors' reports, military maps, etc. These inputs are usually acquired in many different digital formats, frequently proprietary, as well as physical documents (e.g. hand-drawn or printed on paper). One of the strong points of the proposed expert system is that it can use any data documents that are available for decision support. This requires from the ontology model to a comprehensively describe all knowledge elements that may be used and in sufficiently expressive detail.

The data acquisition phase incorporates information from different sensors used to collect additional data such as matrix, line, multispectral, hyperspectral, radar, Lidar, magnetometer and others if available. Afterwards specialized software is used to manipulate this information and the developed maps may also be used to plan subsequent data collection operations. Traditionally this is done manually by highly trained data acquisition specialists.

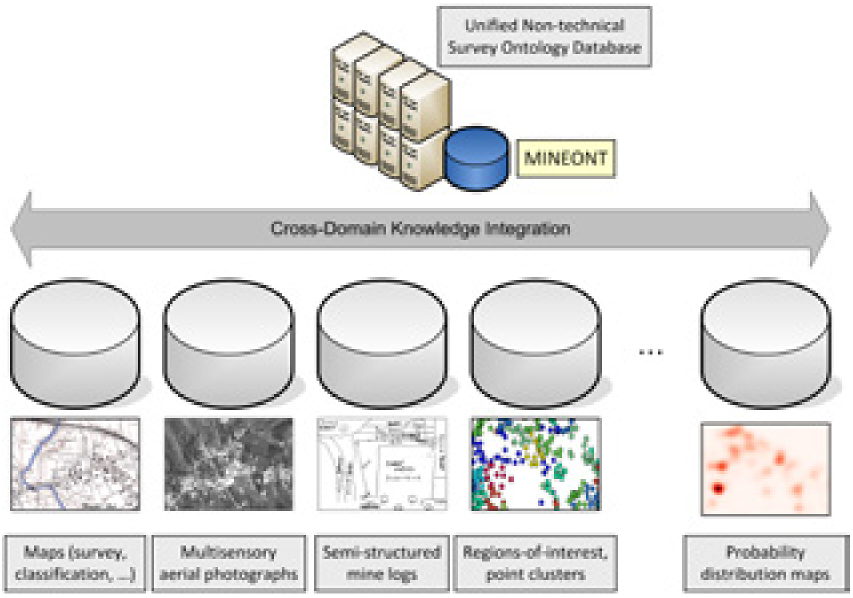

Figure 1. A schematic diagram of cross-domain knowledge integration of a diverse set of data inputs for construction of a unified Non-technical Survey Ontology Database.

Because of the different complex and diverse procedures involved in creating minefield records some of the documents are made available only in physical format such as handwritten reports, manually drawn maps etc. Such documentations must be first converted in an appropriate digital format to be included in the mine action dataset. This preparatory process, at the least, involves scanning and character recognition algorithms for image to text conversion (OCR) and conversion of data files between different digital formats. Additionally, the preparation of physical documents may include different image processing techniques such as image enhancement, edge finding and vectorization. Ideally these should be performed automatically because of the large volume of the traditional documentation that needs to be included in the dataset, multiple actions that must be performed in exact sequences, and the overall quality of the process that has to be ensured.

After the data acquisition phase has been finished, pre-processing and processing of data may begin. The pre-processing involves parametric geocoding of hyperspectral and multispectral images, conducting atmospheric correction on hyperspectral images providing the coverage of the field with images, the determination of the quality of images) and so-called "triage" which is manipulation and separation of images for further processing. This phase is also usually accomplished exclusively by small teams of skilled specialists. After the required data has been acquired and adequately processed, it can be stored in the ontology model of the integrated knowledge database.

3. The MINEONT model

The MINEONT is designed to – as stated previously – provide a formal and comprehensive, yet simple and manageable, description of a minefield containing different UXOs. The MINEONT model has necessary and sufficient expressiveness and decidability and can be used in inferences and SPARQL queries [7]. This ability enables the MINEONT to be used together with an AI mine action expert system in order to discover hidden knowledge and generate expert recommendations.

All documents required to describe a minefield chart and listed in the previous section must be structured and formally described at the sufficient level of semantic expressiveness to be included in the ontology's model. In this process properties and functional dependencies of all categories of mine action documents will shape the ontology's structure. Some knowledge elements will form individual concepts while others will be encapsulated as functional or data relationships between different concepts. Further, data categories in documentation will be transferred to concepts' data attributes.

The MINEONT model showing the structure of the ontology concepts, functional properties and data attributes is in Figure 2. The model is written in the OWL 2 DL XML-based annotation language [8].

The top concept in the MINEONT ontology is MinefieldChart which is directly subsumed by owl:Thing class. An instance of MinefieldRecord is related to one or more instances of MinefieldDrawing, OrientationPointList and UXOList classes with their respective object relationships:

$$\begin{aligned} &\mathit{MinefieldRecord} \\ &\qquad \equiv \exists_{\geq 1} \mathit{MinefieldDrawing} \\ &\qquad \sqcap \mathit{OrientationPointList} \\ &\qquad \sqcap \mathit{UXOList} \end{aligned}$$

Each UXO in MinefieldChart is represented in the knowledge database (KB) ABox as exactly one instance of UXO concept. This concept can have a labeled name, description, and quantity.

tion of collections [9]. The Collections Ontology is an OWL 2 DL ontology developed for creating sets, bags and lists of resources, and for inferring collection properties even in the presence of incomplete information. Although RDF data can be used to define collections and containers to group resources as one entity, this important feature has not been included in OWL and even in OWL 2 DL specifications. The Collections Ontology has been created to address this issue [9].

In the MINEONT model one MinefieldRecord is divided into one or more sequences of UXOs which contain a particular explosive device. Sequences have their index and can be numbered. Likewise, the MinefieldRecord can have at least one OrientationPoint.

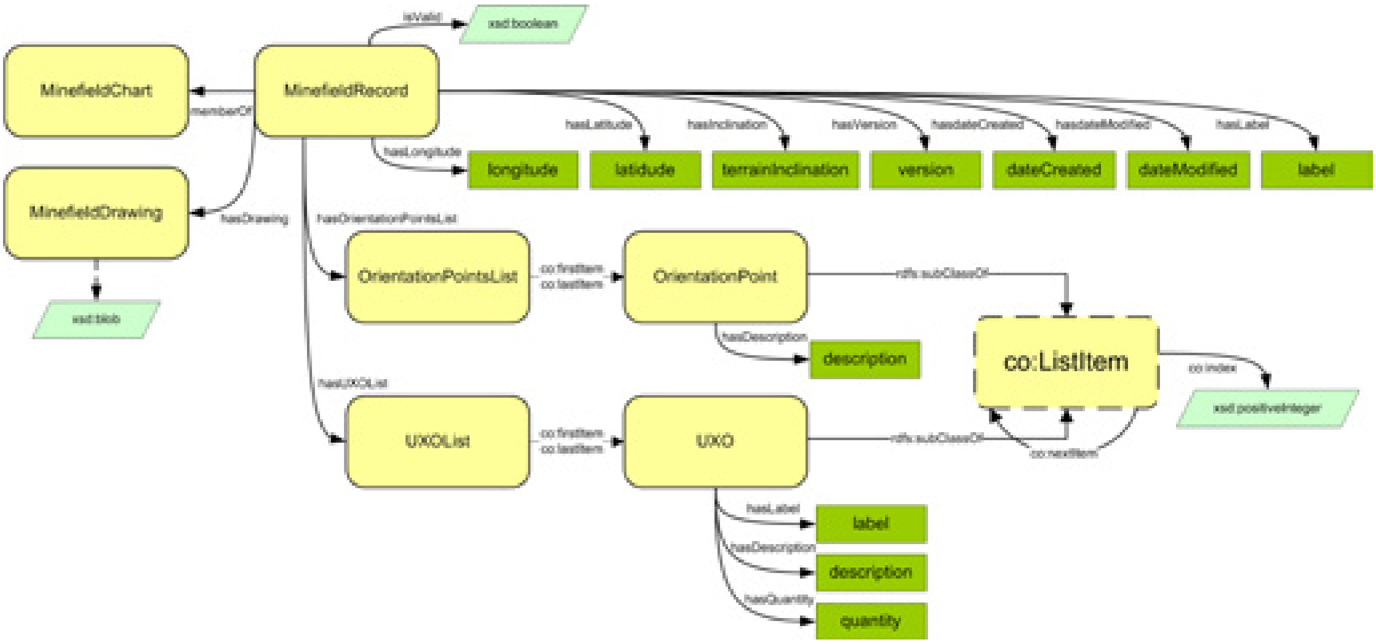

Figure 2. The concepts and relations in the MINEONT model defined in OWL 2 DL. Data properties (owl:DataProperty) are indicated with dashed lines while class inheritance (rdfs:-subClassOf) and object properties (owl:ObjectProperty) are denoted with solid lines. External ontology concepts have dashed borders.

The order of UXOs in the sequence is defined as in a linked list. In this scheme the first sequence member in the list is attached to a UXOList individual using co:firstItem object relation. The second member in the list is linked to the first with co:nextItem object relation and so on, until, eventually, the last member is denoted using co:lastItem object relation. Thus the sequence can be easily traversed by following all UXO individuals in the chained list. Each list item has its index that uniquely identifies it.

In accordance with the most important ontology designing objectives the MINEONT reuses an existing ontology Collections Ontology (prefix “co”) for formal representa-

UXOs and OrientationPoints are hierarchically organized into sequences. Sequence is a type of List from the Collections Ontology: In the MINEONT model one MinefieldRecord is divided into one or more sequences of UXOs which contain a particular explosive device. Sequences have their index and can be numbered. Likewise, the MinefieldRecord can have at least one OrientationPoint. UXOs and OrientationPoints are hierarchically organized into sequences. Sequence is a type of List from the Collections Ontology [9]. The co:List cannot be empty, i.e. data property co:index of the class co:ListItem is a positive integer. Therefore, at least one instance of UXO and OrientationPoint classes must exist in ABox.. The co:List cannot be empty, i.e. data property co:index of the class co:ListItem is a positive integer. Therefore, at least one instance of UXO and OrientationPoint classes must exist in ABox.

4. Conclusion

The MINEONT ontology presented in this paper enables a formal, consistent, systematic, and expressive model of minefield records. The ontology enables DL-based reasoning about the aggregated content and document metadata.

The MINEONT model enables formal representation of high-level semantics of minefield charts. It facilitates knowledge reuse, interoperability and formalization of UXO information that are superior to the contemporary methods for interpretation of mine-scene information. The MINEONT model was intentionally made simple and compact as to be easier to use by experts and in software tools. However, even more expressive model may be created later incorporating additional mine-scene information.

In the future, we intend to develop a decision support system utilizing the MINEONT model [6] [10]. Such DSS would be built around an intelligent expert system supporting ontological reasoning and packaged as a computer workstation that can be deployed in remote areas. The envisioned system could be used even by personnel not proficient in mine-scene interpretation with minimum training required. We hope that the presented MINEONT is a step toward this larger goal.

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Towards Safe and Explainable Humanitarian Demining with Deep Learning

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Abstract: The remaining landmine hazards pose great security and humanitarian risk throughout the globe. Bosnia and Herzegovina saw a war nearly three decades ago, but still has more than a thousand square kilometers of mine hazardous areas, which bring a detrimental effect on countries' economic development. In this paper, we propose a methodology to automatically detect mine presence indicators in hazardous areas from aerial surveying images. First, a semantic deep learning network is used to produce information about the semantic contents of images, which is crucial as a pre-step for the accurate detection of objects of interest. It helps identify the areas that are still most likely to be hazardous (grasslands, tree lines, etc.) and eliminates areas of no interest. We use the UNET neural network for semantic segmentation to discover the area of interest. Second, an advanced object detection method, based on the YoLOv4 deep learning method, is used to detect the mine presence indicators. We incorporate these two methods to work in synergy, which is the first application of this concept for non-technical surveys. As a result, our methodology provides enough information for the end-users to confirm or dismiss the prediction of the mine presence indicators. Additionally, the system is integrated with an Explainable AI (XAI) component which enables users to interact with the system and get more information about the outcomes, and insights into how the decision is made. We also identify key challenges of human-machine partnership in the application of automatic detection of mine presence by examining which XAI techniques are suitable for such a problem.

Keywords: Deep Learning, Semantic Segmentation, Explainable AI, Mine presence indicators

1. Introduction

There are several ongoing armed conflicts that are taking place around the world. All of these leave hazardous areas with numerous landmine hazards, from which anti-personnel mines may be one of the most widespread, lethal, and long-lasting forms of pollution the world has encountered [1]. Bosnia and Herzegovina (B&H) saw a war nearly three decades ago. Even though the SHA area was significantly reduced in this period, there are areas that are still considered dangerous. According to Bosnian-Herzegovinian MAC (BHMAC), the area of 228,157,000 m^2 has been reduced and cleared; while 69,202 antipersonnel mines, 8,554 anti-tank mines, and 61,456 EWRCs were found and destroyed in 1996 to 2020 [2]. The current size of the suspected mine risk area in BiH is 956.36 km2 or 1.96% of the total area of B&H, affecting more than 500,000 people, while there is still 5,000 tons of ammunition surplus. The BHMAC reviewed, defined, and marked all the SHA in Bosnia and Herzegovina, where a larger area has been defined to reduce the risk to local populations, tourists, and others. The terrain of the SHA area in B&H typically consists of hills, mountains, and forests, which are difficult to access by motorized vehicles.

The importance of the problem of remaining SHA areas has also been highlighted in the new UNDP strategy for Bosnia and Herzegovina (2021 - 2025) [3], where it is stated that capacities for effectively addressing human-induced hazards need to be further strengthened. One possible solution is to explore new technologies, which use modern equipment such as drones, advanced sensors, and new artificial intelligence and machine learning methods. These methods enable automatic de-

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tection of mine presence indicators in hazardous areas, which is crucial for reducing the consequences of mines and explosive remnants of war. In recent literature, state-of-the-art approaches often rely on extracting knowledge with deep learning from aerial surveying images. In this way, the SHA area can be identified, and the experts can further confirm or dismiss the results. Hence, the SHA area could be reduced without direct demining. The cost and time associated with this problem-solving can also be reduced.

Artificial intelligence (AI), and more precisely Deep Learning (DL), is a popular research field that has shown excellent results in the field of computer vision [4]. Deep learning has the potential to improve autonomy in complex military systems such as fighter jets, submarines, drones, and satellite surveillance systems [5]. Since the output of the AI system plays a crucial role in the susceptible and dangerous task of clearing the remaining landmine hazards, it is necessary to enable users to get more information about the network outcome and explain how the decisions are made.

In this paper, we propose a methodology for automatic detection of mine presence indicators in hazardous areas from aerial surveying images. Images are taken from different height perspectives, where it might be difficult to detect desired objects. Thus, we use a semantic deep learning network to produce information about the semantic contents of images. This helps pinpoint the areas that are still most likely to be hazardous (grasslands, tree lines, etc.) and eliminates areas of no interest. Then, an advanced object detection method, based on the YoLOv4 deep [6] learning method, is used to detect the mine presence indicators. We incorporate these two methods to work in synergy, using a new concept called deep multi-modal perception. This is the first application of this concept for non-technical surveys. As a result, our methodology provides enough information for the end-users to confirm or dismiss the prediction of the mine presence indicators. In the last step, we use a novel concept in AI system design that enables human users to understand, and effectively manage the emerging generation of artificially intelligent partners [7]. This concept is known as explainable AI (XAI). Luotsinen et al. [1] identified that XAI explanations in the military context are typically required to ensure that: human users have appropriate mental models of the AI systems they operate, specialists can gain insight and extract knowledge from AI systems and their hidden tactical and strategic behavior, AI systems obey international and national law, developers are able to identify flaws or bugs in AI systems even prior to deployment.

2. Design and Development of AI-based system for Safe and Explainable Humanitarian Demining

The system is designed to analyze images obtained from aerial surveying. These are mainly visible-light-spectrum images, but it can also take into account thermal and/or multispectral images. The architecture of the system is multi-stage in nature. The overall architecture of the system is given in Fig. 1.

First, we semantically analyze the content of the images, *i.e.,* which regions represent different semantic categories (*e.g.,* grasslands, forests, roads, roofs, etc.) This is performed by Semantic Segmentation DL Network based on U-NET DL Network [8], which was originally devised for medical imaging purposes, but found applications in a range of different fields [9-11]. Second, semantic categories that are most useful for the mine detection indicators are singled out for this task and forwarded to the Mine Indicator Detection DL Network. Lastly, the outputs of these two networks are given to the XAI component that produces a reasonable explanation about the obtained results.

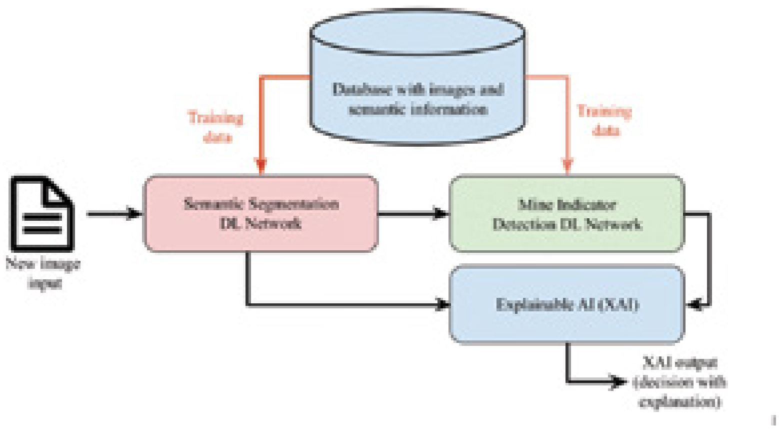


Figure 1. The high-level overview of the AI-based system for Safe and Explainable Humanitarian Demining

2.1. Data Acquisition and Preparation

Advanced AI methods for Non-Technical Survey typically try to design solutions with several requirements, such as:

A. **Accuracy**: methods need to provide precise information of the environment,
B. **Robustness**: methods are required to work properly in various weather conditions, and desirable in a situation that might not be covered during the training process, and
C. **Real-time properties**: methods need to provide fast response in some situations.

Meeting these requirements usually implies the existence of several multi-modal sensors (e.g., cameras, LiDARs, Radars). To exploit the properties of multi-modal sensors, different sensing modalities are typically fused in a unique way to extract the useful features that will be used in the decision-making process. Recently, Deep learning Neural Networks (DNN) have proven to be a powerful tool for learning hierarchical feature representation when given enough data to learn from. Acquiring huge amounts of data during aerial scanning requires proper storage facilities that can be incorporated into the machine and deep learning pipelines. Data may come from several sources such as 3D laser scanners, RGB cameras, thermal cameras, and hyperspectral cameras all of which can be used to extract useful information for this particular task. For the purpose of Semantic Modeling, the experts need to label the data. This is a very important task for the development and the implementation of machine and deep learning models. Aerial data collection is performed using a multisensory UAV system, consisting of at least multispectral and thermal infrared sensors. For the processing and interpretation of the collected images, traditional AI and modern DL methods are used to show the potential for detecting objects of interest (indicators) on them. The output of this step is paired with additional information to bring insights of the decision-making process and explain the results of previous methods. Finally, a fusion of all available data (data from the mine information system and additionally collected data) is carried out for the purpose of producing mine danger maps.

2.2. Semantic Segmentation Deep Learning Network

When trying to select the regions of interest, it can be crucial to observe the environment properly. In this case, knowing the terrain can significantly help in determining whether and what types of landmines can be found on such terrain. This is the task of Semantic Segmentation DL Network in Fig. 1. There are now many proposed techniques to perform this task and can be divided mainly into these categories [12]: feature encoder-based methods, regional proposal-based methods, recurrent neural network-based methods, up sampling / deconvolution-based methods and increased resolution of feature-based methods. All of these methods, in a different fashion, learn the model that connects the image with an image mask representing semantic categories. To understand better, please refer to the Results and Discussion section.

2.3. Mine Indicator Detection DL Network

Once the region of interest is localized (typically mine presence indicators and mines absence indicators) with methods of semantic segmentation, we use a modern object detection tool to create a solution for the detection of mines presence indicators. Examples of these indicators include pedestrian shelters, artillery shelters, trench shelters, bunkers, drywalls, and other objects of interest. We use the fourth version of the "You Only Look Once" algorithm (YOLO), whose main advantage is that the single neural network can evaluate the whole image with a single-stage approach. The network uses the Darknet-53 backbone which is a 53-layer DNN whose main goal is feature extraction.

Prior to training, images need to be well-organized and labeled with appropriate bounding boxes. Each bounding box is assigned to one label. Dataset is then divided into training and testing subsets. The algorithm uses training data to train the YOLO algorithm, while the accuracy of the method is verified on the testing set. In YOLO, all input images are automatically resized to 416 × 416; therefore, we used multiple 416 × 416 × 3 input tensors for training and testing. Once the model generates the results, they are presented within the image by a bounding box with an identification of the indicator and the percentage of the algorithm's certainty. These results provide enough information for the end-users to confirm or dismiss the results of the algorithm. Typically, an extensive set of experiments on real-time situations based on criteria defined by international and local partners needs to be performed to confirm the usefulness of this approach.

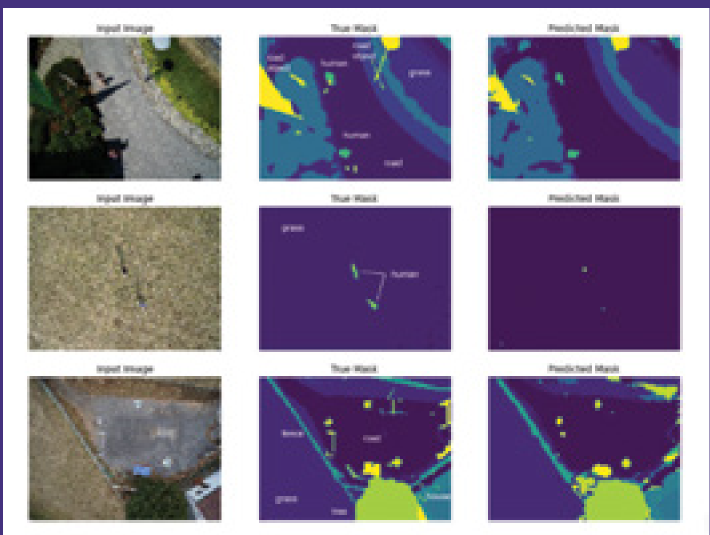
Since the system of data acquisition is capable of gathering data from multi-modal sensors (e.g., cameras, LiDARs, Radars), we use a concept called deep multi-modal perception to fuse together several different sensing modalities so that their complementary properties are exploited [13].

2.4. Explainable AI

In addition, the system will provide an explanation of its outputs that will be used to clarify the algorithm's decision (Explainable AI, XAI). The system is iteratively improved based on periodical feedback from the end-users, where the accuracy of the algorithm is improved with every iteration. The current state-of-the-art XAI methods for Deep Learning involve *Visualization methods*, which express an explanation by highlighting parts in a visualization that strongly influence DNN output, *Model distillation,* which develops a separate inherently explainable ML model that is trained to mimic the input-output behavior of the DNN; and *Intrinsic methods*, which are DNNs that have been specifically created to have an output together with explanation. Most of these methods are focused on ML expert users [14]. In this paper, we propose a combination of Visualization and Model distillation method to explain output of a DL model. The visualization will include methods such as Activation Maps, Class Saliency, Segmentation Score Maps and Similarity Mapping, as utilized in Neuroscope XAI toolbox [15].

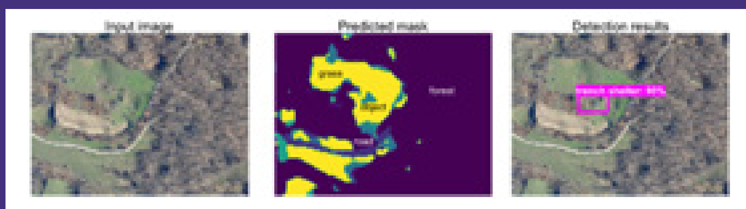
3. Results and Discussion

In this section we present some initial results from our previous research with the focus on the safe and explainable human demining. In Figure 2., we present the results of the model training on the drone image dataset that contains images masks representing semantic categories. The dataset consists of 400 images, which were augmented to 1600 using different techniques. The initial model training achieves accuracy of 88.85%, but we expect to significantly increase this percentage with higher resolution images and richer dataset.



◀ Figure 2. Results of the model training; first two columns are inputs for Semantic Segmentation DL Network, where the first image represents an actual image, the second represents a mask with semantic categories; and third is a

▼ Figure 3. Output of the Semantic Segmentation DL Network for a new image.



In Figure 3., output from the Semantic Segmentation DL Network (predicted mask) and Mine Indicator Detection DL Network (detection results) for an arbitrary input image are illustrated. The image is from a different data source.

Based on the survey Luotsinen et al. [5] conducted in 2019, current XAI techniques are useful primarily for development purposes (i.e., to identify bugs). More research is necessary to conclude if these techniques are also useful for supporting users in the process of building appropriate mental models of the AI-systems they operate and to ensure that future military AI systems are following national and international law. Therefore, evaluation of the proposed explanations is necessary. In order to examine the benefits of proposed solutions, we aim to design a user study with military experts using guidelines and an Explanation Satisfaction questionnaire as proposed in Explanation Satisfaction by Hoffmanet al. [16].

4. Conclusion

In this paper, we propose an approach for automatic detection of mine presence indicators in hazardous areas from aerial surveying images in a safe and explainable manner. The further steps involve a thorough testing of proposed Deep Learning-based methods with large datasets, determining XAI components to be the most informative and conducting a user study to verify the significance of the AI system outcome.

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Quantifying the Metal Detection Signatures of Minimum Metal Anti-Personnel Landmines

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Abstract: The Magnetic Polarizability Tensor (MPT) is a characterization, which represents the signature of a metal object within a metal detection system. The MPT depends on the object's shape, size, material, and excitation frequency. This property can be utilized to minimize false alarm rates and improve target classification on landmine detectors capable of measuring MPT spectral signatures of target objects. To date there are very few reports on the values of the MPT coefficients and this paper studies such characterizations several common types of low metal landmines and their components for the first time. The MPT signatures of their components were then compared with each other. It was found that firing pins and springs in most landmines were responsible for the magnetic aspect of the landmine's MPT.

Keywords: Electromagnetic Induction Spectroscopy, Magnetic Polarizability Tensor, Metal Detection, Metal Classification, Humanitarian Demining

Introduction

Landmine contamination in post-conflict areas is a major issue and landmine clearance is a slow, challenging process. Currently, the most common method for humanitarian demining is Metal Detection (MD). However, using MD for landmine detection results in a high False Alarm Rate (FAR), caused by the metal clutter in post-conflict areas. In some areas, the FAR can be as high as above 99% [1]-[4]. Ground Penetrating Radar (GPR) has recently been utilized as a second sensor in dual-mode type landmine detectors to reduce FAR. However, GPR is affected by soil inhomogeneities, such as moisture, vegetation, burrows, and stones, which also results in high FAR. In addition, detecting flush buried landmines with GPR is challenging, as the landmine can be lost within the large response caused by the ground bounce of the emitted waves [4].

The Magnetic Polarizability Tensor (MPT) is a characterization, which represents the signature of a metal object within a metal detection system. The MPT depends on the object's shape, size, material, and excitation frequency. It has been rigorously proved in terms of the mathematical theory that the leading order term in an asymptotic expansion of the perturbed magnetic field $(\boldsymbol{H}_\alpha - \boldsymbol{H}_0)(\boldsymbol{x})$ at position $\boldsymbol{x}$ in the presence of a small object at position z placed in a time varying background field $\boldsymbol{H}_0$ is as shown in (1) [5]-[9].

$$\begin{aligned}(\boldsymbol{H}_\alpha - \boldsymbol{H}_0)(\boldsymbol{x})_j \\ = (\boldsymbol{D}_x^2 G(\boldsymbol{x},\boldsymbol{z}))_{jm} M_{mi} \big(\boldsymbol{H}_0(\boldsymbol{z})\big)_i \\ + \big(\boldsymbol{R}(\boldsymbol{x})\big)_j\end{aligned} \qquad (1)$$

In (1), $\boldsymbol{D}_x^2 G(\boldsymbol{x},\boldsymbol{z})$ is the Laplace Green's function and $\boldsymbol{R}(\boldsymbol{x})$ denotes the residual involving the higher order terms in the asymptotic expansion. An explicit formula (2) has been derived in [8] relating the rank 2 MPT to the voltage induced on the receive coil of a metal detector in the presence of a metal object. Equation (2) holds when the generated magnetic field is uniform, causing $\boldsymbol{R}(\boldsymbol{x})$ in (1) to vanish. This means the contribution of higher

1 The authors would like to thank the EPSRC (Grant ref EP/R002177) and Sir Bobby Charlton Foundation for financial support of this research. P.D. Ledger gratefully acknowledges the financial support received from EPSRC in the form of grants EP/V049453/1 and EP/V009028/1. The authors would also like to thank Fenix Insight Ltd for providing access to the landmines characterized in this paper

order terms in (1) to the MPT is negligible.

$$V_{ind} = -\frac{j\omega\mu_0}{I_r} \boldsymbol{H}^R \cdot \mathcal{M} \cdot \boldsymbol{H}^T \quad (2)$$

In (2), V_{ind} is the voltage induced on the receive coil, $\boldsymbol{H}^R$ and I_r and are the pseudo magnetic field and pseudo current of the receive coil if it was used as the excitor, $\boldsymbol{H}^T$ is the magnetic field generated by the transmit coil, and $\mathcal{M}$ is the complex rank 2 MPT describing the object's properties. As the rank 2 MPT is made up of six unique coefficients, the object can be placed at six different orientations inside the magnetic field, resulting in different induced voltage in each orientation. By using the orientation information and the induced voltage, (2) can be utilized to generate a problem with six linear equations, which can then be solved with using least squares method.

Recent research has used MPT characterizations to classify metal objects [10], [11]. The same method can be applied to humanitarian demining by building a library with MPT characterizations of anti-personnel (AP) landmines and metal clutter. This library can then be utilized by MDs capable of characterizing MPTs of the target objects to better classify and reduce FAR.

An instrument capable of measuring rank 2 MPT characterizations of metal objects was previously built and reported by our team in [17]. In this paper, we present rank 2 MPT characterizations of four AP landmines and their metal components by utilizing the instrument. We present the MPT eigenvalues instead of the MPT matrix as the eigenvalues are independent of the object's orientation and are absolute to the object, irrespective of how it was characterized.

Experimental Setup

The instrument has three main parts which are a coaxial coil arrangement, system electronics and control software. The coaxial coil arrangement in Figure 1 was designed using Helmholtz Coil principles to generate a uniform magnetic field inside the coils. A custom optimization algorithm utilizing the principles was used to decide the number of coil sections as well as the number of turns for each coil section for both transmit and receive coils. The transmit coil is made up of nine coil sections which are connected in series addition. There are two receive coils, each made up of four individual coil sections connected in series addition. The two receive coils themselves are connected in series opposition and balanced to have no voltage output when there is no object placed in the coil arrangement. The coil arrangement is designed to characterize metal objects up to 130 mm in diameter, which is specifically chosen to fit AP landmines. The instrument is designed to have a wide frequency spectrum from 100 Hz to 100 kHz. The frequency range was chosen to best capture the spectral characteristics of metal objects with similar size to a minimum metal AP landmine's metal components.

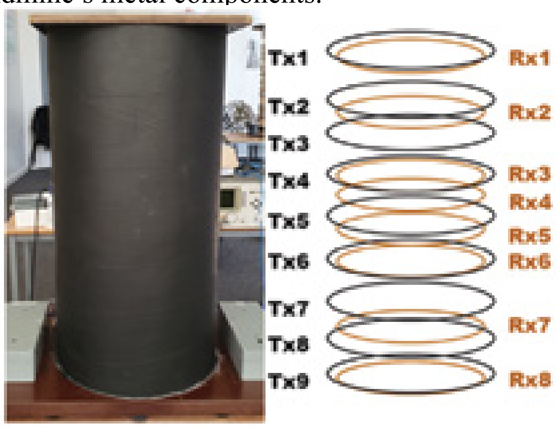

Figure 1 - Coaxial coil arrangement of the instrument. (a) is the completed coil arrangement encapsulated in epoxy resin. (b) is the coil geometry of both the transmit and receive coils.

The coils were driven by the system electronics consisting of receive electronics for capturing the induced voltage on the receive coils, transmit electronics for driving the transmit coil, a microcontroller to excite the transmit electronics and for data acquisition, and the power supplies. The control software of the instrument runs on a PC and controls the experiment by communicating with the microcontroller in real time.

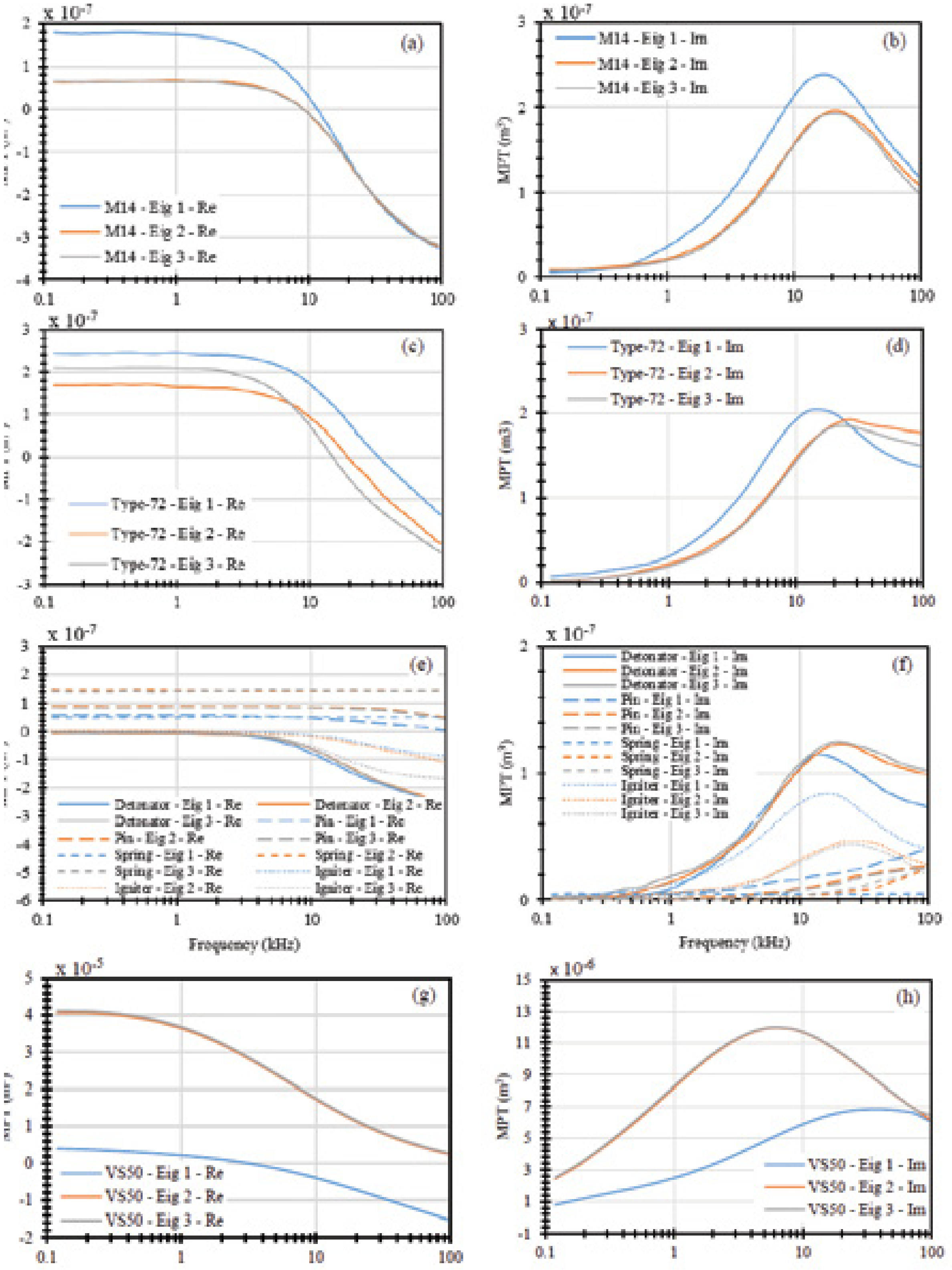

Figure 2 – Real and imaginary MPT eigenvalues of M14 (a, b), Type-72 (c, d), VS50 (g, h) AP landmines and components of Type-72 (e, f).

Post-processing of the data is also automatically done by the control software. The instrument and its MPT characterization performance are described in detail in [17].

Results and Conclusions

For each experiment, the target object was placed in the coils at sixteen pre-determined orientations by using a custom made target orientation manipulator. Although, six orientations are enough to obtain the rank 2 MPT, sixteen are used to have a better posed problem. The voltage measurements from all 16 orientations and the rotation information were then used to generate the linear equations using (2) and then calculate the MPT. Finally, the rank 2 MPT eigenvalues of the MPT were calculated and plotted.

MPT eigenvalues of M14, Type-72, VS50 and PMN AP landmines as well as their metal components were characterized for the first time. A subset of these characterizations are shown in Figure 2. It was found that firing pins and springs in most landmines were responsible for the magnetic aspect of the landmine's MPT.

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UAV deployed 3-dimensional Ground Penetrating Radar

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Abstract: Ground penetrating radar (GPR) systems make use of electromagnetic waves to generate high resolution images of the subsurface. These systems have been successfully deployed for detecting metallic and nonmetallic explosive devices hidden at surface and near-surface level, such as improvised explosive devices (IEDs), unexploded ordnances (UXOs) and landmines. Recently, GPR systems have been integrated with both unmanned ground vehicles (UGVs) and unmanned aerial vehicles (UAVs, or commonly known as «drones»), allowing to scan risky areas while ensuring the safety of the operator. The most common type of GPR used with unmanned vehicles is single channel: one scan provides a vertical section of the subsurface. Multiple passes with the system are therefore required to build a full representation of the area under investigation. This paper describes a novel system from Kontur AS of Norway: a full 3-dimensional step-frequency continuous waveform (SFCW) GPR integrated with a heavy-duty UAV. This system has the major advantage of collecting up to 17 parallel vertical scans in a single pass over a width of 1.4m. Areas under investigation can therefore be covered more efficiently and in shorter time compared to single channel GPRs, reducing the time spent on the field. The data is recorded in a dense 3D data cube. The data cube is key for recognizing specific target geometries and making it easier to identify the signatures of potential targets. Identification of potential targets is supported by 3dimensional software, allowing interpretation of data from several directions through the soil.

Introduction

GPR technology has consolidated itself as one of the methodologies used for localization of explosive threats [1]. GPR sensors detect both metallic and nonmetallic objects and produce high resolution images of the subsurface, providing complementary information to other devices, e.g., metal detectors. Of particular interest for the application are 3dimensional GPR systems, which are based on array of antennas and capture dense data cubes with a single swath. Kontur AS (formerly 3DRadar AS) is a GPR manufacturer specialized in 3D GPR hardware and software. Sensors from Kontur AS are integrated in mine detection vehicles, Fig. 1., and successfully deployed on the field for localization of explosive devices such as IEDs.

Figure 1. 3D GPR system from Kontur AS mounted on a mine detection vehicle

Kontur AS has recently developed a lightweight 3D GPR system specifically designed for operation on a UAV. This system has full 3D, real time capabilities and is well suited for demining applications, allowing to scan large areas in relatively short time while ensuring the safety of the operator.

UAV deployed 3D GPR

The UAV 3D GPR system (Fig. 2) is composed of three main parts: the GeoScope radar unit, which is responsible for generating the radar signal as well as data preprocessing and transmission, the LW-AIR array of antennas, and a highcapacity payload UAV. The complete GPR system, GeoScope and LW-AIR array, has a total weight of only 19kg, which is roughly half the weight of a ground vehicle mounted system with similar characteristics, and is powered by an independent battery mounted on the UAV. The GPR is controlled remotely via Wi-Fi connection through a data collection software running on the operator's PC (Fig. 3). The operator can set up the GPR system, start and stop data collection, and also visualize in real time the radar data in three dimensions as these are being collected. The system can be operated at an elevation from the surface between 20cm and 100cm and offers a penetration depth down to approximately 150cm[5].

Figure 2. UAV 3D GPR system from Kontur AS during operation

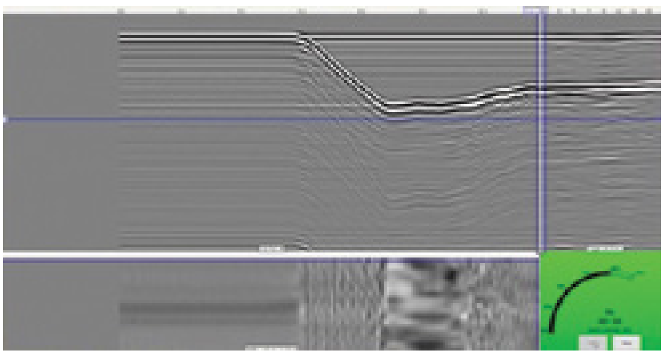

Figure 3. Real time data visualization in the data collection software.

GeoScope radar unit

The GeoScope is a stepfrequency continuous waveform (SFCW) GPR unit with a bandwidth spanning from 30MHz to 3050MHz. While traditional, impulse based GPRs probe the subsurface by transmitting a short electromagnetic impulse and recording reflections from the subsurface, SFCW radars transmit a series of sinewaves at increasing frequency within a defined frequency band and resolve the equivalent of the frequency response of the subsurface within that span of frequencies [2]. The main purpose of SFCW technology is to overcome the traditional tradeoff of impulse GPR, where the bandwidth is tied to the central frequency of the system: a larger bandwidth determines a higher resolution, but also a higher central frequency which in turn determines less penetration in the subsurface. This is because higher frequencies are more strongly attenuated as they propagate in the subsoil. SFCW GPR, on the other hand, records the response of the subsurface at each frequency within the bandwidth, and therefore is not bound to the concept of central frequency. In practice, a SFCW GPR brings together large bandwidth and low frequency content, aiming at producing a radar image with optimal resolution at every depth.

LW-AIR array

The LW-AIR array has a total width of 1.4m. It counts 9 transmitting antenna elements and 9 receiving antenna elements, which are paired together for a total of 17 channels with a spacing of 7.5cm between each other. The displacement of the antenna elements within the array is shown in Figure 4: the antennas within the array are colored in yellow and the red dots along the lines connecting transmitters and receivers indicate the position of the channel relative to each pair. The antenna elements are designed based on the same elements of the DX aircoupled array series from Kontur AS [3], and have an effective bandwidth between 200MHz and 3000MHz. Although the option is not covered in this paper, it is worth mentioning that the scan sequence, i.e., the sequence of pairs transmitterreceiver, can be fully customized via the data collection software, giving the possibility to collect multioffset data.

The highcapacity payload UAV

The UAV has a weight of 18kg and has the capacity to host a payload up to 24kg. It has a height of 62cm and a diameter of 216cm including propellers.

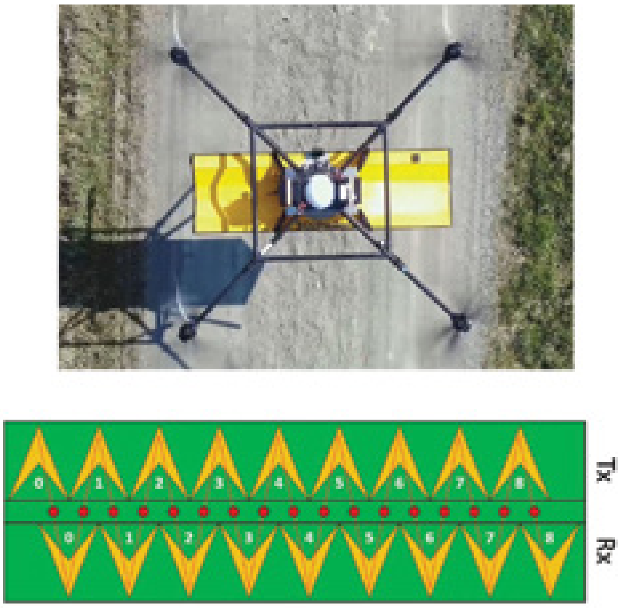

Figure 4. LW-AIR array: view from top during operation (top), geometry and displacement of the antenna elements (bottom).

The maximum speed of the UAV is 55kmph, while the flight time during operation of the 3D GPR is 20 minutes.

Data examples

The UAV 3D GPR system has been tested for field operation and data collection with positive results. Figure 5 shows a vertical profile (top) where two hyperbolic reflections due to targets at different depths are visible in the data, and their signature in "depth slices" (middle and bottom), that is, horizontal data slices taken at the depth of the targets. The depth slices are displayed in a map and can be overlaid to aerial photography or other georeferenced imagery.

The data displayed in Figure 5 are available with a single swath of the 3D GPR system, whereas using a single channel GPR would have required multiple passes in order to build a data volume with similar density. Figure 6 shows a case where a target is only partially covered by the width of the array: the target is only visible in the radar profiles from the channels on one side of the array. In this scenario, the target could have been completely missed by a single channel GPR following the same acquisition line. The data presented here have been postprocessed with Examiner software from Kontur AS.

Figure 5. Vertical radar profile (top) and georeferenced display of depth slices (middle and bottom) showing targets at different depths.

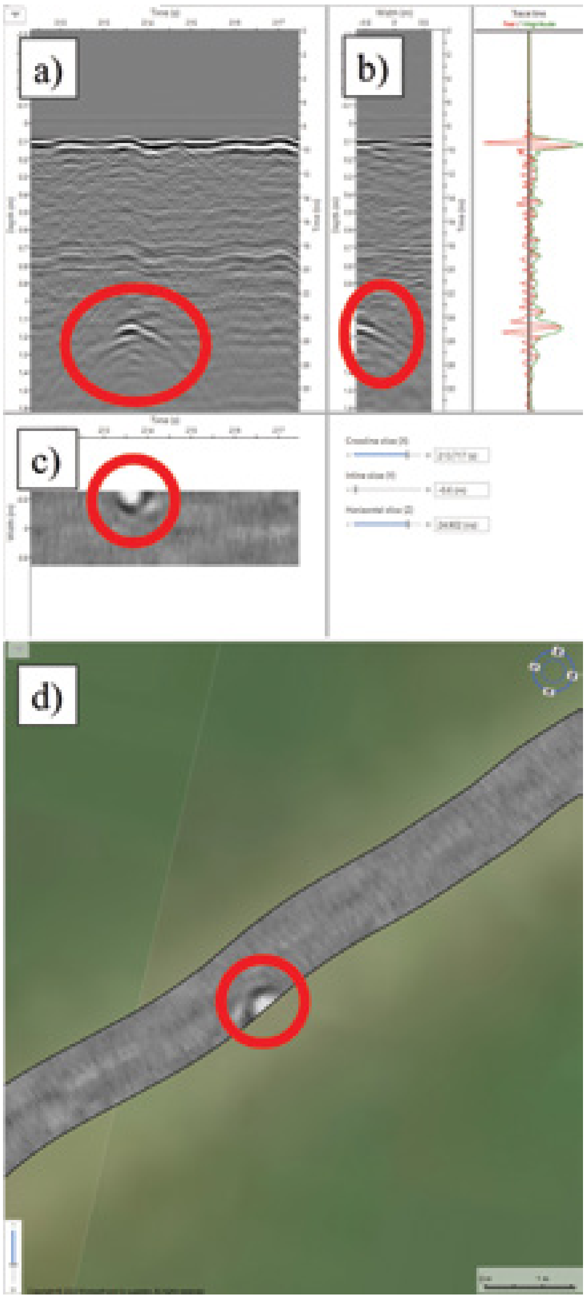

Figure 6. Target partially covered by the 3D GPR: a) vertical profile; b) vertical profile across the width of the array; c) depth slice; d) georeferenced depth slice.

Conclusions and future work

The tests performed with UAV 3D GPR have given positive results both in terms of operability and data quality. The system is easy to deploy and operate in the field. The high density and resolution of the 3dimensional data cubes allow to identify targets more easily compared to analyzing single radar profiles or more coarsely sampled data cubes reconstructed from multiple passes of a single channel GPR. Furthermore, the 3D GPR allows to cover large areas in a relatively short time, effectively reducing the time spent on the field. Kontur AS will perform additional tests with the UAV 3D GPR, to further demonstrate its capabilities in different soil conditions and for detection of various types of targets.

Acknowledgements

The UAV 3D GPR was developed within the project “Georadar for montering på drone og autonome luftfartøy”, supported by Innovation Norway.

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Accelerating Mine Clearance by Introducing a User-Friendly and Cost-Effective Dual Sensor Detector in Humanitarian Demining Operations

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Abstract: A new dual sensor "ALIS", which was developed at Tohoku University, Japan, will be evaluated for application in humanitarian demining activities in Bosnia and Herzegovina. ALIS can visualize buried landmines on a tablet PC screen, so that a deminer can easily understand the shape of the buried objects and can discriminate mines from other metal fragments. In this project, we will evaluate its performance and establish a new SOP (Standard Operation Procedure) for this new sensor. We will also evaluate the improvement of the efficiency of mine clearance by introducing ALIS for further deployment in mine affected countries.

Keywords: ALIS, dual-sensor, ground penetrating radar, GPR, humanitarian demining, testing, SOP development

Introduction

Speeding up humanitarian demining operations can be achieved in two ways. By adopting procedures and protocols that enable faster implementation of the operations and by introducing technology that saves individual labour or team effort put in the fieldwork. The most efficient way is combining both methods where either existing technology is used in an innovative way by adopting advanced operational procedures, or introducing generation technology and subsequently developing a completely new set of the procedures to enable its optimal usability. The NATO SPS funded project "Accelerating Mine Clearance by Introducing a User-Friendly and Cost-Effective Dual Sensor Detector in Humanitarian Demining Operations" applies the later model with the goal to provide a set of rules which contains training curriculum, accreditation/ testing protocols and operating procedures for the next generation dual sensor detector ALIS[1]-[3].

ALIS Dual sensor

ALIS-Advanced Landmine Imaging System is a dual-sensor mine detector, developed by Tohoku University and produced by ALISys inc. Tokyo, Japan, that combines a metal detector (EMI sensor: equivalent to CEIA MIL-D1) and a ground penetrating radar (GPR). This device exploits new SAR-Synthetic Aperture Radar algorithms that process sensor readings and give visually conceivable output on a colour display of a hand-held tablet. Simply put, ALIS' interface shows the silhouette of the buried object to the deminer while it retains ease of handling, instead of conventional audio signal.

Visualisation of the underground object in many cases may relieve the deminer from using traditional tools for inspecting and unearthing the buried object, which is saving in the individual labour put in demining. On the other hand, combining the next generation GPR technology with traditional metal detection in such a way that one operator with ALIS detector supports 2-3 deminers with ordinary metal detectors may bring saving of the team effort by synergic application of the technologies.

Figure 1 ALIS training in BiH.

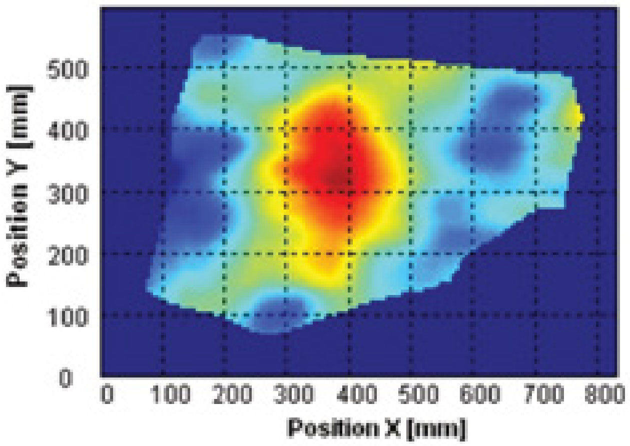

Figure 2 GPR image obtained by ALIS.

Soil evaluation

EMI sensor and GPR is sensitive to soil properties. In order to use dual sensors effectively, we have to characterize the soil and adjust the sensor parameters. Comprehensive study on soil properties in BiH was published by Hannam and Dearing [4]. In this study two methods to estimate these soil properties in BiH were used: (1) using information on magnetic susceptibility and frequency dependent susceptibility of soils from other temperate and Mediterranean regions and (2) measuring these properties in available samples at the Bosnian National Soil Archive. The results of these two methods give the indication that between 4% and 30% of the area of land in BiH is problematic for metal detectors. In northern Bosnia the magnetic properties of soils are mostly unproblematic for metal detectors, while in central Bosnia there is a moderate effect. In southern and western Bosnia and Herzegovina approximately 30% of the area consists of soils that affect metal detector performance.

For (field) measurements of the magnetic susceptibility and frequency dependent susceptibility of soils, the Bartington MS2B Dual Frequency sensor can be used, which works in the frequency domain relevant for metal detectors (0.465 and 4.65 kHz).

Because the ALIS dual-sensor detector contains, apart from a metal detector, also a GPR, soil properties affecting the GPR performance are also important for the overall detection performance of the ALIS detector. The soil property relevant for the GPR performance is the electric permeability or, better, the contrast between the electric permeability of the soil and the target.

The reflection of electromagnetic wave from subsurface material which includes soil, gravels and other organic material is very complicated. These materials reflect electromagnetic wave, therefore, GPR can "see" these materials, but it is not landmines, which we need to detect. In addition, inhomogeneous soil moisture can be reflectors to electromagnetic wave. Typically, even in homogeneous soil, soil moisture can easily vary more than 30%, and this inhomogeneity can be detected by GPR. Generally unwanted reflections to radar system are called "clutter" in radar engineering, and it is very different from "noise", because clutter is very stational while noise is time-varying. Understanding the clutter is the most effective way to remove the clutter from GPR signals.

We will use TDR (Time-Domain Reflectometer) IMKO-Trime system for in-situ measurement of soil moisture, and soil moisture can be related to the dielectric constant. We will measure not only the moisture of soil, but we will measure the spatial distribution of the soil moisture. The material included in the soil will be also analyzed. This information can generate electric model of inhomogeneous soil and can be used for electromagnetic scattering simulation software. Typically, we use FD-TD method to evaluate electromagnetic wave scattering in inhomogeneous soil and can be utilized for characterization of soil for landmine detection by GPR.

The set-up of test lanes in BiH and training plan have been delayed due to the travel restrictions. The Co-director has identified a number of suitable locations for these test lanes, that can also be used for the training of the operators with the ALIS detectors. These locations are already used for training of mine detection dogs and their handlers in BiH, and have all types of landmines planted. Most important these locations have soil settled around mines as in real minefields so ALIS operation resembles that in live minefield. Also metal debris can be added in the lanes in the advanced stage of training.

To adjust the detector for the specific environment critical task is to obtain critical pieces of information about the soil characteristic by conducting basic investigation of the soil types, which will be added to its software.

Training

Drafting the procedures to be used by ALIS operators is based on the understanding of the present procedures and the way of incorporating them in the new procedure.

The operation of ALIS is quite different from conventional metal detectors. The deminers who will learn the ALIS operation will be experienced deminers, who would be typically team leaders. Even though, training through web meeting has very strong restriction, and need much longer time for training.

Training of the operators is based on the experiences gained by operational testing of the ALIS in Cambodia and Colombia. Training with the ALIS detector will be conducted in the Federal Administration of Civil Protection of Bosnia and Herzegovina whose personnel will conduct testing in the field.

Existing documentation for training of the ALIS detectors, i.e. the ALIS operating manual and a video for ALIS training, are translated into the Bosnian language. Since an operating manual in the Bosnian language is mandatory for the accreditation of demining equipment in BiH, the ALIS operating manual is translated by a professional translating agency. The training video is adapted for use in BiH by replacing the spoken text into Bosnian language.

Two ALIS detectors arrived in BiH, only a first start with training has been made. Moreover, this training was limited because of the weather conditions in Sarajevo (snow), so that most of the training had to be done indoor. Moreover, due to COVID-19, Sato could not visit BiH for training of deminers, so we had a Web meeting for training of deminers. Initial training performed with the team leaders and QA officers showed that learning how to operate the device is less issue than building the confidence in the new technology and completely new MO derived from it.

Figure 3. Training of ALIS operation.

Establishment of a new SOP for ALIS

According to standing SOP every indication given by metal detector has to be inspected manually using prodder and spade. In highly metal contaminated soil ratio of detecting to manually inspecting is rather unfavourable in terms of physical work and working hours put in. ALIS detector provides an opportunity to reverse ratio in favour of detecting thus saving labour and speeding up the process. In order to use the ALIS detector, combining a metal detector and a ground penetrating radar (GPR), in demining operations, an agreed Standard Operating Procedure is necessary. The project team discussed the options for SOPs and drafted 3 different versions. One version is suitable for the assessment of the ALIS detector in operational demining. In this SOP the ALIS detector will be used after the standard metal detector has been applied. With the ALIS detector in GPR mode the locations that are marked due to a metal detector indication, are checked. In a second SOP version, a procedure is proposed that is expected to speed up demining considerably by using the ALIS detector. In this SOP the lay-out of the demining lane is modified, and the ALIS detector can be used together with one or more standard metal detectors. This SOP will be trialled in the SPS project. Finally an SOP is proposed in which only the ALIS detector is applied, i.e. without any other (metal) detectors. This SOP will also be trialled in the SPS project, since it has to be accepted by the national mine action authority before it can be applied in operational demining.

Test and Evaluation in BiH

Operational testing, conducted through a series of trials in training and operational environment, is the major project activity in which all previous activities converge. It aims to proof applicability and expediency of each task result and to direct us to the ways in which ALIS application in the operations will provide best result. It will be conducted in order to IMAS 03.40 “Test and evaluation of mine action equipment” so the final project outcome can be recognized through accepted protocols and presented in a uniform manner. The necessary requirement for the operational testing in the field is the accreditation of the detectors by the BHMAC. As no protocols for the accreditation of GPR currently exist, detectors were accredited as metal detectors solely. That means that during operational testing in the field GPR itself and related procedures will be tested by comparing to traditional procedures. We need to mention that development of the GPR accreditation protocol is also a one of the project goals.

Conclusion

Preparation of field test of ALIS in Bosnia and Herzegovina has started, and evaluation test will start in spring 2022, under the support of NATO SPS.

Acknowledgement

This research was sponsored by the NATO Science for Peace and Security Programme under grant id. G5607

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VAROIOUS MINE ACTION TOPICS

Evolution of The Journal: Advancement in the Digital Realm and its Implications for Accessibility and Inclusion

Brenna Matlock, Sabryn Dotson[1]

For nearly 26 years, *The Journal of Conventional Weapons Destruction* has been a resource for the humanitarian mine action (HMA) community. *The Journal* has published over 1,700 articles in print and online, enables individual contributors and organizations working in the sector to share their unique perspectives, insights, and experiences, and broadens the community of practice's understanding of past and present issues. *The Journal* is sponsored by the U.S. Department of State and is published by the Center for International Stabilization and Recovery (CISR) at James Madison University.

Ever-evolving, *The Journal* continues to adapt. Due to the increasingly online environments created in response to the global COVID-19 pandemic, many HMA organizations have moved away from exclusively using traditional webpage and print mediums as a conduit through which they highlight their programs, activities, and research. These include more innovative ways to reach and interact with audiences to create and share knowledge. For example, *The Journal* authors now have the option to co-create short video interviews that resemble the popular video formats of social media platforms. In addition, the various online media options highlight the ways that articles can be more inclusive and accessible. *The Journal* has acknowledged these advancements and has put them into practice, progressing toward a more accessible and virtual presence.

In this paper, we identify the various digital developments for *The Journal* as we work to create a more interactive, inclusive, and accessible publication for our community of practice. *The Journal*, partnered with its video production sector *The Exchange*, has been researching and developing methods in which to diversify its media. Our goal is to be a more inclusive and accessible medium through which a diverse audience can access *The Journal*.

Key Factors Related to Audience Outreach and Access

Since its inception, *The Journal* has been an open access trade journal. By open access, it means that *The Journal* does not have barriers common to other reputable, peer reviewed literature (memberships, subscriptions, fees, etc.).[2] In theory, anyone with access to the internet has access to the information *The Journal* provides. Without traditional publication barriers, *The Journal* should be able to successfully share and discuss valuable HMA-related information with those that need it.

However, the concept of public access as a solution of equitably sharing information alone has been critiqued. In many cases, public access publications assume that readers may not have disabilities that prevent them from reading online, and be literate, English-speaking, have access to the internet, amongst other factors.[3] It is for these reasons we continue to contemplate ways make the publication more fully inclusive, acknowledging the challenges of having truly universal texts.

Another matter to consider is how audiences (particularly the HMA community and its beneficiaries and stakeholders) are consuming information and interacting with media. While the written article is the full capsule of the author's work, it is not the only medium that *The Journal* has at its disposal. Numerous studies have demonstrated that individuals, depending on their age, gender, culture etc., may consume and interact with media differently. We can also see how users interact with shared information through trends noted on online spaces and social media platforms. Recognizing these factors, *The Journal* continues to explore and introduce new modalities and tech-

1 James Madison University Center for International Stabilization and Recovery, USA; Email: cisr@jmu.edu
2 Peter Suber, open access overview (definition, introduction). (n.d.). http://legacy.earlham.edu/~peters/fos/overview.htm
3 L. McLaughlin. "Feminist Journal Editing: Does This Job Include Benefits?" Ada: A Journal of Gender, New Media, and Technology, No.4. (2014) doi:10.7264/N3N58JP6

nological tools to share the work of our authors to their target audiences and beyond.

The Journal's Innovations in Technologies and Modalities

In 2021, CISR added a new initiative to its portfolio called the CISR Exchange. The Exchange engages with *Journal* contributors, subject-matter experts, and leaders in the mine action sector through pre-recorded, informal conversations with CISR staff. These videos are available on CISR's social media pages and YouTube channel. Captions are generated for each *Exchange* video. The text is thoroughly proofed to ensure its accuracy and is precisely timed to the content in each interview. After researching the best typeface and fonts to use for video captions and general readability, *The Exchange* changed all video subtitles to Tahoma, a narrow-bodied sans-serif typeface considered to be one of the most accessible fonts.[4]

The Journal has also branched out from exclusively publishing its content in print form and now offers its full articles through an abundance of online mediums, including the CISR website, the JMU Scholarly Commons, and issuu.com. The CISR webpage contains a plain text version of each article that is accessible for screen readers for viewers of *The Journal* who have visual impairments. Looking ahead, *The Journal* plans to incorporate specialized text-to-speech software for visually impaired readers, embed all multimedia within its corresponding articles, and create a mobile app to broaden its readership.

Many HMA organizations take advantage of the ability to reach people all around the world, promote their initiatives, and connect using social media. CISR operates on social media in a very similar way, promoting *Journal* articles, highlighting organization-wide events, interacting with other HMA organizations, and utilizing its various platforms to expand its understanding of the needs of its audiences.

There are several resources available that outline the best practices for accessible media and information sharing. For example, CISR utilizes the U.S. Department of Labor's Office of Disability Employment Policy (ODEP) toolkit to aid online entities in their mission to create inclusive media. The toolkit highlights specific language, the correct use of hashtags, and ways to effectively communicate information to the full scope of an audience.[5] To spearhead the integration of these ideas, CISR's post caption text took on a more condensed, concise, and clear appearance, ensuring that the language is comprehensible and free of jargon. Additionally, the use of "camel case," a form of hash tagging that capitalizes each individual word in a hashtag, was applied when creating a complex hashtag on CISR's social media (for example, #thejournalofCWD becomes #TheJournalOfCWD). CISR has focused not only on the importance of incorporating accessibility elements into its feed, but also how to immediately develop attainable information for its audience.

Conclusion

We hope this information not only improves our audience's experience with *The Journal* but also inspires other HMA organizations and partners to consider how they can make their communications and publications more accessible and inclusive. In addition, we acknowledge that communication is multi-directional and we remain receptive to the ideas and experiences of others to improve *The Journal.* While we recognize *The Journal* is still not universally accessible, we continue to push toward a better understanding of the needs of our broad readership. By increasing our audience through accessibility and adaptation, we create an informed and interconnected HMA sector ready to address the challenges our organizations face.

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International development cooperation of NGOs in mine action education of civil society: an example of good practice - Croatia and Ukraine

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HRVATSKA POMAŽE
REPUBLIKA HRVATSKA MINISTARSTVO VANJSKIH I EUROPSKIH POSLOVA
SIGURNO KRETANJE
Hrvatska i Ukrajina
Ukrainian Deminers Association

Introduction

The Association for Support and Encouragement of Community "Croatia Support" applied for a public call issued in April 2021 by the Ministry of Foreign and European Affairs of the Republic of Croatia with the aim of developing cooperation between civil society organizations. The aim of the competition was to contribute to the creation and strengthening of partnerships between Croatian and foreign partner NGOs. In this competition, eleven civil society organizations were given the opportunity to develop international partnerships and cooperation. One of these associations is the Association for Support and Encouragement of Community "Croatia Support".

Geographical, sectoral and thematic priorities were highlighted as a special criterion, additionally scored. The countries of Southeast Europe, including Ukraine, are listed as one of the three geographical priorities. The Association "Croatia Support" found its partner in the Ukrainian association called "Ukrainian Deminers Association" (UDA) based in Kiev. After the approval of the project, in September 2021, a contract was signed with the Ministry, which marked the beginning of the project implementation.

Safe Movement Project Activities

In accordance with its theme, the project was called "Safe movement: mine education for children and youth, Croatia and Ukraine." It consists of 4 groups of activities: Preparatory and accompanying activities, Education-mine action, field work in Ukraine, Arrival of children from Ukraine to the Republic of Croatia and

Promotion and visibility. The estimated duration of the project is from September 2021 to November 2022. At the suggestion of the partner organization, educational activities in Ukraine began in late September 2021, which proved to be a great move given the escalation of the war in Ukraine in February 2022. Preparatory activities began at the moment when the host organization was informed about the results of the public call, i.e. in July 2021. In the two months leading up to the signing of the Treaty, talks began on possible co-operation on UDA-funded projects funded by major funds such as the United Nations Development Assistance Programme (UNDP). After the Ministry gave the green light to start the activities, a five-day official visit of Croatian experts and the project team to Ukraine is planned, which is scheduled for the end of September and the beginning of October 2021. Mrs. Anica Djamic, the ambassador of Republic of Croatia in Ukraine had the major role in organising of official visit and communication between partner organisation. The official trip began with a working meeting of the project team and the Ambassador immediately upon arrival in Kyiv. On the second day, the schedule was filled with meetings and educations. In the morning, a meeting was held at the Ministry of Foreign Affairs of Ukraine. The meeting was attended by the Ambassador of the Republic of Croatia to Ukraine Anica Djamić, representatives of the Association Croatia Support (Mihaela Boltižar, Mladen Crnković), a representative of the partner Association UDA Tymur Pistriuha, and meeting was hosted by Vasyl Zvarych, Head of the 2nd Territorial Administration MVP and Anna Tertychna, interim head of department for the Balkan countries. After that meeting, a central event was held, which was also the initial conference of the project: presentation of the project and educational workshops for members of the partner organization. The topics of the workshops were: Establishment of mine action, Mine risk education and assistance to mine victims, Crisis communication, International and national standards and their application to various components of mine action. On the third day in Ukraine, the events were located in Kiev but also in Kharkiv. Given that the partner organization UDA has about 200 members from different parts of Ukraine, it was decided that part of the educational workshops will be held in Kharkiv. Members of the UDA in Kharkiv were able to attend three workshops: Establishment of mine action, International and national standards and their application to various components of mine action and Crisis communication. At the same time, an EORE workshop was held in Kiev at the Yaroslav Mudri Elementary School, organized by the partner association UDA, where an example of Croatian and Ukrainian practice was presented. The way of work of the two organizations was compared and the practice of education for students in the Republic of Croatia was presented. The afternoon was reserved for a meeting at the Ministry of the Temporarily Occupied Territories with their representatives: Igor Yaremenko, Deputy Minister for the Temporarily Occupied Areas, Svitlana Avramenko, Head of the Expert Group on Humanitarian Demining and Alyona Berezhok, Assistant Deputy Minister. The project and cooperation in the Ministry were presented by members of the team of the association "Croatia Support", a representative of the partner organization UDA and Ambassador Mrs. Djamić. On the last day of the field activities, a meeting was held between all project participants (lecturers, project team) and representatives of the "Ukrainian Deminers Association", which once again analyzed all activities carried out during these days. The main conclusions of the visit and individual meetings were drawn. It was found that good cooperation has started between the two organizations, both Ministries where the meetings were held praised the initiative and promised assistance as needed. A total of 5 different educational workshops were held in the Ukraine, as envisaged by the project, and more than 30 members of the partner organization and 70 primary school students participated in the educations.

Plans for the next period

Given the further development of events in the territory of Ukraine, the timing for the departure was perfectly chosen. The continuation of activities is planned to take place in Croatia. It was originally planned that a group of children from Ukraine would visit the Republic of Croatia and spend 5 days in Novi Vinodolski, where appropriate educational workshops would also be held for them under the guidance of experts. As the situation changed from day to day, project activities had to be adapted to the course of events. Therefore, it is planned that children from refugees from Ukraine who are located in Croatia will participate in the workshops in Novi Vinodolski in June. In addition to these activities, through the activity of Advertising and Visibility, it was agreed to produce educational bilingual leaflets that will contain security information.

It is important that the implementation achieves the set thematic goals: transfer of experiences from democratic transition and human rights, security (with emphasis on demining and strengthening the security of particularly vulnerable target groups) and environmental protection. Cooperation between organizations exchanges experiences in the field of demining, which include an overview of the way of working and mutual learning on examples, with emphasis on the example of good practice from the Republic of Croatia.

The mine problem in Ukraine was large even before the start of the Russian aggression in February 2022. According to data from the partner organization presented at the meetings in the fall of 2021, as many as 1.5 million people were displaced by the war-affected area (Donetsk and Lugansk regions). According to data from the beginning of April (https://data2.unhcr.org/, accessed on April 9, 2022), about 4.5 million people have fled Ukraine since the beginning of the invasion in February.

The partner organization also said that in 2020 Ukraine was the third country in the world in terms of mine contamination, the year before it was in fifth place. Due to the escalation of the war, it is assumed that in 2022 he will be at the top of the list. Recovery will take years and mine training of civilians will be a burning issue, as fighting has taken place in urban areas, increasing the risk of civilians encountering mines and explosives.

Conclusion

The current situation has unfortunately stopped the development of further projects. Since the beginning of the implementation of the MoFA project, the two partner organizations have been developing new ideas on cooperation, and in the meantime, new project has been submitted to the UNDP tender. The holder is the Ukrainian Deminers Association, and the Association for Support and Encouragement of Community "Croatia Support" is a partner, along with another partner organization (Air-Light, Ukraine). The name of the project is Increasing the efficiency of the Humanitarian Mine Action process including Mine Victim Assistance in Eastern Ukraine through the development of the national Capacity Building. After the normalization of the situation in Ukraine, we hope to start project activities related to this project. By signing the new partnership, the specific goal of the project "Safe Movement: Mine Education for Children and Youth, Croatia and Ukraine" was achieved, which is capacity building and networking of national civil society organizations in the field of international development cooperation.


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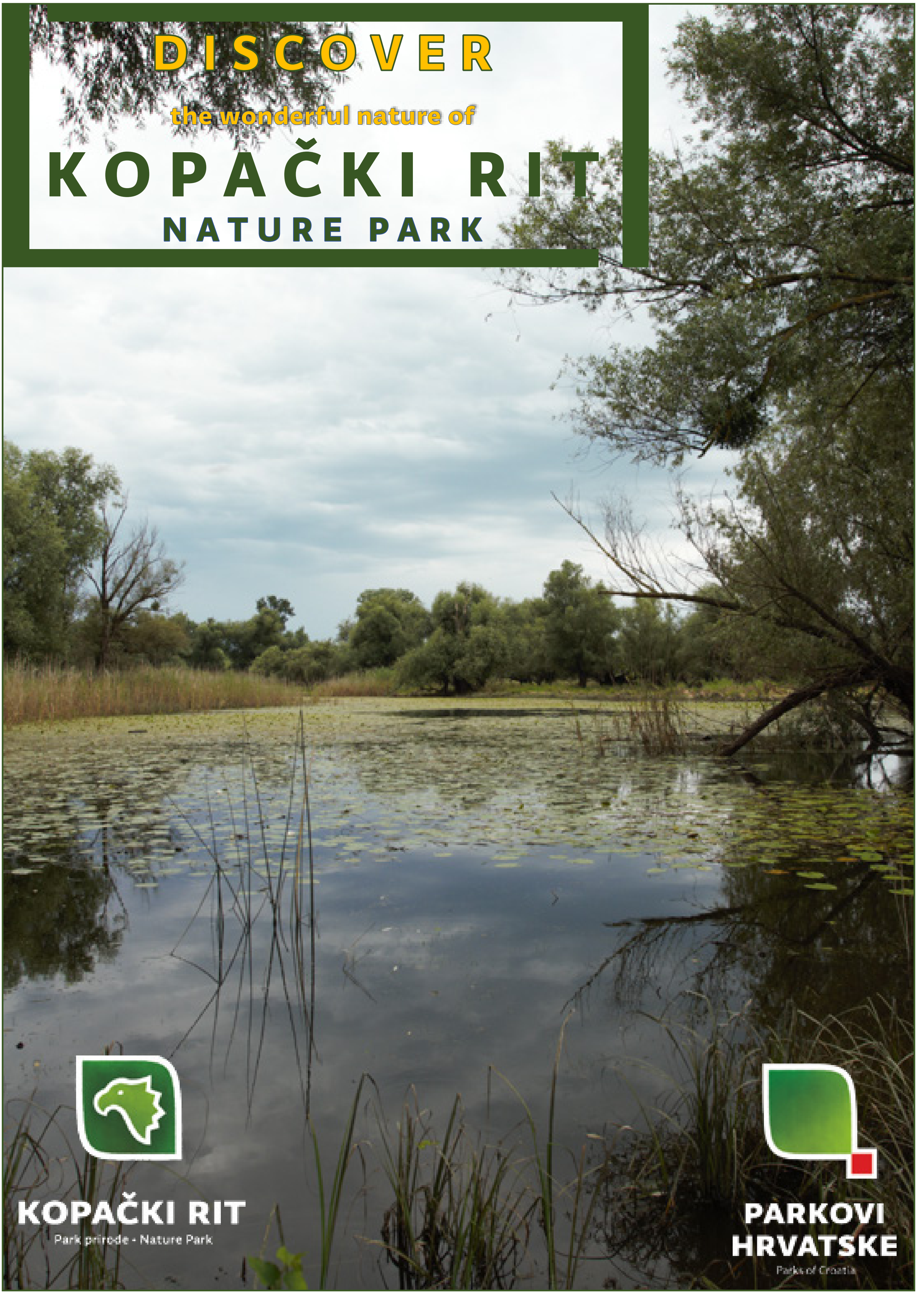

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