Issue 27.2 | Summer 2023

THE JOURNAL of Conventional Weapons Destruction

COMPUTER VISION in Mine Action
Using AI to detect objects in the field

CLEARING UKRAINE'S Agricultural Land
Mine Action's role in food security

ENVIRONMENTAL Mainstreaming
Moving beyond "Do No Harm"

LAND RIGHTS in Mine Action
Mitigating land dispute risks

Special thanks to our contributing organizations:

routescene beyond the point · JICA · CMAC · FSD · THE HALO TRUST · T4T TECH4TRACING · VFRAME · THE SOCIAL POLICY GROUP · GICHD · minemark

THE **JOURNAL**
of Conventional Weapons Destruction

Issue 27.2, Summer 2023

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The Journal of Conventional Weapons Destruction is a professional trade journal for the humanitarian mine action/conventional weapons destruction community, including but not limited to mine action, physical security and stockpile management, small arms and light weapons, and other related topics. It is a forum for best practices and methodologies, strategic planning, risk education, and survivor assistance.

The editorial board reviews all articles for content, accuracy, and appropriateness for *The Journal.* The editorial board reserves the right to reject articles.

Authors who submit articles to *The Journal* are expected to do so in good faith and are solely responsible for the content therein, including the accuracy of all information and correct attribution for quotations and citations.

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ON THE COVER: An image of explosive ordnance contamination on the streets of Kharkiv, Ukraine in November 2022, edited as if it is being viewed with computer vision.
Courtesy of Fondation suisse de déminage, FSD/edited by CISR.

COMING FALL 2023

*See detailed topics at www.jmu.edu/cisr/journal/cfps.shtml

- Ukraine
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- Gender and Age in CWD
- History of SA/LW & PSSM: Lessons Learned and the Way Forward
- Legal Considerations for Remote Sensing and Artificial Intelligence in HMA
- Explosive Hazards Clearance and Debris Disposal
- The Blurred Line of Humanitarian Aid in Conflict Settings
- Munitions Destruction: Techniques and Equipment
- Linking Explosive Hazards Clearance and Industry
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A MESSAGE FROM THE DIRECTOR

It has been a busy time here, with CISR hosting leadership from the Young African Leadership Initiative (YALI); a delegation of Ukrainian mine action personnel who met with JMU faculty, CISR staff, and representatives from Washington, D.C.-based mine action organizations as part of the Open World program sponsored by the U.S. Congress;; Aleena Inthaly of Legacies of War and former U.S. Ambassador to Laos, Douglas Hartwick, who presented to JMU students on Laos and its deadly unexploded ordnance (UXO) contamination; Colin King and Leon Harris of Fenix Insight Ltd, who provided a demonstration of Fenix Insight Online; and Giles Duley, documentary photographer and improvised explosive device (IED) survivor who presented to the JMU community, and whose visit coincided with CISR's recent discussions on how we can draw attention to global conflict while sharing the stories of those who have experienced trauma respectfully and with dignity. Through our programs and publications, we continually strive to learn from our partners.

With this in mind, we greatly appreciate the information shared by our most recent contributors in this issue of *The Journal*.

- Abigail Hartley (United Nations Mine Action Service), Lionel Pechera, and Sasha Logie (Geneva International Centre for Humanitarian Demining) provide a summary of the most recent updates to the International Mine Action Standards (IMAS) including the release of one new IMAS on the management of human remains; updates to several IMAS including personal protective equipment, victim assistance, marking of explosive ordnance (EO) hazards, glossary of terms, and information management in mine action. Additionally, one new Test and Evaluation Protocol has been published and one existing Technical Note for Mine Action has been revised.
- Markus Schindler and Anthony Connell from the Fondation suisse de déminage (FSD) discuss their operations in Ukraine, highlighting FSD's work to help clear the country's vital agricultural lands of UXO and the key challenges they have encountered, while also underscoring the link between food security and mine action.
- Authors Nils Hegel and Jonathan Walsh (Mine Mark Foundation) introduce their organization and both the challenges and opportunities posed by smaller nongovernmental organizations operating in the mine action sector as well as their innovative digital explosive ordnance risk education (EORE) interactive games and the importance of tailoring EORE to specific audiences, as trialed by Mine Mark in Azerbaijan.
- In her article on environmental mainstreaming in mine action, Emily Chrystie of The HALO Trust (HALO) encourages the sector to continue to apply the *do no harm* approach to mitigate the environmental effects of clearance while also encouraging us to move beyond this, understanding the full impact of EO contamination (pre-, during, and post-conflict) to take advantage of the full remit of environmental mainstreaming in mine action.
- Hayashi Ontoku Akihito of the Japan International Cooperation Agency (JICA) discusses JICA's partnership with the Cambodia Mine Action Centre (CMAC) to promote South-South and global cooperation, an effective program that leverages a country's expertise in mine action and shares it with countries with less experience managing legacy or new contamination.
- Katherine James, Pedro Pacheco (HALO), and Gert Riemersma (Routescene) outline their work with an unmanned aerial vehicle mounted light detection and ranging (Lidar) mapping system in detecting and mapping minefields in Cuito Cuanavale, Angola. The authors also discuss the benefits of the data derived from Lidar surveys including a reduction of human bias in data analysis, potential use in training of machine learning, and building a database of country-specific minefield features.
- Author Nicholas Ross from the Social Policy Group highlights the less discussed issue of land rights in relation to mine action, identifying how the clearance of EO and release of land can lead to land disputes amongst civilians and pinpoints key strategies for mine action stakeholders to mitigate risks, curtailing the potential negative consequences of cleared land while increasing its positive impacts.
- Adam Harvey's (VFRAME) and Emile LeBrun's (Tech 4 Tracing) on a computer vision algorithm creation workflow developed to automate the detection of 9N235/9N210 cluster submunition, heavily deployed in the current war in Ukraine. The authors detail computer vision as a promising AI technology that can enhance future mine action.

As the seasons change, so too have there been changes for the editorial team at *The Journal* and *To Walk the Earth in Safety*. Steve Costner, former Deputy Director at the US Department of State's Office of Weapons Removal and Abatement recently retired after a career of thirty-three years. We are forever grateful for his support, expertise, and the time and effort he put into both publications for well over two decades. We, along with so many others, remain deeply appreciative of his commitment to our sector and wish him the very best in his retirement.

In looking ahead, I am eager to see everyone at the upcoming APMBC Intersessionals and the 26th International Meeting of Mine Action National Directors. Mine action is at the forefront of many current global issues, from active conflict in Ukraine, mine action's impact on the environment and food security, to the use of AI detection technology and the current warnings regarding its potential future use, *The Journal* is eager to hear from researchers and mine action practitioners and organizations as they actively address these issues through their programs, research, field work, and operations.

Sincerely,

Suzanne Fiederlein, PhD

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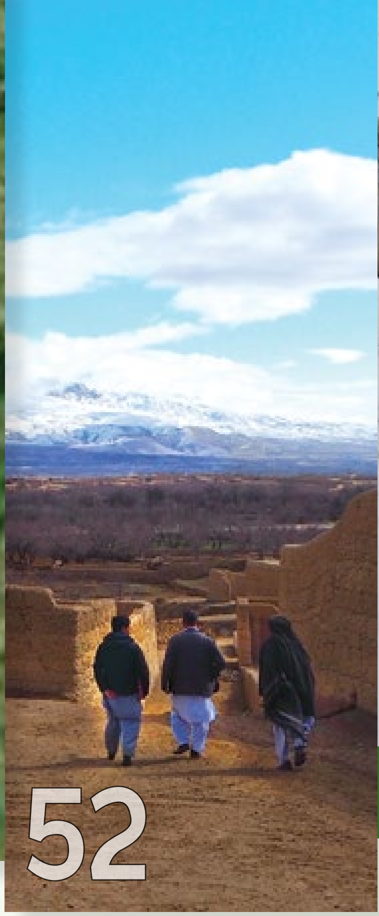

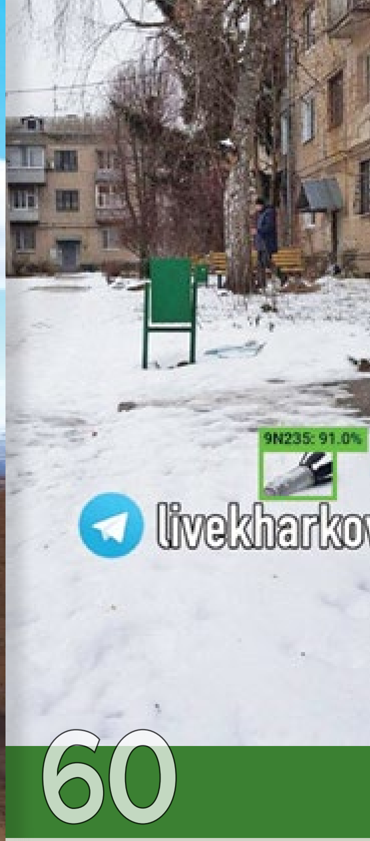

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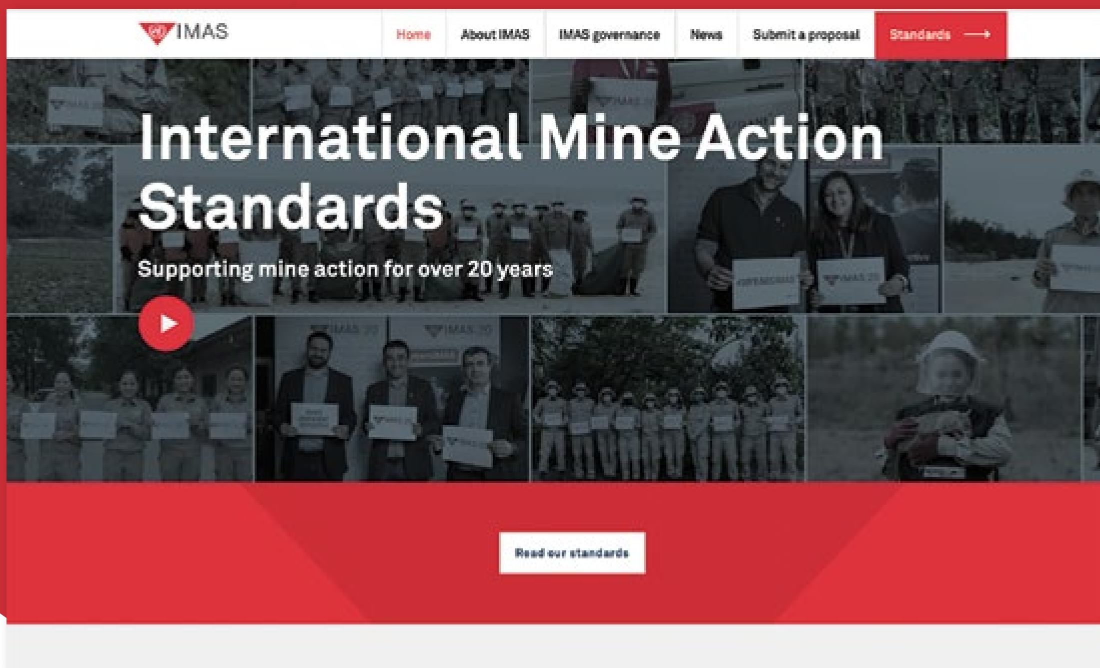
IMAS: An Overview of New and Amended Standards



Visit the IMAS website.

By Abigail Hartley [United Nations Mine Action Service], Lionel Pechera, and Sasha Logie [Geneva International Centre for Humanitarian Demining]

New and existing International Mine Action Standards (IMAS) doctrine (including standards, technical notes for mine action, and test and evaluation protocols) are developed and regularly updated to ensure that IMAS remain fit for purpose to support mine action programs in reducing the risk of explosive ordnance (EO) to affected populations. This article provides a summary of the most recent IMAS publications to enable mine action organizations and authorities to stay up to date with the latest IMAS developments.

INTRODUCTION

IMAS support mine action programs and organizations by promoting the standardization of safe and effective mine action. The IMAS Review Board (RB), with oversight from the IMAS Steering Group, reviews and revises standards on a regular basis to maintain their continued applicability. This process ensures that IMAS remain consistent with the most recent developments in mine action.

One new IMAS has been released:

- **IMAS 07.50**, ***Management of human remains in mine action***

The following documents have been revised:

- **IMAS 04.10**, ***Glossary of mine action terms, definitions and abbreviations;***
- **IMAS 05.10**, ***Information management in mine action***;
- **IMAS 06.10**, ***Management of training***;
- **IMAS 08.40**, ***Marking explosive ordnance hazards;***
- **IMAS 10.30**, ***Personal protective equipment***; and
- **IMAS 13.10**, ***Victim assistance in mine action***.

In addition, one new Test and Evaluation Protocol (T&EP) has been released, and one existing Technical Note for Mine Action (TNMA) has been revised:

- ***T&EP 07.31.02.2022, Competencies required for ADS handlers, team leaders and instructors;***
- ***TNMA 12.10.01, Risk education for improvised explosive devices.***

The publication of these documents in late 2022 to early 2023 marks the culmination of nearly two years' work by the IMAS RB and multiple technical working groups composed of subject matter experts from across the mine action sector. The updated and amended doctrine reflects broad consensus between countries affected by EO, donors, the United Nations, mine action operators, and the Geneva International Centre for Humanitarian Demining (GICHD). Gender and diversity perspectives were taken into consideration throughout the process.

This article provides a short overview of each of the IMAS documents noted and highlights the key themes that practitioners should be aware of. All documents are available on the IMAS website.[1]

A Norwegian People's Aid clearance site in Bosnia and Herzegovina, 2018.
Courtesy of Johannes Müller.

GICHD Francophone Regional Cooperation Program Workshop at CPADD.
Courtesy of GICHD.

NEW INTERNATIONAL MINE ACTION STANDARDS

IMAS 07.50, Management of human remains in mine action

Following requests for better guidance from mine action operators, the new IMAS 07.50 provides national mine action authorities and mine action organizations with guidance for the management of human remains in EO-contaminated contexts. While the standard recognizes that managing human remains is beyond the remit of mine action, it emphasizes that the sector has a responsibility to help ensure that the dignity of the deceased is preserved, and that human remains can be recovered and identified by the relevant authorities and agencies.

The standard provides minimum requirements to situations where human remains may be encountered in two scenarios: Firstly, when human remains are likely to be found, or are found incidentally during mine action operations, and secondly, when mine action support is requested to assist interventions for the recovery of human remains.

IMAS 07.50 stipulates that mine action organizations have the possibility to refuse requests to provide mine action support, based on context and circumstances.

In light of this new chapter, a technical working group formed by the IMAS RB is reviewing the TNMA 10.10/01 *Guidelines on the management of human remains located during mine action operations*.

IMAS 04.10, Glossary of mine action terms: definitions and abbreviations

Terminology is essential to standardization. Using a commonly understood language facilitates mutual understanding and ways of working among mine action stakeholders.

The revision of IMAS 04.10 includes the addition of a new annex which provides guidance for the management of terminology in IMAS to ensure that mine action terms and definitions that are entered, deleted, or amended throughout the IMAS framework are managed in a consistent and standardized manner.

The guidance also provides a useful framework for national authorities in the management of terminology within national mine action standards (NMAS), including where mine action terms are translated from English into other languages.

IMAS 05.10, Information management in mine action

IMAS 05.10 has been amended to include definitions of the beneficiaries of mine action interventions. Much of the content of this amendment derives from the existing guidelines on *Standardising Beneficiary Defi itions in Humanitarian Mine Action,* published by a group of mine action international nongovernmental organizations (INGOs), which are already being applied by many mine action organizations.

Annex B of IMAS 05.10, which addresses minimum data requirements in mine action, has been amended to incorporate the definitions of direct, and in some instances indirect, beneficiaries of:

- explosive ordnance risk education (EORE);
- land release;
- explosive ordnance disposal (EOD) spot task; and
- victim assistance (VA) (consistent with the also amended IMAS 13:10).

IMAS 06.10, Management of training

IMAS 06.10 addresses training provisions which are essential to the safety, effectiveness, and efficiency of mine action.

The revised document focuses on training where the degree of achievement of learning is formally assessed and documented. This focus aims to guarantee the quality and recognition of competencies acquired by the trainees.

The content is structured according to a management cycle comprising six steps and starting with the analysis of training needs. The new edition is aligned with quality and risk management as described in IMAS 07.12 and IMAS 07.14. The combination of requirements for the management of training and competency standards aims to reinforce the safety and efficiency of mine action.

IMAS 08.40, Marking explosive ordnance hazards

IMAS 08.40, formerly known as “marking mine and explosive remnants of war hazards,” has been revised and published in its third version.

In contrast to the previous edition, which was centered on the type of marking or physical barrier (permanent versus temporary), the current edition focuses on marking efficacy. It also recognizes the difficulties associated with marking hazardous sites.

In accordance with relevant IMAS chapters, it strengthens the link between marking, risk management, and quality management. It handles issues such as long-term monitoring to safeguard the efficacy of marking over time.

The strategy for community engagement was also revised. While the previous edition addressed the population's responsibility to preserve existing markings, the revised version emphasizes the importance of liaising with the population at an earlier stage to enable effective marking. In accordance with IMAS 12.10 on EORE, a section on the relationship between EORE, community liaison, and the general population regarding marking has been added.

This third edition specifies further the obligations of national mine action authorities and mine action organizations. The description of tasks aims to ensure the long-term monitoring and maintenance of marking, which has been identified as a problem in multiple countries.

A mine sign in Ukraine captured during a GICHD workshop in 2022.
Courtesy of GICHD.

The standard also includes guidelines for ensuring contaminated buildings are properly identified.

Finally, this new IMAS 08.40 features modified terminology. The terms "danger sign" and "mine sign" were replaced by "explosive ordnance sign," and the term "explosive ordnance marking" was substituted for the terms "marking," "marking system," and "hazard marking system."

IMAS 10.30, Personal protective equipment

The RB reviewed IMAS 10.30, as it had not been reviewed since 2013. The review led to minor amendments to the existing standard. The new version also removed the requirement for ballistic boots to better align the IMAS with the experience of mine action operators on the ground.

IMAS 13.10, Victim assistance in mine action

Although victim assistance (VA) is the responsibility of the government of an EO-affected state, this standard describes the specifi roles and responsibilities of the mine action sector in supporting VA.

The standard describes the roles and responsibilities of national mine action authorities and national mine action centers working in support of relevant government entities charged with coordinating and providing VA to meet the needs and address the rights of victims. It also identifies the roles of mine action operators, as well as the United Nations and survivor organizations, in support of these efforts.

A key point is that the document distinguishes between "specific efforts," which are efforts undertaken by the mine action sector to contribute to facilitating access to VA services, and "broader efforts," which are undertaken by sectors other than the mine action sector, including delivery of VA services, data collection, coordination, laws, and policies.

The terms and definitions in section three were revised and new terms were introduced. Modified defi itions include "victim assistance," "victim," "direct victim," "survivor," "indirect victim," and "EO survivor organisation."

A new annex was added to clarify the use of the terms "survivor" and "victim."

NEW TEST AND EVALUATION PROTOCOL

T&EP 07.31.02.2022, Competencies required for animal detection system (ADS) handlers, team leaders and instructors

This new T&EP has been developed to provide information on the competencies required to qualify ADS handlers, team leaders, and instructors for their work. This T&EP builds on experience within and outside the mine action sector to define a set of 115 required skills or competencies that personnel must possess to be considered IMAS-compliant ADS handlers and ADS instructors.

This T&EP provides guidance on required competencies for ADS handlers, team leaders, and instructors. It identifies the skills required and recognizes competency gained from operational ADS work.

This T&EP complements EOD and improvised explosive device disposal (IEDD) competency standards. Additional competency standards in demining, mechanical, and non-technical survey are currently being developed.

A mine detection dog in the Norwegian People's Aid clearance site in Bosnia and Herzegovina.
Courtesy of Johannes Müller.

REVISED TECHNICAL NOTE FOR MINE ACTION

TNMA 12.10.01, Risk education for improvised explosive devices

This TNMA is concerned with the provision of risk education for improvised explosive devices (IED RE) to the local population in affected countries. It is intended to provide guidance on specific factors to be considered when designing, planning, and conducting IED RE. It is complementary to the general principles and guidance set out in IMAS 12.10 on EORE, which was used as guidance to address the particular factors that may be present in places where IEDs threaten communities.

In addition, the TNMA contains recommendations for the design of messaging and supporting materials for IED RE. Building on the principles established for risk management in IMAS 07.14, the TNMA also provides guidance on the management of specific risks to the intended beneficiaries, EORE teams and operators, and its annexes propose tools to support the management of these risks.

While it is not primarily intended for the provision of safety and security training to the staff of humanitarian organizations, some of the principles set out in this TNMA may be of use to organizations operating in IED-threat environments wishing to provide appropriate advice to their own personnel.

FUTURE DEVELOPMENTS IN IMAS

The IMAS RB will continue to review and revise IMAS over the course of 2023 and 2024 to ensure they remain fit-for-purpose. The IMAS RB workplan includes revisions to IMAS related to mechanical demining, occupational safety and health, and environmental management in mine action and allows for the development of new doctrine, including T&EPs on deminer, non-technical survey and mechanical competencies, cluster munition remnant survey, and the measurement and reporting of beneficiaries.

The IMAS RB workplan, which contains the list of outputs and timelines, is available on the IMAS website. You can also sign up to receive email alerts when a new or revised IMAS is released by clicking on the 'sign up now' link on the website homepage.

See endnotes page 69

ABIGAIL HARTLEY
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Abigail Hartley is the Chief of the Policy, Advocacy, Donor Relations, and Outreach at the United Nations Mine Action Service (UNMAS) and the IMAS Review Board Chair, with over twenty years of experience in the mine action and humanitarian sectors. She joined the UNMAS program as a Senior Programme Officer and thereafter held posts of Chief of Staff and Programme Manager overseeing policy, political, legal, humanitarian, social, and economic aspects of the program. Her responsibilities include the leadership of the Inter-Agency Coordination Group on Mine Action, development of mine action policy, monitoring of the UNMAS Strategy 2019–2023, and advocacy in support of mine-related international legal instruments. She spent almost six years with UNMAS in Afghanistan, and also worked for many years with Mines Advisory Group (MAG) globally but primarily in South Sudan, Sri Lanka, and Sudan. Ms. Hartley is a graduate of the Universities of Newcastle-upon-Tyne and Bradford and holds a Master's in International Politics and Security Studies.

LIONEL PECHERA
Advisor on Mine Action Standards
Geneva International Centre for Humanitarian Demining (GICHD)

Lionel Pechera has worked at the Geneva International Centre for Humanitarian Demining (GICHD) as an Advisor on mine action standards since December 2021. In this role, he has coordinated several IMAS technical working groups leading to the creation or revision of IMAS documents. He also supports training on IMAS and the development of national mine action standards. Mr. Pechera previously worked with the United Nations Mine Action Service in Mali and Nigeria as a project manager and program coordinator. Prior to that, he served as a combat engineer officer in the French military for two decades, deploying to Central Asia, East Africa, and South America, and supporting the development of standards for the North Atlantic Treaty Organization. He holds a Master's in International Affairs, Ecole Spéciale Militaire de Saint-Cyr.

SASHA LOGIE
IMAS Secretary
Geneva International Centre for Humanitarian Demining (GICHD)

Sasha Logie is currently the IMAS Secretary to the IMAS Review Board and IMAS Steering Group. As the IMAS Secretary, his responsibilities include the coordination and management of the process through which the IMAS framework is maintained and developed, a function which is implemented in close coordination with the United Nations Mine Action Service (UNMAS) and the wider IMAS Steering Group and Review Board. Mr. Logie previously worked with the United Nations Mine Action Service as a Senior Programme Officer in South Sudan, and later as the head of the UNMAS Palestine Programme. He has also worked with the United Nations Office for Project Services and the British Government on issues related to environmental programs. His academic background includes a Master's in International Politics from the University of London.

MINE ACTION AND FOOD SECURITY:

The Complexities of Clearing Ukraine's Agricultural Lands

Non-technical survey in Chernihiv, 2023.
All images courtesy of FSD.

By Markus Schindler and Anthony Connell [Fondation suisse de déminage, FSD]

Over the past decade, peace has eluded Ukraine. The annexation of Crimea and a separatist insurgency—sufficiently concerning in their own right—proved to be a mere prelude to Russia's full-scale invasion of Ukraine in February 2022. The largest land-war that Europe has seen since the Second World War is causing immense human suffering, devastating destruction, and extensive explosive remnants of war (ERW) contamination. Mines, submunitions, and unexploded ordnance (UXO) continue to cost the lives of countless civilians and the death toll is rising by the day. Mine action organizations such as Fondation suisse de déminage (FSD) are working in Ukraine to clear these hazardous remnants of war and to prevent and mitigate their impact on Ukraine's people and infrastructure. This article provides an overview of FSD's operations in Ukraine, both prior to and during the war. It particularly emphasizes FSD's work to clear Ukraine's vital agricultural areas, highlighting the intricate link between mine action and food security. The article also underscores some of the key challenges that FSD has encountered while working in war-torn Ukraine.

A handwritten sign indicates the presence of a mine under this box, Andryivka, November 2022.

BRIEF HISTORY OF CONTAMINATION

Like many other European countries, Ukraine has been grappling with ERW dating back to World War II. However, this "legacy" contamination pales in comparison to the explosive ordnance (EO) left behind during various phases of armed conflict that started in 2014 and culminated in the invasion of Ukraine by neighboring country Russia. Today, towns, agricultural lands, and seaways across Ukraine are littered with a wide range—and enormous quantity—of ERW, including anti-personnel and anti-vehicle mines, sea mines, large amounts of cluster munitions, thermobaric weapons, and other unexploded or abandoned ammunition, with the highest concentration found in the eastern and southern parts of the country.[1] These explosive hazards present a high risk to the lives and limbs of civilians—a risk that, all too often, turns into grim reality.

Contamination in Kharkiv, November 2022.

FSD IN UKRAINE BEFORE THE WAR

FSD has been involved in Ukraine since early 2015, specifically in the Donbas region along the line of contact separating the Ukrainian government-controlled area and the separatist-controlled area. At first, FSD's teams focused on emergency risk education campaigns, aiming to significantly reduce civilian casualties. This was achieved by teaching the conflict-affected population to live with the presence of mines and UXO until the surrounding land could be cleared. Subsequently, FSD's survey teams began assessing the ERW contamination in eastern Ukraine. In 2016, around fifty local staff were recruited, trained, and deployed from operational bases in Sloviansk and Mariupol to begin demining work. Over the next few years, these teams investigated numerous former battlefields, successfully locating hundreds of UXO. Additionally, FSD provided support to Ukrainian institutions to establish a national mine action authority.[2]

During the armed conflict in Ukraine, FSD faced a challenge in accessing affected populations in the nongovernment-controlled area (NGCA) in the country's far east. To mitigate

FSD teams marking EO in eastern Ukraine, November 2022.

the risk of accidents with ERW, FSD utilized two methods for explosive ordnance risk education (EORE). The first involved direct contact with people from the NGCA at checkpoints located along the contact line, while the second approach employed a digital campaign through various social media platforms. FSD reached over 367,988 adults and 78,433 children in the NGCA with EORE messages from 2020 until 2022. Due to the outbreak of war and international sanctions, digital EORE in the NGCA became infeasible. However, FSD continues its digital EORE campaign in Ukraine's government-controlled area through social media platforms such as Instagram, particularly targeting users under the age of eighteen in newly reclaimed and conflict-affected areas.

FSD conducting EORE for school children in Kramatorsk, June 2021.

FSD'S REACTION TO THE WAR

FSD responded promptly to the unexpected and forceful Russian invasion of Ukraine by taking measures to safeguard its staff and activities. Despite being caught off guard by the scope, rapidity, and intensity of the invasion, FSD quickly evacuated crucial equipment from Mariupol to Sloviansk and ceased all field operations and travel outside of these two locations for a period of two weeks. To offer its Mariupol-based personnel flexibility, FSD gave its eighteen employees there the choice to remain in place or leave, which some did while others stayed. As telephone networks were progressively shut down and the city's electrical supply was curtailed, communication with the remaining Mariupol staff became increasingly challenging. Tragically, one FSD staff member was killed in his hometown of Mariupol during the intense assault on the city. FSD's office suffered significant damage and two pickups that FSD had left in Mariupol, in anticipation of the possibility of staff needing to relocate, were lost.

Responding to the enormous need in the immediate aftermath of the onset of war, FSD shifted its focus from mine action to humanitarian assistance, particularly targeting people evacuating from the Donbas area and internally displaced persons (IDPs) in evacuation centers. Additionally, FSD continued its EORE outreach. While face-to-face sessions were difficult to conduct, FSD published material on various social media platforms.

In addition to adapting its operations to the changing circumstances, FSD also coordinated with national authorities and donors to ensure a seamless transition. FSD's donors displayed extraordinary levels of flexibility and support, and FSD's accounting team reduced much of the routine requests during these trying months, which proved helpful in streamlining processes and coping with sudden changes. The Sloviansk office was eventually fully evacuated as the war progressed, but FSD was able to stay in country, continue its work, and adapt to the new realities of the conflict.

Destroyed playground in Chernihiv, 2022.

RETURN TO OPERATIONS

By mid-2022, the situation in Ukraine had stabilized enough for FSD to return to its pre-war operations. FSD still had existing funding, and funds that were put on hold at the start of the war were allowed to flow once again. FSD's donors agreed to shorten existing funding timeframes to allow for a significantly expanded new project, reflecting the vastly increased need following Russia's invasion of Ukraine. New donors approached FSD, offering to fund additional teams. Thanks to the support and flexibility of FSD's old and new donors, the new project had funding for seven battle area clearance (BAC) teams, one mechanical team using a Dok-Ing MV-4 ground preparation machine, two rubble removal teams (each rubble removal team consisting of an armored excavator, an armored front-end loader, and a tipper truck), three non-technical survey (NTS) teams, and three risk education teams. Most of these teams, as well as FSD's support teams, are staffed with both women and men.

An FSD investigator records the specific condition of a localized explosive device, April 2022.

EXPANSION OF OPERATIONS AND TEAM

Due to shortages in funding in the pre-war period, as well as losses in the early stages of the war, FSD had reduced equipment and was forced to restart with the procurement process—a major task considering that FSD's operations and staff numbers were increasing significantly. Of the more than fifty staff that were with FSD before the war, twenty-four continued to work with or returned to FSD, including many senior staff members in both operational and support roles. As a result, FSD was able to set up a new country office and restart operations in a relatively short timeframe, while continuously recruiting and training new staff.

Deminer inspecting a building in Chernihiv, September 2022.

Years of local experience have taught FSD that the onset of winter in Ukraine can be sudden and harsh, so restarting operations as soon as possible was crucially important. By mid-August 2022 and with the war in full swing, FSD teams were on the ground delivering EORE, conducting NTS, and working on explosive ordnance disposal (EOD) spot tasks—all while continuing to recruit and train new staff; and, slowly, the required equipment continued to trickle in.

After re-locating FSD's office from eastern Ukraine to Chernihiv, an embattled but reclaimed area north of Kyiv, FSD's teams engaged in rapid response spot tasks due to the large amount of surface contamination.[3] From there, FSD's teams deployed further east to Izium in Kharkiv Oblast. The city saw heavy fighting during 2022 but was eventually liberated by Ukrainian forces. The picture that presented itself to FSD's teams in Izium was grim: The large-scale destruction, obliterated villages, and cratered streets, littered with burned out military and civilian vehicles, was reminiscent of images from the Second World War. Over 70 percent of multi-story buildings in Izium were devastated, alongside the destruction of over 80 percent of infrastructure, including the centralized heat supply system.[4] FSD staff cleared numerous destroyed military vehicles, cars, hospitals, and schools. In the span of less than four weeks FSD's teams were able to mark, move, or clear 542 items of EO.

PFM-1 anti-personnel mine (otherwise known as a butterfly mine) next to a road in Kharkiv Oblast.

By the end of October 2022, the fighting in most other areas of Kharkiv Oblast had stopped and the Ukrainian forces had liberated the area. FSD immediately sent two EOD spot task teams, a risk education team, and an NTS team into Kharkiv Oblast to utilize the last operational month before the onset of winter.

During the winter stand-down, the Geneva International Centre for Humanitarian Demining (GICHD) organized a donor conference that allowed the Ukrainian authorities to elaborate on their country's most pressing needs. The conference succeeded in highlighting Ukraine's mine action priorities, and in garnering additional donor support. FSD has since re-activated a standby agreement with the World Food Programme (WFP) that saw FSD collaborate with WFP in the early 2000s.[5]

Field operations resumed once the harsh winter conditions relented in mid-March 2023. By then, FSD's donors, content with FSD's operations in 2022, made available additional funding for another twelve months, which required FSD to expand once again. By the start of field operations in 2023, FSD's team had grown from seven to thirteen internationals, and from ninety-five to about 170 national staff.

IMPORTANCE OF UKRAINE'S AGRICULTURAL SECTOR

Contaminated agricultural fields around Chernihiv, April 2023.

Ukraine is often considered one of the world's great "bread baskets"—the country of 41 million inhabitants produces enough food to nourish 400 million people around the globe, making it one of the world's largest exporters of agricultural products.[6] Ukraine's significance to global food security is indisputable: The country has vast arable land, fertile soil, favorable climate conditions, and a highly skilled agricultural workforce, which has enabled it to become a major player in the global agricultural market. Ukraine is the world's largest exporter of sunflower oil and one of the leading exporters of corn, wheat, and barley. The country's agricultural products are exported to markets in Asia, Africa, Europe, and the Middle East, contributing to global food security by providing a reliable source of affordable and high-quality food products. However, years of insurgency and warfare, and the resulting contamination with EO, have severely hampered Ukraine's ability to maintain previous levels of agricultural production and global distribution. This is felt in many parts of the world, particularly in regions reliant on food imports to meet domestic production, such as many countries in North Africa and the Middle East.[7]

FSD's operations in Ukraine, particularly the clearance of agricultural lands, impact all three sectors of the humanitarian-development-peace nexus (commonly referred to in the mine action sector as the "triple nexus").[8]

Humanitarian. Mine action is a critical component of humanitarian work in Ukraine. The presence of mines, UXO, and other ERW in the country has led to countless deaths and injuries, with civilians, in particular, being at risk. Local officials have reported numerous EO accidents with farm workers that resulted in deaths and injuries, and media reports bring to light the highly dangerous practice of desperate farmers who remove mines and UXO from their land without any training or proper equipment.[9] The professional clearance of mines and other explosive hazards therefore not only saves lives but also helps to create safer communities, enabling people to return to their homes and rebuild their lives. EORE campaigns provide people with the knowledge and tools necessary to protect themselves and their families from explosive hazards, which contributes to the protection of human rights, including the right to life, liberty, and security of person.

Development. Years of insurgency and warfare, and the resulting contamination with EO, have severely hampered Ukraine's development.[10] By clearing contaminated agricultural land, FSD and other mine action organizations in Ukraine seek to enable farmers to return to their work and to cultivate their crops, ultimately aiming to stimulate economic and human development on the local level and contribute to Ukraine's recovery. EO clearance thereby plays an important role in linking short-term humanitarian relief with medium-term rehabilitation and sustainable long-term development.

Non-technical survey in Chernihiv, 2022.

Peace and Security. Econometric research shows strong evidence of a positive correlation between increases in food prices and the probability of protests, riots, or social unrest.[11] By clearing Ukraine's vital agricultural land, FSD and other mine action actors are not only helping Ukraine to meet the increasing demand for food and ensuring food security in many parts of the world; FSD's clearance of Ukrainian farmland is also making an important contribution to peace and stability in regions far beyond Ukraine's borders.

Triple Nexus. The contamination of Ukraine's agricultural land is an explicit indicator that mine action increasingly sits across the three sectors of humanitarian, development, and peace and security efforts. FSD's long-term strategy has clearly realized these linkages and encourages the integration of mine action in the wider triple nexus programming. The organization recognizes that durable peace and sustainable development cannot be achieved if the natural resources sustaining livelihoods and ecosystem services are damaged, degraded, or destroyed. On the contrary, environmental protection and the sustainable management of resources are important pathways to consolidate peace and promote longer-term development.

Ammunition on a farm in Kukashivka, Chernihiv, July 2022.

Environment. FSD recognizes that the presence of ERW and other pollutants has a direct and long-term impact on the environment. To address this issue, FSD is promoting the integration of its mine action activities with environmental land remediation and protection efforts. Consequently, FSD's environmental activities are focused on post-clearance and/or decontamination land use, which links to socio-economic development in affected regions. This approach aims to support the rehabilitation of communities, enhance food security, and build climate change resilience, particularly for vulnerable and poor populations.

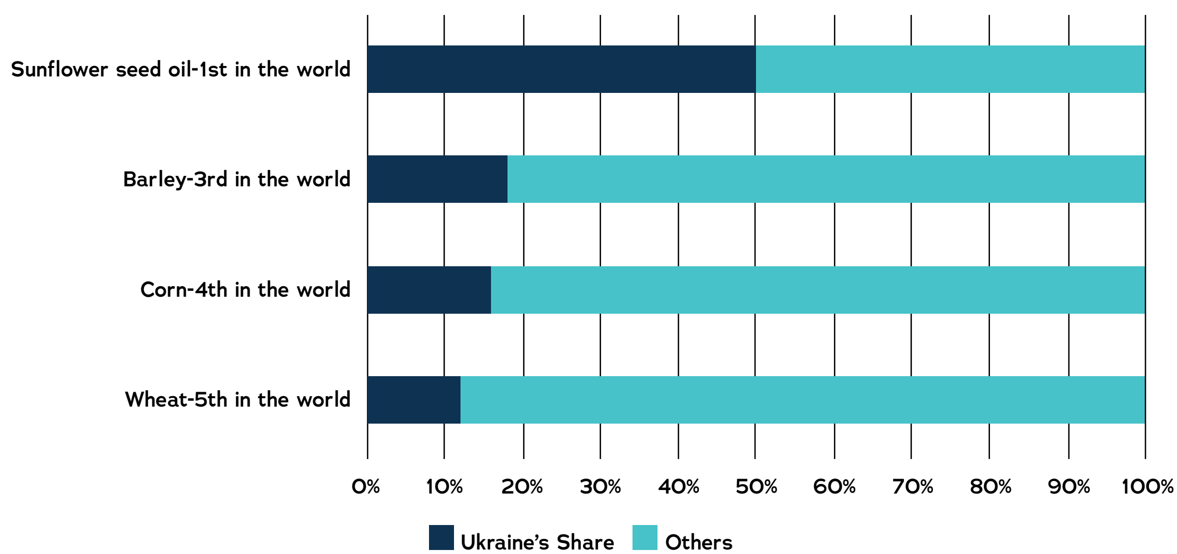

Figure 1. Ukraine's share of the global exports and worldwide ranking before the Russian invasion.
Sources: European Commission, FAO (Food and Agriculture Organization of the United Nations), International Grains Council, Ministry of Agrarian Policy and Food of Ukraine. Council of the EU and European Council, "Infographic - How the Russian invasion of Ukraine has further aggravated the global food crisis," Council of the EU and European Council, 2 December 2022, accessed 10 April 2023, https://bit.ly/41A9IMJ.

CLEARANCE OF AGRICULTURAL LANDS

As shown in Figure 1, the clearance of ERW from agricultural land is essential for local recovery, national development, and global food security. It allows farmers to return to their fields and plant crops without fear of injury or death, thereby reclaiming arable land for food production—ample reasons for FSD to make the clearance of Ukraine's agricultural land a priority. To do so, FSD has acquired a remote-controlled Dok-Ing MV-4 mechanical clearance asset and a larger MV-10 clearance machine, both with flails and tillers, and is planning to import more demining machines of similar size. Having received the required accreditation from the Ukrainian authorities, FSD has since deployed its machines and commenced with the mechanical clearance of Ukraine's agricultural lands.

FSD recently established operations in Mykolaivska, in the southeast of Ukraine, on request of the Ukrainian Mine Action Authority. One of the country's key agricultural centers, this area was liberated by Ukrainian forces in 2022. However, resulting from offensives and counteroffensives, Mykolaivska remains heavily contaminated with EO. After conducting a reconnaissance visit, FSD dispatched two NTS teams and is preparing to deploy initial BAC teams to the region. Thanks to continued and increasing funding from various donors, FSD's clearance operations of agricultural lands in Mykolaivska continue to grow steadily.

As a result of the invasion and EO contamination, most of the liberated areas are struggling with high unemployment rates.[12] This is why FSD, wherever possible, recruits national staff from these local areas. This helps both FSD and the local population: Local staff know the area, and employing and training them helps to put money back into the local economy. However, employing local staff requires a new mobilization phase every time FSD moves to a new area, which, primarily because of the often insufficient availability of clearance equipment, can take up to three months.

FSD recognizes the potential of modern technologies, such as drones and satellite imagery, to enhance the effectiveness and safety of NTS in mine action. The use of drones equipped with high-resolution cameras and sensors allows for rapid and efficient aerial surveys of large areas, such as Ukraine's vast agricultural lands, providing valuable information on potential EO contamination, which can be used to prioritize and plan clearance operations. In addition, the use of drones can minimize the risks associated with conducting NTS in hazardous or challenging areas.

To leverage the potential of these technologies, FSD has been collaborating with "FindMine," a cooperative R&D project between a Swiss foundation and various Swiss and German universities that has developed an unmanned aerial vehicle (UAV)-based sensor system for mine detection.[13] The discussions aim to identify and explore the latest developments in the use of drones for mine action, as well as to identify best practices and lessons learned from previous applications. With the right technologies and partnerships, FSD hopes to improve its NTS capability and reduce the risks associated with mine action activities.

Non-technical survey in Chernihiv, March 2023.

ONGOING CHALLENGES

Specialized Doking MV-4 makes it possible to speed up mine clearance.

Equipment. When FSD resumed operations in mid-2022, the organization was facing a significant scarcity of the required equipment such as vehicles, trailers, personal protective equipment (PPE), and metal detectors. Despite this, FSD managed to be fully equipped by the end of November 2022. However, the ongoing expansion of operations means that equipment used for training of new staff cannot be deployed with the new teams until it is replaced, which results in delays. A variety of factors contribute to the slow arrival of additional equipment. The high demand for metal detectors and PPE for operations in Ukraine has resulted in a global shortage. Moreover, customs procedures at Ukraine's border often take significant time, particularly for potential "dual-purpose" items such as metal detectors. Compounding these challenges, international logistics companies currently do not deliver to Ukraine, so ordered equipment must be collected in a neighboring country by Ukrainian logistics companies or directly by FSD and transported to Ukraine.

Accreditation. Ukraine had already formulated national mine action standards (NMAS) before the war. However, the writers of Ukraine's NMAS had not foreseen the unimaginable levels of EO contamination that the country is facing as a result of the Russian invasion, and consequently the document series needed to be rewritten and expanded. FSD supported the Ukrainian authorities during this crucial process, helping to develop important capacities for accreditation processes. FSD's subsequent re-accreditation process was successful, permitting FSD to continue mine action operations in Ukraine for the next five years. However, the accreditation left out several core clearance capacities as more work needed to be done to add key NMAS documents on mine detection dogs (MDD), EOD spot tasks, and others. NMAS and accreditations for these vital work areas will allow FSD to increase the impact of its operations, for example by conducting much-needed spot tasks of surface contamination.

Security. The initial Russian invasion was followed by retreats and successful Ukrainian counter-offensives. As a result, many of Ukraine's contaminated areas lie far in the rear of the current front lines. Humanitarian mine action operations in Ukraine are therefore relatively safe from the ongoing fighting in the east of the country. Nevertheless, missile attacks and indirect fire continue to pose a threat to humanitarian workers and the Ukrainian population, and many roads in the areas in which FSD works are suspected of being contaminated with ERW and require careful checking.

Explosive ordnance training in Chernihiv, October 2022.

CONCLUSION

The agricultural lands of Ukraine—Europe's second largest country after Russia—are enormous in scale, stretching over thousands of square kilometers. With the war still raging and mine action operations still in the process of expanding and adjusting to the new realities, it appears that, at the current stage, BAC alone is insufficient to achieve rapid successes in addressing the most urgent clearance needs, particularly with respect to Ukraine's agricultural lands and key infrastructure. Given the enormous contamination Ukraine is facing, the publication of key NMAS documents and a swift accreditation process for the use of MDDs, high risk search, and spot tasks, among others, will be an important step. This will allow FSD teams and other mine action organizations to ensure the maximum impact for the people of Ukraine.

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BAC teams inspecting a field in Chernihiv, September 2022.

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Project Manager
Foundation suisse de déminage

Markus Schindler is currently a Project Manager for Fondation suisse de déminage (FSD) in Iraq, where he is leading a capacity development project that aims to build the professional competence of a local mine action NGO. His experience spans nine years working with FSD in various roles spread across multiple countries, including Afghanistan, Iraq, Tajikistan, Ukraine, and the Philippines. Mr. Schindler holds a Master's in Strategic Studies from University College Cork, a Master's in Social Science and Ethics from Ruhr University Bochum, and a Bachelor's in Philosophy from the University of Regensburg.

ANTHONY CONNELL
Country Director, Ukraine
Foundation suisse de déminage

Anthony Connell is a citizen of New Zealand who served in the NZ Army for twenty-four years. He is currently the FSD Country Director in Ukraine. Mr. Connell started his mine action work in 2000 with ELS in Northern Iraq and has worked in Albania (twice), Sudan, Switzerland, Denmark, Angola, Syria/Turkey, Ukraine, and Colombia. He began working with FSD in Ukraine in 2016 and, aside from a brief sabbatical in Colombia (2019–2020), has remained in Ukraine since then.

MINE MARK DIGITAL EORE: Being Innovative as a Small NGO in the Mine Action Sector

By Nils Hegel and Jonathan Walsh [Mine Mark Foundation]

The Mine Mark GAME home screen.
Courtesy of Mine Mark Foundation..

Children account for approximately one-third of all civilian casualties caused by unexploded ordnance (UXO), yet explosive ordnance risk education (EORE) for young people is often outdated, dry, or too technical.[1] In this article, the Mine Mark Foundation outlines the promising potential for digital EORE, the challenges and opportunities faced by smaller nongovernmental organizations (NGOs), and the benefits they can offer the global mine action community.

INTRODUCTION

Running a small NGO in a field where access to funding is as competitive as mine action is both the main challenge and the driving force behind the Mine Mark Foundation. Providing engaging and informative digital EORE solutions on a limited budget is difficult. However, doing so in an organization composed entirely of volunteers highlights the importance of soft skills—such as adaptability to uncertain situations, and interpersonal skills for building relationships with partner organizations—in running an NGO.

Mine Mark was first conceived by Nils Hegel and Lala van der Kolk in 2018 to provide physical, game-based activities for children living in areas afflicted by landmines and explosive remnants of war (ERW) left behind by conflict. It has functioned as a grassroots movement as much as it has as an NGO over its lifetime. Securing the necessary funding, volunteers, expert insights, and support has required the ability to create interest and build relationships with a variety of local and national academic, political, and civil society actors.

From Fenix Insight's EORE Card Game[2] for Ukraine to Mine Mark's Gaming Application for Mine Education (GAME), mine action organizations have found ways to respond innovatively to the needs of communities globally. As Mine Mark operates with a small team with minimal operating costs, conflicting priorities, and affiliations, we have found ways of fostering cooperation with community-based partners and schools and achieving shared success through a flexible, collaborative approach. Engagement in publications such as *The Journal of Conventional Weapons Destruction* and gatherings held by mine action organizations such as the Geneva International Centre for Humanitarian Demining (GICHD) Innovation Conference play an important role in fostering this collaboration; creating a platform where successes and challenges encountered in various contexts with different approaches can be shared.

Fenix-Insight Ltd.'s EORE card game.
Courtesy of Fenix Insight Ltd.

The first iteration of the interactive risk education game that Mine Mark Foundation created required game collaboration among designers, child psychologists, teachers, and mine action specialists to ensure a quality product that would promote behavioral change. Mine Mark considers children's mine risk education a complicated and multi-faceted problem. Developing a perspective on the balance between how informative and engaging the product is and what is considered "child appropriate" when the risks are so high, has required close collaboration between these experts, and an iterative field-testing approach.

PAPER-BASED TO DIGITAL: The Evolution of the Mine Mark GAME

The Mine Mark Foundation was initiated with the creation, testing, and improvement of traditional (in this case, printed, paper-based) cartoons and games. This allowed us to learn about which content resonated most with children, and how their comprehension of mine risk awareness and safe behaviors could be sustainably increased.

To create effective and engaging educational materials, we conducted a comprehensive literature review on existing EORE standards, guidelines, organizations, and possible pilot countries. Subsequently, we consulted with EORE experts to ensure that the content was accurate and relevant to the needs of children living in areas affected by landmines and ERW. This led us to base our paper-based games and cartoons on United Nations Mine Action Service guidelines. Finally, we tested the first games and cartoons with children in Azerbaijan, Ukraine, Germany, The Netherlands, Norway, and Italy.

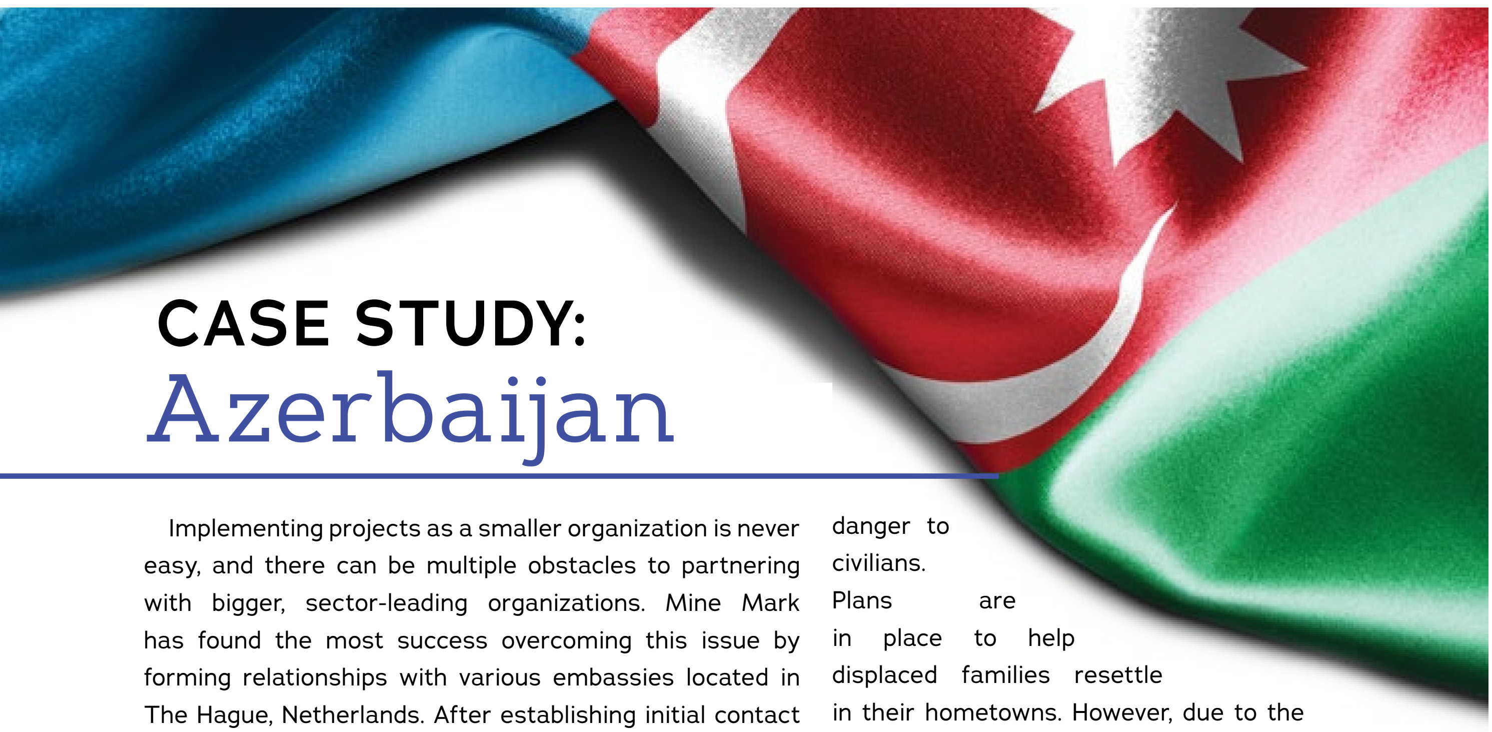
After the sessions, feedback was collected on how the children interacted with the content, how long they would keep playing, and which games they enjoyed the most. It was discovered that the age of the children heavily infl enced their interests regarding the games provided. Younger children liked playing the coloring or the find-the-memory games, whereas older children preferred playing find-the-differences and jigsaw puzzle games. Following data analysis, the games and cartoons were adapted accordingly. Subsequently, the first large-scale tests within several schools in Azerbaijan were conducted to gather more reliable and robust quantitative data to further improve the educational materials.

Since analysis of the feedback showed that the games and cartoons were successful in effectively engaging and educating the children, we decided to scale to other countries with past and ongoing conflicts. Furthermore, the focus was shifted to creating and publishing digital content to reach more children and lower costs since printing and distributing the materials was costly and resource intensive. This production and medium shift led us to create the GAME.

Creating, coding, and publishing our GAME brought challenges requiring entirely different skill sets than that of producing paper-based content. Fortunately, recruitment efforts on social media and leveraging our connections within the NGO sector in The Netherlands, as well as internationally, enabled us to onboard web developers, graphic designers, and programmers, who provided their services pro-bono.

For the first version of the GAME, it was decided to structure it into three parts: **1)** cartoons providing the necessary educational information to the children; **2)** six games to test their knowledge and to continually reinforce what they have learnt; and **3)** educational videos supplementing the learning experience in an entertaining, accessible manner. Currently, the GAME is available in four languages: Azerbaijani, Bosnian, Croatian, Serbian (BHS), Ukrainian, and English.

Digital content presents significant opportunities that are not available with paper-based content. We can tailor and update the content remotely for each country or even regions, with IOS and Android app stores enabling developers to publish games for specific countries. So far, we have not embarked on this localization strategy as it is a massive undertaking. However, we are optimistic about acquiring the necessary funding to further develop and improve the GAME, as well as create tailor-made games to account for regional differences and municipal needs.



CASE STUDY: Azerbaijan

Implementing projects as a smaller organization is never easy, and there can be multiple obstacles to partnering with bigger, sector-leading organizations. Mine Mark has found the most success overcoming this issue by forming relationships with various embassies located in The Hague, Netherlands. After establishing initial contact with the embassies, we had ongoing dialogue to discuss synergies and areas for potential collaboration. Out of those first contacts, Mine Mark chose Azerbaijan as a country to conduct its first pilot project in April 2019.

Azerbaijan has been grappling with landmine contamination for over thirty years since the Nagorno-Karabakh conflict erupted between Azerbaijan and Armenia from 1988–1994. As a result, the Armenian forces took over the Karabakh region and seven neighboring districts of Azerbaijan. Although Azerbaijan regained control of parts of Nagorno-Karabakh and surrounding areas in 2020, explosive ordnance (EO) contamination remains a distressing reminder of the war and continue to pose danger to civilians. Plans are in place to help displaced families resettle in their hometowns. However, due to the challenges of detecting and removing landmines, it could take more than ten years for the territory to be fully cleared, so EORE will be critical for Azerbaijan to facilitate this resettlement.

On its first visit to Azerbaijan, the Mine Mark team held several meetings with Azerbaijani state bodies. During these meetings, views were exchanged on issues of mutual interest and prospects for cooperation with the Azerbaijan National Agency for Mine Action, the State Committee on Diaspora's Affairs, the State Committee for Affairs of Refugees and Internally Displaced Persons, and the Azerbaijani Chapter of the International Campaign to Ban Landmines.

Image taken in front of the secondary school in Jojuq Mehjanli, 2019.
Courtesy of Mine Mark Foundation..

Mine Mark also met with internally displaced persons (IDPs) in the Masazir settlement near Baku, and Jojuq Mehjanli village in Karabakh to gain insights into the living conditions of children co-existing alongside the risks of UXO. The opportunity to engage with secondary school pupils, and to gain feedback on the effectiveness of learning materials, was invaluable for the incremental development of the game.

As for so many NGOs, the COVID-19 pandemic made it difficult to build upon our work undertaken in 2019. We addressed this challenge in Azerbaijan by hosting Training of Teachers (ToT) workshops online. This was carried out through partnerships that were established prior to the pandemic. It helped us to build a broader network, ensuring more consistent implementation of the EORE materials and a clearer feedback system that allowed teachers to inform us of what did and did not work.

In June 2022, the Mine Mark team conducted another field visit to Azerbaijan to test the recently developed GAME in several schools in the regions of Aghdam and Baku. Following the field tests, fruitful meetings were held with governments and NGOs to discuss project opportunities.

The team was also able to travel to the abandoned town of Aghdam to obtain first-hand accounts of the scale of the EO contamination, the status of Azerbaijani National Agency for Mine Action's demining efforts, and the proposed schedule for constructing vital infrastructure and relocating IDPs. The sheer extent of the contamination reinforced the team's belief that EORE is essential in safely relocating IDPs. In addition, the project implementation in Azerbaijan further demonstrated that there is an urgent need for updated EORE that is also tailored to the specific needs of each target group.

The Agdham Mosque and its representation in the Azerbaijani language version of the Mine Mark game. Drawing by Christine Ball (2018).

Courtesy of Mine Mark Foundation.

NEXT STEPS: SCALING EORE TO REACH MORE CHILDREN

One of the main issues encountered in Azerbaijan has been the disparity between different schools' access to computers needed to provide digital EORE. We are currently partnering with Computer Aid and the State Committee on Diaspora's Affairs to ensure the provision of laptops to several schools across Azerbaijan and are hoping to host more ToTs and educational sessions for schools together with the State Committee for Affairs of Refugees.

Our next milestone to reach our vision of a world where not a single child gets killed or maimed by UXO is to scale collaboration with more organizations globally to introduce the GAME in other countries that are contaminated by EO. In the medium term this includes acting upon an agreement signed in April of this year with the Bosnia and Herzegovina Mine Action Centre to provide the Bosnian language version of the game to schools, as well as laptops where they may be needed.

Over the long term, we have the capacity to translate the game into various languages, create additional content, and gather knowledge about the best practices in various cultural contexts. We will continue to seek to create long-term partnerships with donors, companies, and other organizations to make our project even more financially resilient.

CONCLUSION

The development of digital EORE for children in the form of interactive games is a crucial, impactful step in protecting children living in areas affected by landmines and ERW. As a small NGO, we have been able to create an effective and engaging tool that directly addresses the needs of the community we serve. We believe that small NGOs have an important role to play in the mine action community, as they can be more creative, responsive, and flexible in developing solutions to complex problems. For Mine Mark, the next steps are the distribution and development of additional content for the GAME, to gather structural funding, and to cooperate with other mine action organizations.

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Nils Hegel is one of the two co-founders of the Mine Mark Foundation and chose to get involved in the topic of explosive ordnance risk education after his military service where he was deployed to several conflict areas. After finishing his Bachelor of Science in international relations and Master of Science in transition management studies, Hegel currently works as a Consultant for Climate Protection in the Corporate Research & Development department of a multinational corporation.

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Jonathan Walsh met Mine Mark at the GICHD's Mine Action Technology Workshop (Innovation Conference) in 2021 and now volunteers as a Research Officer, working to identify new opportunities and sector developments. Walsh is currently enrolled in a Master of Science program in Earth Observation and has a special interest in the application of remote sensing to humanitarian and environmental problems.

ENVIRONMENTAL MAINSTREAMING IN MINE ACTION: A Case Study of Moving Beyond "Do No Harm"

By Emily Chrystie [The HALO Trust]

Interest within the mine action sector in mainstreaming environmental issues has rocketed in the past few years. The establishment of cross-sector working groups, the investigatory work of organizations such as the Conflict and Environment Observatory (CEOBS), and increased donor interest in directing funds toward environmental projects are arguably the result of broad scientific consensus on the increasingly destructive effects of anthropogenic forces on global ecosystems.

The well-established concept of *do no harm*[1] is a framework commonly applied in the broader humanitarian sector and has been put forward as directly applicable to environmental concerns within mine action.[2] The concept broadly reflects current approaches of mine action organizations to mitigate and minimize direct (negative) environmental impacts of mine clearance operations. This is reflected in the current International Mine Action Standards (IMAS) on Environmental Management[3] (under review), with its focus on avoiding environmental harm through the direct impacts of mine action activities, including through emissions, erosion, residual waste, and harm to wildlife and vegetation.

Mangrove restoration in Sri Lanka's Northern Province.
Courtesy of The HALO Trust.

This article posits that, while the *do no harm* approach remains well suited to mitigation of direct impacts of mine action activities and should continue to be applied, it is necessary to understand it as a single component within a broader framework to take full advantage of the potential for environmental mainstreaming within mine action.

WARFARE ECOLOGY

The Warfare Ecology[4,5] field of study, put forward in 2008 to address the fragmented nature of environmental research into ecological change caused by human conflict, encapsulates both natural and social (human) impacts of conflict and their reverberations over time. The approach facilitates a holistic understanding of the impacts (both positive and negative) of conflict on ecosystems and ecosystem services[6] by structuring potential impacts into a broader taxonomy. This taxonomy accounts for three distinct stages of conflict: preparations, war, and post-war activities. Each stage is understood to have corresponding impacts observable at different scales: landscape, regional, and global. Mine action activities, commonly found at the time of *post-war* and *scale of landscape*, can be understood as one product of a complex system which is inextricably linked with the ecological consequences of the entire lifecycle of war.

The growing literature on warfare ecology has seen the concept applied to environmental analyses of multiple conflicts around the world[7,8,9,10,11] and reflects a growing trend of viewing social and natural impacts of conflict as being inseparable from the broader lifecycle of war.

As noted by Ian McLean in his feature on environmental applications in demining, the ecological consequences of human absence due to contamination with explosive hazards are not necessarily negative in terms of impacts on local biodiversity.[12] Conflict-related area denial, in which human presence is limited due to the effects of conflict (whether through contamination by explosive ordnance (EO) or other factors), can relieve human pressures on struggling ecosystems. While the intent of such area denial may be conflict related, the effect can be reminiscent of *fortress conservation*, a term that is broadly understood as the forceful eviction of peoples from land in the name of conservation.

However, legal and moral imperatives aside, the focus of environmentalism in a post-conflict setting has long since moved on from the de facto fortress conservationism[13] that can in some contexts be provided by conflict-related large-scale area denial.[14] Rather, the focus has moved to ensuring sustainable reintegration of human communities into a functioning ecosystem.[15]

CASE STUDY:
MANGROVE RESTORATION IN SRI LANKA

To demonstrate the relevance of a *warfare ecology* approach to environmental mainstreaming in mine action, an example is taken from The HALO Trust's (HALO) work in Sri Lanka. In 2021, HALO sought funding for an environmental restoration project that would see 4,000 mangrove saplings planted in previously mined lagoon and coastal areas of the Jaffna Peninsula. Considered Sri Lanka's dry zone, this fragile ecosystem has come under increased ecological pressure due to the combined effects of the reverberating impact of conflict, and changes to weather patterns and sea levels resulting from climatic changes. The largest minefield on the peninsula, Muhumalai, saw dense minelaying activities by both the Sri Lankan Army and the Liberation Tigers of Tamil Elam (LTTE) for over a decade until the culmination of the war in 2009.

> **"We were [always] catching prawns under the roots of mangroves on our beach. We then cooked the prawns and enjoyed eating them on the beach too. Those mangrove forests were totally destroyed by the war."**
>
> **~Sixty-five-year-old participant of community orientation session, Jaffna Peninsula**

As contaminated land on the peninsula is cleared of explosive hazards and families return to their pre-war lands, the reverberating effects of conflict continue to affect local livelihoods. A key problem in the Northern Province is that of changes to soil salinity levels, leading to abandonment of previously fertile paddy lands that can no longer support rice crops.[16] Saltwater intrusion—the migration of seawater onto landmasses—is a key driver of soil salination in the region. Studies of salinity changes in agricultural wells on the peninsula from 1999–2020 found groundwater salinity to have increased by 1.6-fold over that period,[17] with increased groundwater salination affecting 45 percent of the peninsula.[18] Leading to the over-salination of previously fertile paddy fields, the problem of saltwater intrusion has been exacerbated by sea level rises in the region, as well as through the

A manually cleared breach lane through mangrove trees on the edge of Maruthenkerny Lagoon. Yellow marking sticks indicate the position of mines that have been found and removed.
Courtesy of E Chrystie.

destruction of coastal mangrove systems and man-made bunds and barrages designed to mitigate saltwater intrusion during the period of conflict.

Coastal vegetation, an effective, low-cost bio-shield that can mitigate the occurrence of salt-water intrusion on the peninsula through dissipation of storm surges and prevention of erosion,[19] has been further depleted by ongoing mine clearance activities, the safe clearance of complex minelines necessitating removal of significant areas of vegetation.

Applying a *do no harm* model in the Sri Lankan context requires mitigation of further damage to coastal ecosystems that may be caused by mine clearance activities, and restoration of any areas damaged through, for example, the essential use of mechanical clearance techniques. HALO's environmental project goes a step further here, however, by applying a broader understanding of the impacts of decades of EO contamination and addressing the reverberating effects of the conflict itself that continue to preclude livelihoods restoration for the beneficiaries of mine clearance activities. This was achieved by centering restoration efforts on an understanding of the pre-war ecosystem, rather than on pre-clearance ground conditions and flora.

"Conservation is not our area of expertise, but partnering with local environmental experts helped us to understand where we could direct our own resources in support of this project. Facilitating HDO to take ownership of the project precipitated local engagement, and has bought in local researchers and other stakeholders who are passionate about long-term restoration of the mangrove ecosystem."

~Iris Frakking, HALO Sri Lanka

The problems identified previously were recognized organically throughout HALO's long-standing work on the ground in Sri Lanka. In the future, as pre-clearance environmental assessments become the norm across the mine action sector, it is predicted that issues such as these will increasingly be recognized early in the land release process, facilitating donor engagement and identification of local partners and environmental experts.

A map showing a mangrove plantation site in Kilali. HALO completed clearance of this area in 2011, safely destroying 266 items of EO including anti-personnel blast mines and unexploded ordnance (UXO). Although forming part of a mangrove forest pre-war, no trees remained at the time of clearance.
Courtesy of The HALO Trust.

PROJECT SUMMARY

The project itself was initially proposed with this broader context in mind: to address the cumulative impact of EO contamination from every stage of the conflict lifecycle. In practice, this meant targeting restoration efforts not only in areas affected by mine clearance operations, but also in areas that were already free from vegetation at the time of clearance due to war-time damages.

The project was initiated on the ground in June 2022, and is due for completion by June 2023. Through HALO's partnership with a local NGO, Humanitarian Development Organisation (HDO), a local ecologist with expertise in mangrove conservation was contracted to assess the suitability of proposed project sites. Three mangrove

HALO staff accompanied by a mangrove expert conduct DGPS mapping pre-planting in the Kilali coastal area.
Courtesy of The HALO Trust.

HALO staff conduct aerial mapping of a proposed restoration site.
Courtesy of E Chrystie.

conservation experts, two of whom visited the project site in person, independently reviewed the resultant report. HALO's own geographic information system (GIS) teams assisted in accurate mapping of proposed sites, and HALO's non-technical survey (NTS) teams, benefiting from longstanding relationships with local communities, assisted in conducting stakeholder meetings to gather input from local fishermen, nearby landowners, and government officials.

HALO and HDO have since run four village-level community orientation meetings and involved local grassroots organizations including the Rural Development Society, Fisheries Society, and local youth clubs and religious committees. These meetings saw a collaboration between HALO, who delivered explosive ordnance risk education (EORE), and HDO who delivered environmental awareness sessions.

PROJECT OUTCOMES

To date, the project has seen 3,000 mangroves planted in a 6,000 sqm area, with 1,000 additional trees to be planted before the end of 2023. The long-term impact of this project on the local ecosystem and communities who rely on it will take longer to establish.

However, the model of using expert mine action personnel with different focuses—GIS, community liaison, and survey, alongside partnerships with local NGOs and environmental experts to facilitate long-term local ownership—is one that would benefit from further research and wider application in the sector.

CONCLUSION

The impacts on livelihoods caused by conflict and mine laying activities go beyond the very real risk to life and limbs posed by EO contamination. When viewed through the broader framework of warfare ecology, the applicability of projects such as the one described in this article to the core work of mine clearance organizations can be better understood. In Sri Lanka, the dense contamination of coastal areas by landmines and UXO has not only taken an enormous human toll, but has also directly exacerbated further ecosystem degradation through years of access denial that precluded replanting of coastal mangroves and rebuilding of protective bunds and barrages, further impacting post-conflict livelihoods restoration. Taking the definition of mine action as "activities which aim to reduce the social, economic and environmental impact of mines, and ERW...,"[20] it is therefore suggested that engaging with ecological damages caused at all stages of EO contamination—pre-, during, and post-conflict—is not beyond the core remit of mine action organizations.

See endnotes page 69

Clearance in Sri Lanka's Northern Province approaches a mine line within a wetland ecosystem.
Courtesy of E Chrystie.

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UXO Lao participants visiting a CMAC operations site.
Courtesy of Hayashi Ontoku Akihito.

MINE ACTION AND SOUTH-SOUTH COOPERATION: Case of JICA and CMAC

By Hayashi Ontoku Akihito [Japan International Cooperation Agency]

South-South cooperation has been pursued across various fields of international development. However, there has been a paucity of efforts to promote South-South cooperation in mine action. Japan International Cooperation Agency (JICA) and Cambodia Mine Action Centre (CMAC) have been at the forefront of expanding South-South and global cooperation by leveraging CMAC's extensive experience and expertise accumulated over its thirty years' of operation. This article delves into the motives and mechanisms behind JICA's and CMAC's joint efforts to foster this collaboration.

INTRODUCTION

Many developing countries facing severe landmine and unexploded ordnance (UXO) contamination have experienced conflict and struggle with poverty. Despite this, several countries have made efforts to strengthen their national capacity and ownership of mine action programs.

Cambodia is one such example. Having overcome the tragedy of thirty years' of conflict, Cambodia has built institutional and organizational foundations to address the landmine and UXO issue with assistance from the international community. Presently, the country actively engages in mine action with a strong sense of national ownership. Cambodia's experience is a valuable resource for the global mine action community. This first-hand knowledge acquired by one of the most heavily contaminated countries can be leveraged for resolving similar issues in other countries with mine and UXO contamination.

BACKGROUND OF JICA'S SUPPORT IN CMAC'S SOUTH-SOUTH COOPERATION

JICA has supported CMAC in a variety of ways, including supplying demining equipment and providing technical assistance. Over the past ten years, JICA has broadened its focus to include South-South/Triangular cooperation, with CMAC sharing its expertise. South-South cooperation is believed to be one example of an effective and efficient solution to the global landmine and UXO issue. By transferring expertise from countries with extensive experience to those with less experience, mine-affected countries can acquire immediate skills and knowledge without having to follow the difficult path of capacity building from scratch.

The experience and skills accumulated by CMAC have enabled this approach. CMAC has engaged in mine action since its inception under the United Nations Transitional Authority in Cambodia in 1992. Since then, CMAC has significantly developed its capacity, releasing and clearing more than 200 km^2 of contaminated land annually, and disposing of three million landmines and UXO. CMAC has strived to improve its operational efficiency by applying the concept of a "Toolbox," which employs a range of methods such as heavy machines, mine detection dogs, and different types of detectors.

HISTORY OF COOPERATION

JICA and CMAC initiated South-South cooperation with the aim of sharing Cambodia's experience with other mine-affected countries. The first program began with Colombia in 2010, followed by other countries such as Laos, Iraq, and Angola in subsequent years. More than thirty programs have been implemented with over 500 participants. A recent development is the training program for Ukraine deminers on Advance Landmine Imaging System (ALIS), a hand-held dual sensor device for detecting anti-personnel landmines.

(Above) CMAC deputy director general giving a presentation to Colombian participants.
Courtesy of CMAC.

(Below) Ukrainian deminer using ALIS during training in Cambodia.
Courtesy of Hayashi Ontoku Akihito.

Table 1. Program overview.

COLOMBIA:

- 2010–2011: 3 programs/45 participants
- 2017–2022 (second phase): 7 programs/118 participants
- 2023–2025 (third phase): TBD/TBD

LAO PDR:

- 2012–2014 (first phase): 6 programs/100 participants
- 2015–2018 (second phase): 5 programs/30 participants
- 2019–2024 (third phase): 6 programs/42 participants

ANGOLA:

- 2012–2015: 4 programs/51 participants

IRAQ:

- 2016–2020: 7 programs/175 participants

UKRAINE:

- 2023: 1 program/8 participants

A UNIQUE APPROACH TO ADDRESSING CONTAMINATION

There are several notable characteristics of the programs implemented under the cooperation.

Comprehensiveness. More specifically, programs are divided into three categories according to their target and theme. The first category focuses on the institutional and organizational development of the mine action program in Cambodia, offering government policymakers, and mine action authorities and centers, a comprehensive understanding of the long-term strategy for developing their mine action program. The second category focuses on sharing management strategies for running organizations with senior and middle management officials. This provides an overview of how CMAC was established, as well as an overall snapshot of how the organization is managed. The third category aims to impart specific field operation skills and methodologies, such as land release, mechanical clearance, and animal detection, which are relevant for technical and field staff of partner organizations.

Modality. The agendas are systematically and flexibly designed and implemented, with a program's framework determined under the facilitation of JICA. During the preparatory stage, the three parties—JICA, CMAC, and a partner organization—decide on the overall program structure, including format, theme, and duration, based on the requests and needs received from the partner organization. CMAC accordingly develops and prepares relevant course content, schedules, and training materials before a program commences. In addition, the three parties have a mid-term review and conduct a final review at the end of the series of programs to evaluate the overall process and outcomes.

Adaptability. A program's format is designed and adjusted depending on the requirements and anticipated outcomes of partner organizations. Officials from a partner organization visit Cambodia to participate in CMAC-led programs that combine lectures and field training. Alternatively, an exchange program between CMAC and a partner organization can be arranged, in which participants from both organizations visit each other and exchange experiences on a specific theme. This allows both organizations to collaborate and learn from each other. CMAC also sends its experts to partner countries such as Colombia and Ukraine to provide training, enabling CMAC staff to observe a partner organization's operations and provide constructive feedback.

CMAC trainer (left) explaining how to use ALIS to Ukrainian deminers during training in

Courtesy of CMAC.

Table 2. Types of programs.

Program type 1: Institutional and organizational development of Cambodia's mine action

Target:

- Policymaker and senior management officials of national mine action authorities and mine action centers

Theme:

- Sharing Cambodian experience in the institutional and organizational development of mine action in Cambodia
- Linking mine action with development

Program type 2: Management of national mine action authority and mine action center

Target:

- Senior and middle management officials of national mine action authorities and mine action centers

Theme:

- Senior/middle management
- Quality management, SOP's, and national standards
- Project management
- Human resource management
- Operational management
- Information management
- Training management

Program type 3: Field operation and technique

Target:

- Middle management and field staff of national mine action centers

Theme:

- Land release (Non-technical survey, Technical survey, clearance)
- Mechanical landmines clearance and operation
- EOD Level 3
- Battle area clearance (BAC)
- Mine risk education
- Mine detection dog

OUTCOMES

Positive outcomes have been identified through the mid-term and final reviews of past programs. Firstly, the programs under the cooperation have initiated national ownership of partner countries. Participants have learned from CMAC's experiences, particularly their efforts to develop an institutional and organizational structure to address the country's explosive ordnance (EO) contamination. Officials from a partner country confirmed during a review that they developed their strategic mine action plan based on the reviews of previous programs.

Secondly, the programs have strengthened capacity development of national mine action authorities. A wide range of capacities is required of national mine action organizations, including resource mobilization, national standards development, quality management training, and efficient information management. A successful case involves a partner organization developing the national training standard based on what they have learned from other programs. CMAC, as the national operator in Cambodia, has developed various capacities throughout its history, which contribute to the comprehensive capacity building of partner organizations.

Finally, through South-South cooperation, the programs have successfully provided partner organizations with skills and technologies that are readily applicable in the field. For example, CMAC has organized initial trainings for partner organizations to acquire skills in using mechanical clearance machines, which have been employed in Cambodia for many years and were newly introduced to partner countries.

UKRAINE

In 2023, the collaboration between CMAC and JICA took on a new dimension as the cooperation expanded into Ukraine as part of a multi-component cooperation with the State Emergency Service of Ukraine (SESU). Japan, which had been exploring ways to support mine action operations in Ukraine, and in consultation with CMAC, conducted initial practical training for Ukrainian deminers on the use of the ALIS detector in January. Developed in partnership between CMAC and Tohoku University, ALIS is a detection device equipped with ground penetrating radar (GPR), which enables a deminer to distinguish whether an object underground is a landmine or a metallic fragment. The use of ALIS is expected to increase the efficiency of clearance work in Ukraine. CMAC conducted a one-week training for eight members from SESU, including members from the Interregional Center for Humanitarian Demining and Rapid Response, and Pyrotechnic Units in Kyiv, Kharkiv, and Khmelnytskyi. ALIS requires a certain amount of time to master the device. Thus, the second training is scheduled to be conducted in 2023 to ensure the practical application of the device. In addition to ALIS, Japan is considering providing other kinds of demining equipment such as heavy machines to Ukraine.

CHALLENGES

The South-South cooperation programs implemented thus far have made significant strides; however, certain challenges persist. It's important to note two issues: Firstly, it is imperative to factor in the context of the partner country. Prior programs have mainly focused on conveying CMAC's expertise, which has led to programs that were not adequately tailored to the partner country's unique circumstances. Moving forward, it is essential to establish programs that account for the partner country's situation and enhance various approaches, such as consultancy work to respond to their unique needs.

Secondly, it is important to support the organizational commitment of partner institutions. According to feedback from participants, individuals sometimes face difficulties in applying the knowledge they have gained upon returning to their home countries. This is due to limited support in the workplace, making it challenging for individuals to drive changes within the organization. Therefore, individuals must be supported when returning to an organization in an effort to enhance an organization's commitment to create receptive working environments. This requires sharing goals among the relevant parties during the program formation stage and augmenting follow-up activities after its completion.

CONCLUSION

Mine-affected countries can greatly contribute to other countries' success in addressing their contamination. Gaining from their experiences, successes, and lessons learned is a step forward in helping countries address EO contamination. With this in mind, it is anticipated that the expansion of South-South cooperation in the mine action sector will persist.

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HOW UAV LIDAR IMAGING CAN LOCATE AND MAP MINEFIELD FEATURES: Cuito Cuanavale, Angola

By Katherine James [The HALO Trust], Gert Riemersma [Routescene],
and Pedro Pacheco [The HALO Trust]

In this article we outline how an unmanned aerial vehicle (UAV) mounted light detection and ranging (Lidar) mapping system has been used for the detection and mapping of minefields in vegetated areas around Cuito Cuanavale, Angola. Work took place as part of The HALO Trust's (HALO) research into aiding clearance of landmines and unexploded ordnance (UXO) using drones.

HISTORY OF THE CONFLICT AND CONTAMINATION

The Angola Civil war was fought from 1975 until 2002,[1] primarily between the People's Movement for the Liberation of Angola (MPLA) and the National Union for the Total Independence of Angola (UNITA), with, at times, external military support from Cuba and South Africa. The province of Cuando Cubango (Figure 1) saw some of the heaviest fighting, and the Battle of Cuito Cuanavale (September 1987–March 1988) was the largest engagement of the war.[2] There was extensive mine laying throughout the conflict by both sides[3]—including mixed threat, anti-vehicle (AV), and anti-personnel (AP)—which resulted in mine belts that continue to pose a deadly threat to the local community. HALO began clearance operations in Cuito Cuanavale in 2005 and by the end of 2022, it had cleared 29,000 AP mines and 11,000 AV mines.

However, many minefields remain to be cleared. To support the identification of mines in recent years, HALO has trialed drone surveys using thermal infrared (TIR) and red, green, and blue (RGB) cameras. However, AV mines or indicators of conflict such as trenches, bunkers, or craters, are no longer visible from the ground or air using UAV-mounted RGB or TIR sensors due to overgrown vegetation. Therefore, other methods of detection are needed to aid in surveys of these areas.

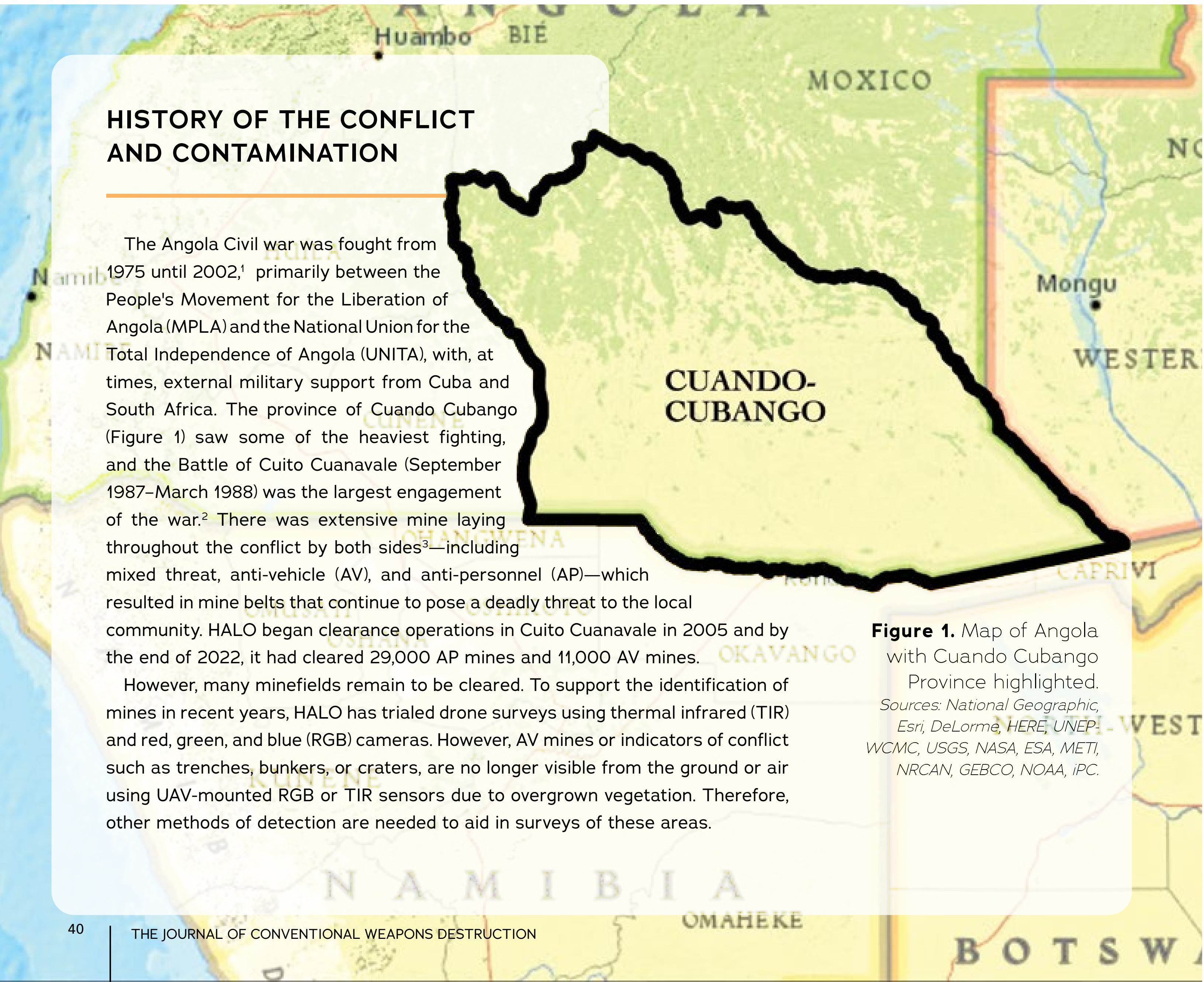

Figure 1. Map of Angola with Cuando Cubango Province highlighted.
Sources: National Geographic, Esri, DeLorme, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, iPC.

Figure 2. A Routescene LidarPod mounted on a DJI M600 Pro in Angola.
Courtesy of Claire Lovelance (The HALO Trust, Angola).

UAVS IN MINE ACTION

Most of the UAV work within the mine action sector focuses on the use of small UAVs equipped with RGB cameras to map known hazardous areas. The results are used to identify surface-level contamination or ground signs of shallow buried contamination, such as AV mines.[4] Therefore, utilizing sensors that go beyond the visible region of the electro-magnetic spectrum can help identify and determine the extent of minefield features and contamination in a region. Current research is looking into how TIR sensors can be used in the detection of shallow-buried AV mines and other large UXO.[5] However, this contamination is often covered with vegetation or the mines are buried too deeply to be detected with TIR or RGB sensors. In these circumstances, Lidar technology can be utilized to identify evidence of craters from detonations or to map trenches that are often associated with the mine lines.

SCOPE

To the authors' knowledge, this is the first time that Lidar technology has been used in the identification of minefield features in Angola to aid in clearance efforts. The ability to map full or partial trenches will allow teams to predict where a mine line may be located relative to a trench, as well as where it may change direction or end. This information can be used to inform clearance planning for future operations, making clearance efforts safer and where possible, speed up clearance through a targeted approach. In areas where there are large gaps in the mine lines or a sharp change in direction, utilizing Lidar technology to identify locations of craters from AV mine detonations, often caused by animal accidents and wildfires, can aid in finding the location of a mine line. This helps streamline clearance efforts by directing teams toward specific evidence points.

THE SCOPE OF THIS RESEARCH INCLUDED

1. Determining if the chosen UAV Lidar system is suitable for the detection of minefield features.
2. Determining which minefield features are detectable using UAV Lidar.

HYPOTHESIS

Vegetation prevents the observation of trenches, bunkers, and craters using conventional remote sensing techniques such as RGB drone imagery and satellite imagery. It is hypothesized that due to Lidar's ability to penetrate vegetation, this will allow for the mapping of trenches, bunkers, and craters.

TASK LOCATIONS

Three tasks were identified in the Cuito Cuanavale area based on heavy fighting and the presence of known or suspected minefield features (Figure 3).

The terrain across the three tasks is relatively flat, showing minimal changes in elevation. However, the vegetation varies: Tasks A and C both have dense tree coverage, while Task B has light tree and shrub coverage. The expected features to be detected were main trenches, communication trenches, foxholes (one-man defensive positions), shell scrapes (shallow excavations allowing soldiers to shield from shell bursts and small arms fire),[6] and craters from detonations.

1. **Task A**
   An abandoned military base outside of Longa village, approximately 100km northwest of Cuito Cuanavale.
2. **Task B**
   An extensive defensive mine line with an associated trench, approximately nine km east of Cuito Cuanavale.
3. **Task C**
   An abandoned military base, approximately twenty-five km southeast of Cuito Cuanavale, with evidence of AP mine laying within the base and at least one known trench and a suspected second trench.

EQUIPMENT AND SOFTWARE

A commercially available Routescene UAV Lidar system, mounted on a DJI M600 Pro UAV, was used for data collection (Figure 2). The DJI M600 Pro is a hexacopter lifting a five kg payload for approximately five minutes, and automated flights were executed using the DJI Pilot Application.

Routescene constructed a demonstration unit for this research project. The unit contained a sixteen-channel Lidar sensor capable of collecting approximately 600,000 points per second, a global navigation satellite system/inertial navigation system (GNSS/INS) sensor, and data storage to capture twelve hours of data. The system effectively penetrates dense vegetation to reach the surface beneath to detect ground disturbances that would not otherwise be visible. The unit is designed to be resistant to vibrations in flight and handling by users. The system does not require mobile or internet connection to operate, providing operational autonomy and data security. GNSS data was collected using a Trimble R2 for the post-processing of the trajectory to ensure the data was as accurate as possible.

The raw Lidar datasets were processed using Routescene's LidarViewer Pro software, specifically developed to georeference, clean, reduce, and visualize Lidar data. The software was used to export a digital terrain model (DTM) of the tasks for analysis in ESRI ArcGIS Pro.

DATA COLLECTION

Data at Tasks A and B was collected from forty meters above ground level (AGL) with one day of collection for each site. Data from Task C was collected at fifty meters AGL over three days. Due to the size of the area and time limitations, the flight height had to be increased to ensure the full area could be surveyed. Tasks A and B were surveyed during the dry season (August 2021) when vegetation cover was at its lowest. Task C was surveyed during the rainy season (April 2022) when vegetation cover was at its highest. The difference in vegetation density may have impacted the results and what could be identified in the data.

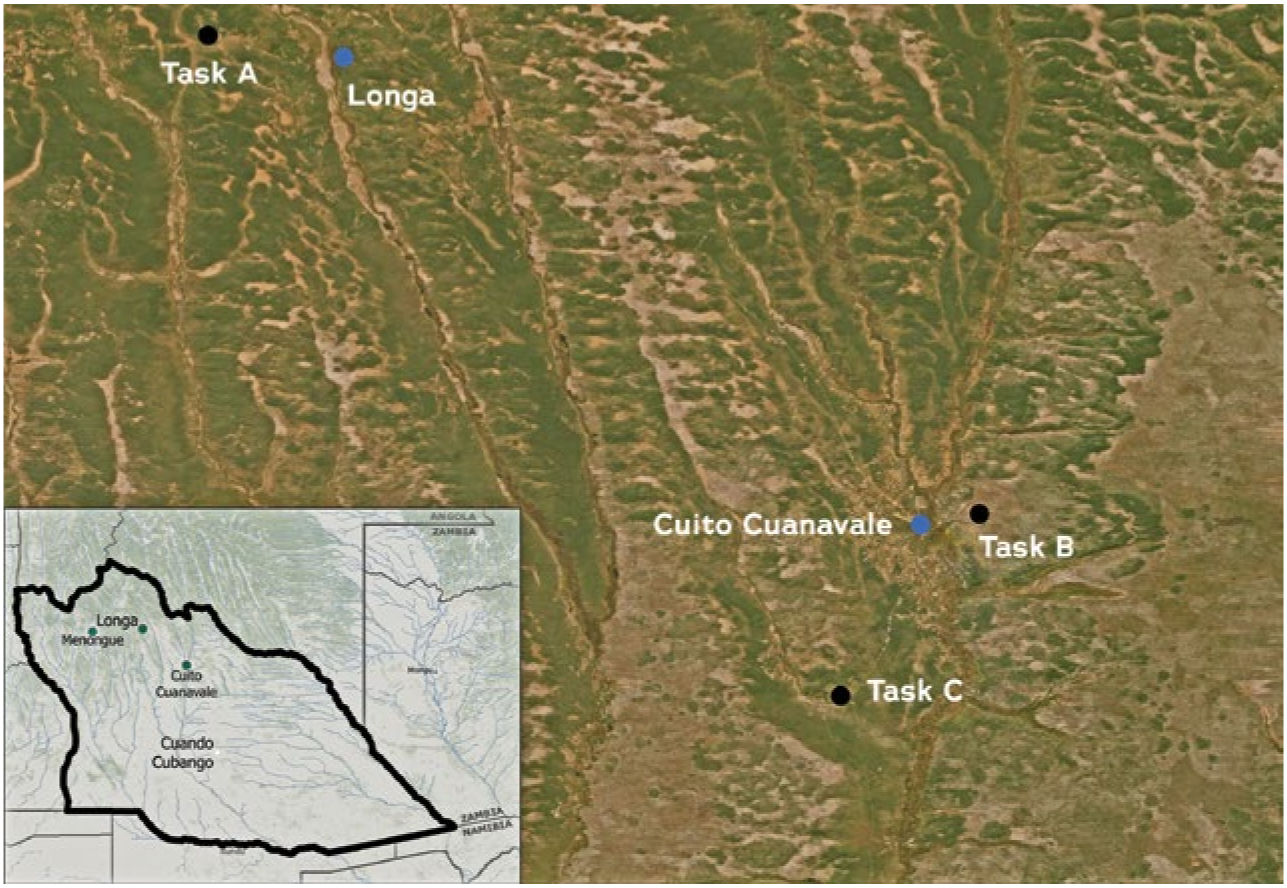

Figure 3. The location of the tasks surveyed in comparison to Cuito Cuanavale and Longa.
Inset base map courtesy of Esri, GEBCO, NOAA, National Geographic, DeLorme, HERE, Geonames, and other contributors. Sources: Esri, DigitalGlobe, GeoEye, i-cubed.

Figure 4. Satellite data over Task A, showing no evidence of craters or trenches.
Sources: Esri, DigitalGlobe, GeoEye, icubed, USDA FSA USGS, AEX, Getmapping Aerogrid, IGN, IGP, swisstopo, and the GIS user community.

RESULTS

The analysis of DTMs created from the Lidar data show positive results for the use of UAV Lidar systems for minefield feature detection across the three locations.

TASK A

Satellite imagery from Task A shows little evidence of the historical military base. While an access path is visible in the southeast of the site, it is not possible to identify other features (Figure 4). Due to a lack of safe access, only a partial survey of the task was possible.

When the Lidar data is overlaid onto satellite imagery, multiple minefield features become apparent (Figure 6). These include a main trench, communication trench, foxholes,[7] and suspected shell scrapes.

The predominant feature is the defensive main trench around the former military base, with a communications trench branching off the northwestern internal side of the trench (Figure 7). In total, 496 meters of main trench and forty meters of communication trenches were identified. A further twenty-four feature points were identified, primarily concentrated in the southern area of the data. Firstly, ten foxholes follow the inside of the main trench line, dug as part of the defensive positions around the base. Secondly, there is evidence of nine crater-like features clustered inside the southern areas of the base, with two further north, closer to the communication trench. It is unclear what caused these features, though it is suspected that these are shell scrapes. Thirdly, there is a line of six crater-like features outside the southern area of the main trench. Similarly, it is unclear what caused these. It is unlikely to be AV mines as none were found in this location. As with those inside the base, these may be evidence of shell scrapes (Figure 7).

At this task site the average depth and width of the foxholes (0.58m and 2.36m respectively) and the suspected shell scrapes (0.77m and 2.38m respectively) were similar, suggesting that these are the same feature. However, due to the suspected shell scrapes not being in the typical location and pattern of foxholes, these were identified as a separate feature. Thick vegetation cover at the task site prevented accurate identification of all features in the Lidar data (Figure 5).

Figure 5. Example of the trench area covered by vegetation at Task A.
Courtesy of Pedro Pacheco.

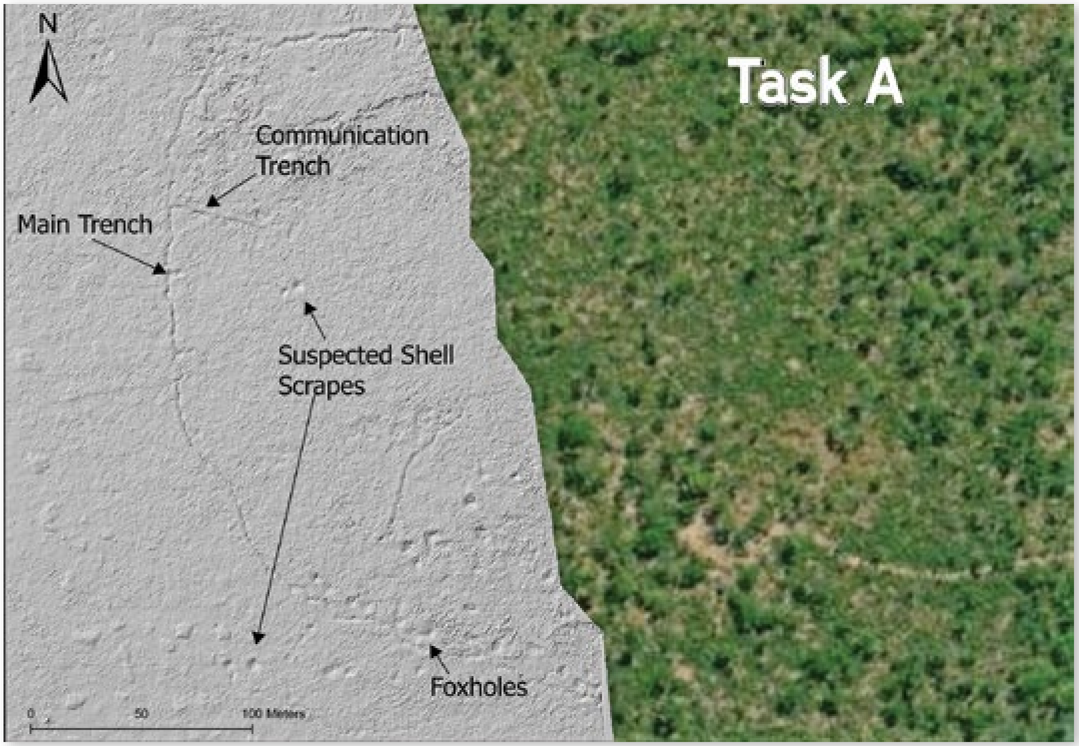

Figure 6. Lidar data overlaid on the task, showing features such as trenches and craters.
Basemap sources: Esri, DigitalGlobe, GeoEye, i-cubed, USDA FSA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS user community.

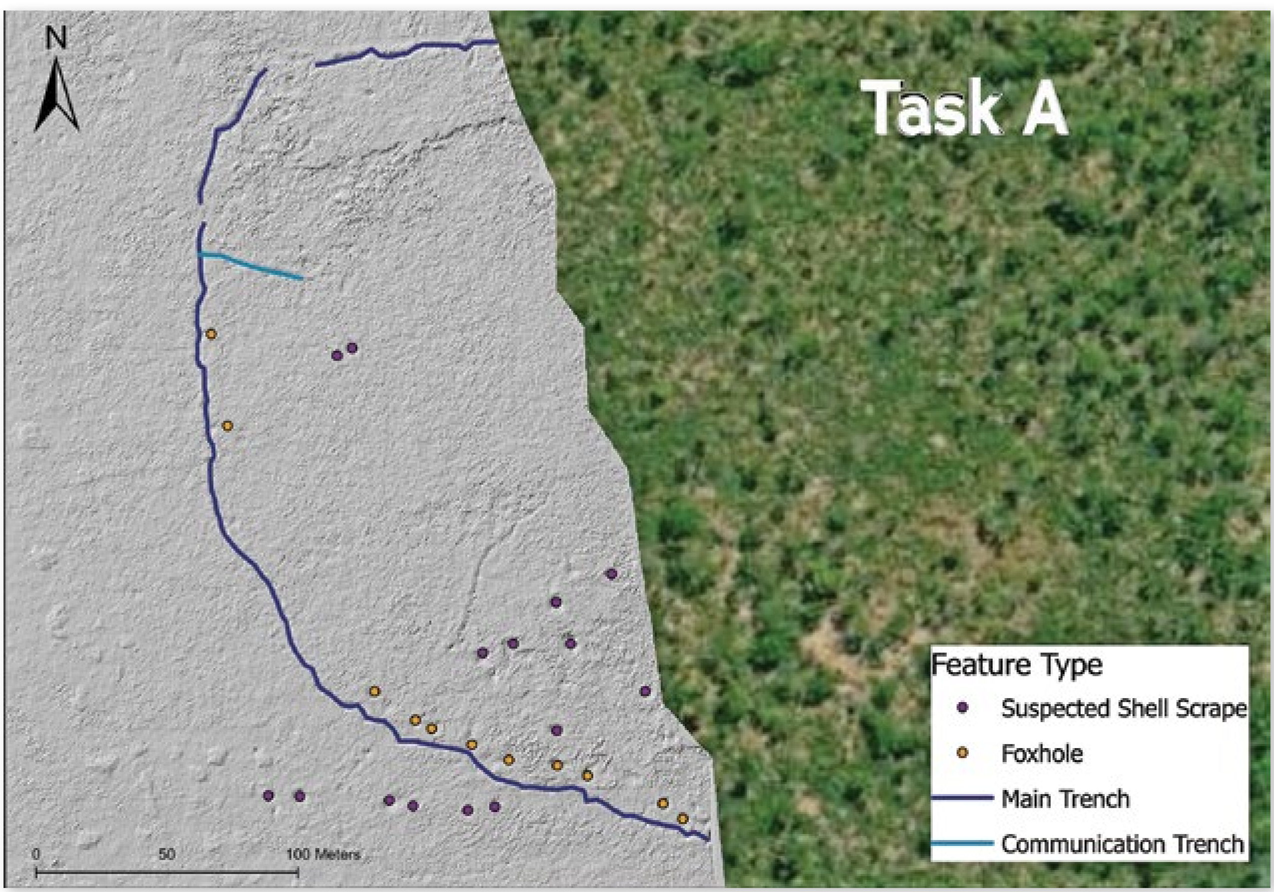

Figure 7. The predominant feature types of Task B mapped with unique symbols.
Sources: Esri, DigitalGlobe, GeoEye, i-cubed, USDA FSA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS user community.

TASK B

Due to lighter vegetation at Task B, there is slight evidence of the main trench remains in satellite imagery (Figure 9). However, other features are not visible.

Due to thick vegetation (Figure 8) and lack of safe access to the task site, it was difficult to see what remained of the trench system during field visits.

The analysis of the Lidar data identified multiple features that could not be seen in the satellite imagery, including a larger extent of the main trench, communication trenches, foxholes, and suspected craters (Figure 10).

In total, 500m of main trench, 281m of communication trenches, thirty-four foxholes, and two suspected craters were identified (Figure 11). The two suspected craters are unlikely to be foxholes due to their distance from the main trench. These may be craters from exploded ordnance (EO), however it is unlikely to be from AV mines as the mine line is to the east of the trench. These features were in an uncleared area, so it was not possible to confirm the exact nature of the features. The suspected craters averaged 5.85m in width and 0.65m in depth. The foxholes on this task averaged 0.67m in depth and 2.54m in width. While the majority of the tracks are visible in satellite imagery, the Lidar data reveals additional historical tracks. This information can be used to identify locations of possible safe access roads to a task site.

Figure 8. Example of the historic trench line at Task B with vegetation overgrowth reducing visibility.
Courtesy of Pedro Pacheco.

Figure 9. Satellite data of task B showing faint evidence of the trench line.
Sources: Esri, DigitalGlobe, GeoEye, i-cubed, USDA FSA, USGS, AEX, Getmaping, Aerogrid, IGN, IGP, swisstopo, and the GIS user community.

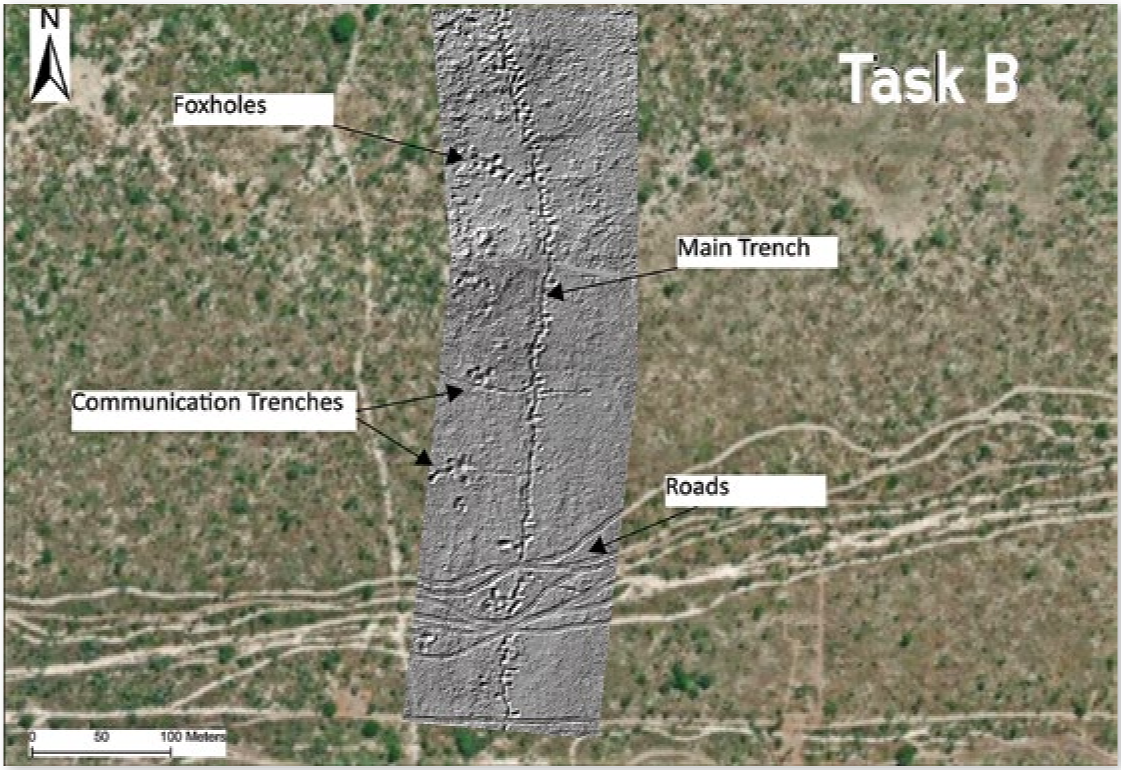

Figure 10. Lidar data from Task B showing one main trench, four communication trenches, and multiple suspected foxhole locations.
Sources: Esri, DigitalGlobe, GeoEye, i-cubed, USDA FSA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS user community.

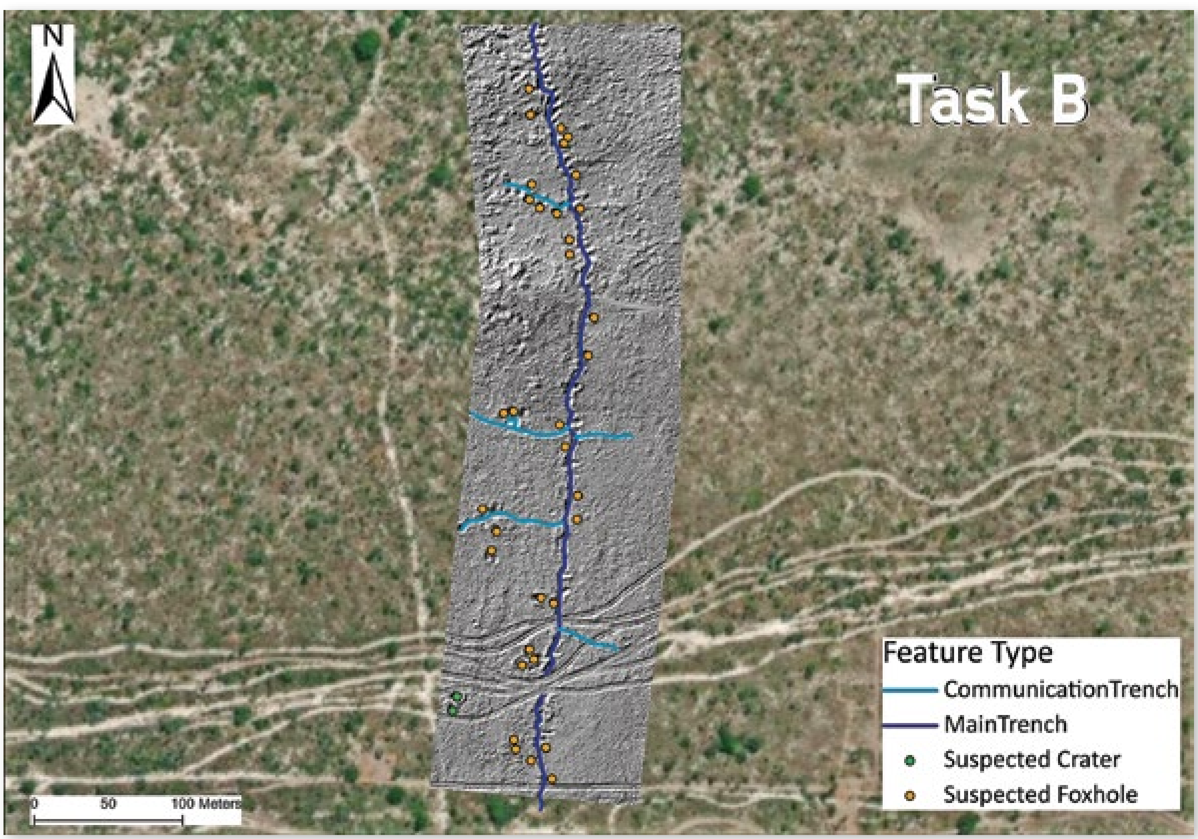

Figure 11. The predominant feature types at Task B mapped with unique symbols.
Sources: Esri, DigitalGlobe, GeoEye, i-cubed, USDA FSA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS user community.

TASK C

From satellite imagery (Figure 12) and from the ground, it is not possible to identify the locations of the suspected minefield features due to the dense vegetation (Figure 13).

Task C was suspected to have at least a single trench and multiple foxholes surrounding the previous military base. However, the Lidar data shows evidence of two trench systems surrounding the former base, as well as communication trenches (Figure 14). The data also shows 157 crater-like features, which follow both trench lines. These are believed to be foxholes due to their regular spacing near the trench lines.

Gaps in the trench systems observed in the data could result from various factors, such as soil infill over time, ground leveling within the trench, or rainwater in the trench obstructing Lidar penetration to the bottom. Although the trench data is incomplete, there is a continuation of the foxholes in the southern region between the two extents of the inner trench. This suggests that the trench once continued to create a circular inner trench system. Overall, 1,429m of main trench (828m on the outer trench and 601m of inner trench), seventy-three meters of communication trench, and 157 foxholes were identified on this task (Figure 15). The foxholes averaged 0.80m in depth and 2.81m in width.

Figure 13. Example of a foxhole from Task C.
Courtesy of Pedro Pacheco.

Figure 12. Satellite data over Task C, showing no evidence of the previous military base.
Sources: Esri, DigitalGlobe, GeoEye, i-cubed, USDA FSA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community.

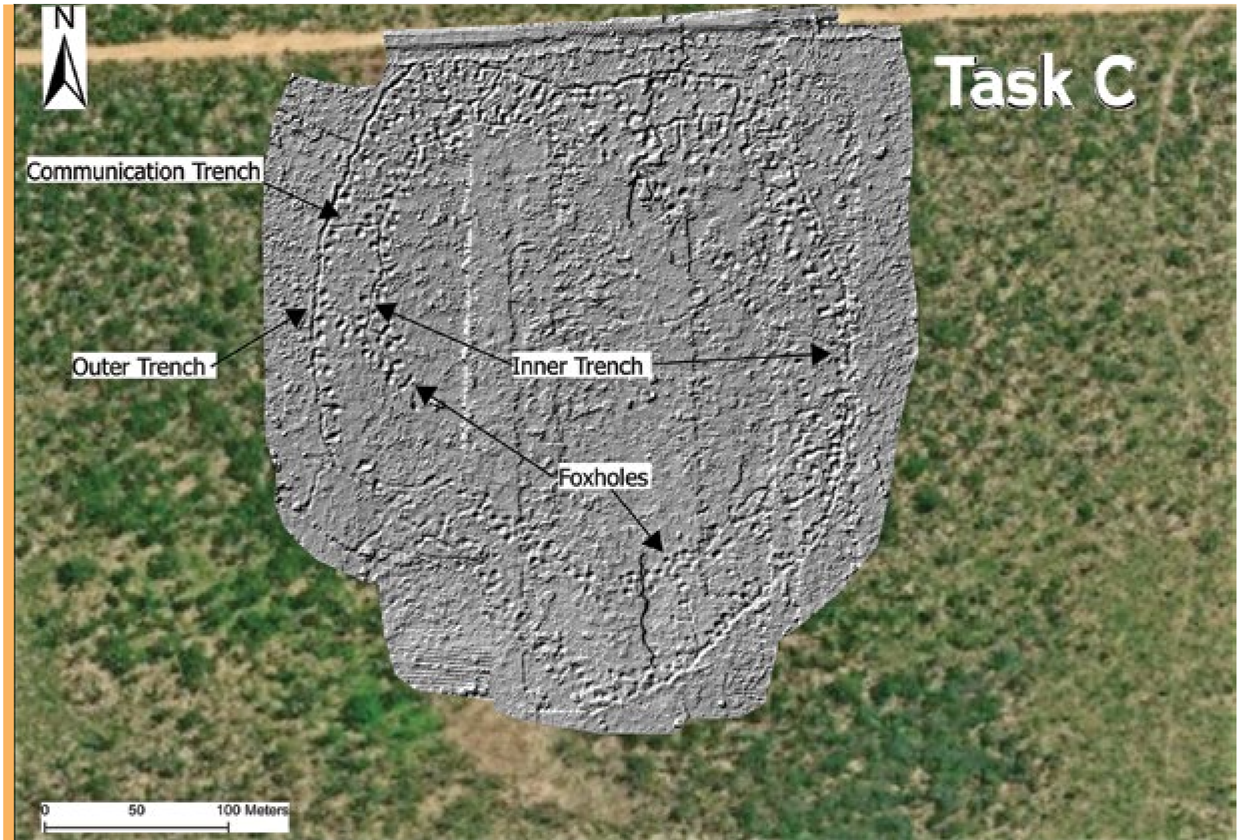

Figure 14. Lidar data over Task C, showing the trenches and foxholes that are not visible through the vegetation. *Sources: Esri, DigitalGlobe, GeoEye, i-cubed, USDA FSA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS user community.*

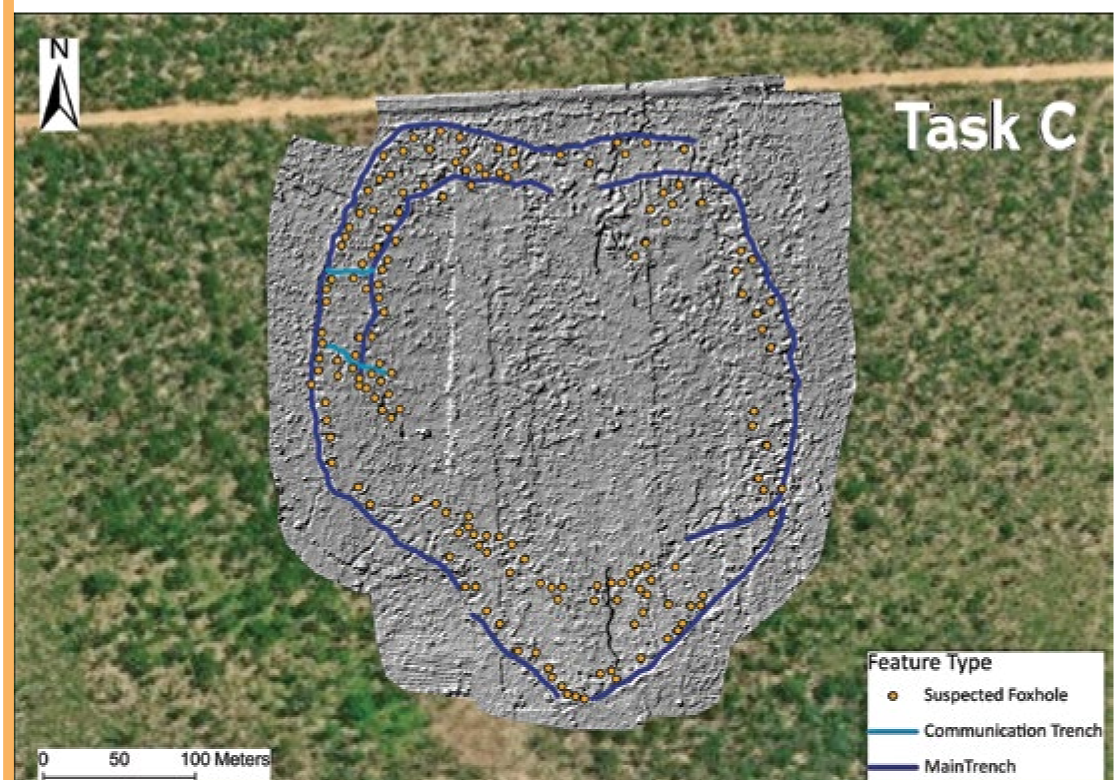

Figure 15. The trenches are suspected foxholes detected in Lidar mapped with unique symbols. *Sources: Esri, DigitalGlobe, GeoEye, i-cubed, USDA FSA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS user community.*

DISCUSSION

This research has shown that off-the-shelf drones mounted with UAV Lidar systems and the associated outputs have significant value in Angola for the identification of minefield feature detection. The results provided solid information that aided HALO in targeting clearance operations on these minefields. To distinguish between foxholes and craters in Lidar data, two methods can be employed to gather ground truth information for accurate feature identification. First, if in safe-to-access areas, onsite measurements can be taken. Second, in unsafe or low-vegetation areas, a drone with an RGB camera can gather data for high-resolution orthophotos to confirm feature identification. This information can contribute to a minefield feature database, including dimensions, location, and age, to enhance future analysis and facilitate work with increased confidence and speed.

There were several operational limitations during this study. Firstly, many of the minefield tasks in Angola are twenty to thirty km long and the maximum distance that the M600 could fly was 1-1.5km. This was due to a short drone battery life combined with loss of visual line of sight of the drone due to vegetation. The lack of suitable drone take-off and landing points also restricted the size of area that could be surveyed in a day. Due to the remoteness of the survey area, there was limited access to power sources to recharge the drone batteries between flights, limiting the number of flights to two per day. If research were to continue using off-the-shelf drones, users should consider utilizing a generator in the field to charge the batteries and to allow for increased UAV Lidar surveys. Future research should consider the use of longer endurance drones and beyond visual line of sight (BVLOS) operations. Hybrid drones rely on fuel rather than batteries and can fly for longer periods of time, enabling larger surveys.

Additionally, environmental conditions may have impacted the data collection. Task C was surveyed during the rainy season, which meant the vegetation was at its densest and there may have been water infilling some of the features. While this study demonstrates that UAV Lidar can successfully penetrate through vegetation of differing densities, the best outputs were gathered during the dry season when the vegetation coverage was lighter. Optimal data collection times and the deployment of a thirty-two-channel UAV Lidar system should be considered when planning surveys in the future. The increased number of channels provides increased vegetation penetration capability, resulting in higher resolution outputs. It also enables flights to be undertaken at higher altitudes without compromising performance.

Further research should also be carried out using Routescene's UAV Lidar systems in other post-conflict countries. The systems have a wide operating temperature range (-20 to +65°C / -4 to +149°F) and can withstand light rain. The systems are used by forestry, environmental, and research organizations operating in diverse conditions across the world from the Arctic to Europe.

While Routescene's LidarViewer Pro software is used offline, the post-processing of the trajectory can only be undertaken online as it requires additional GNSS information, which is only available from specialist portals twenty-four hours after a survey is completed. This caused delays in data processing which should be factored into future planning.

CONCLUSIONS

This research has proven that UAV mounted Lidar systems can be used to detect minefield features which can be indicators of minelaying. The Lidar data provided evidence of trenches, craters, and foxholes across all tasks surveyed, which were either undetectable or only partially visible in satellite imagery. Remote sensing is not a replacement for but is complimentary to conventional minefield non-technical survey (NTS). This work demonstrates how valuable Lidar data can be to provide evidence that is not obtainable by other means, offering advantages over RGB and TIR imagery when looking for minefield features hidden by vegetation.

Within HALO's mine clearance operations in Angola, the Lidar data outputs, combined with contextual knowledge on the ground, have provided valuable information to aid in NTS operations and to target technical survey and clearance operations.

FUTURE WORK

Data collected during Lidar surveys can be used to build a database of minefield features found in each country. This will allow for the classification of features to accelerate learning. This data could also be used in the training of machine learning algorithms, which would speed up the analysis of data and reduce the impact of human bias in data analysis. In the future, HALO plans to carry out further research into the utility of UAV mounted Lidar systems in countries with different environmental conditions and landscapes, such as Ukraine and Sri Lanka.

ACKNOWLEDGEMENTS

We would particularly like to thank an anonymous private donor for their extremely generous support for HALO's UAV trials in Angola and their commitment to innovation in mine action. This project would not have been possible without their help. We would like to thank Routescene for providing the UAV LiDAR system, software, training, and ongoing support since 2020. This has included a demonstration project, technical, and data processing support. In addition, we would like to thank Claire Lovelace and Siân McGee from The HALO Trust Angola programme for their ongoing support in the field and for supporting with the analysis of data.

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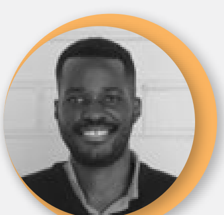

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LAND-GRABBING, TRIBAL CONFLICT, AND SETTLER-NOMAD DISPUTES:

Land Rights in Mine Action

A village cleared of explosive ordnance in Samangan Province, northern Afghanistan. Some community members questioned the power dynamics in the village and distribution of aid during a round of community surveys.
Courtesy of Nicholas Ross/Samuel Hall.

By Nicholas Ross [Social Policy Group]

Mine action is intrinsically linked to land rights. While mine action creates multi-dimensional positive humanitarian and development impacts, clearance of explosive ordnance (EO) and land release can lead to competition, contestation, and potential conflict over that land. Settled farmers lay claim and block access to lands which nomadic pastoralists traverse or use for grazing. Local strongmen grab and confiscate land. Families returning from displacement find their ancestral lands seized. And governments and citizens may have very different ideas about who should own lands close to communities which, following EO clearance, are now more productive, where resources are more accessible, and with land that has increased value. This is especially the case where land ownership systems, including documentation and enforcement, are not fully transparent. Since mine action often takes place in conflict or post-conflict areas, these factors are heightened further, with a breakdown in clear and just land rights and tenure.

The major objective of this article is to help mine action stakeholders identify different land dispute risks and outline key strategies to mitigate those risks. Key strategies include 1) broad and inclusive consultation; 2) centering the principle of *do no harm*;[1] 3) employing the lens of conflict sensitivity; 4) linking with the Housing, Land, and Property (HLP) space;[2] and 5) exploring the opposing effect of how mine action can help alleviate social tensions through land release. Recognition and mitigation of mine action related land disputes will help curtail negative consequences of clearance while increasing positive impacts as the sector works towards a mine-free world.

LAND RIGHTS AND MINE ACTION IN THE 2021 EVALUATION OF THE MINE ACTION PROGRAMME OF AFGHANISTAN

Disputes over cleared lands were documented during the 2021 Samuel Hall and United Nations Mine Action Service (UNMAS) Evaluation of the Mine Action Program of Afghanistan (MAPA).[3] The evaluation found wide-ranging positive impacts across multiple areas, through mixed methods research, as well as the novel use of geographic information system (GIS) methods to assess the impact of EO clearance on road networks and time-to-markets for rural communities across the country.

Alongside these impacts, the study also assessed reported issues in mine action from the perspective of communities. This stock-taking helped inform improvements to mine action operations in Afghanistan and beyond. This included an exploration of how to better extend the economic benefits of landmine clearance to community members who do not own land. It also examined ways to inform women when mine action operations were completed, and address safety fears women continued to have for their family members regarding harm from EO if they were not fully aware of EO clearance. In this assessment of issues, the research also briefly examined reports of land disputes after EO clearance, which formed a small part of the whole evaluation. Only four communities out of twenty-four (across eight Afghan provinces) in the study had meaningful numbers of research participants report land disputes occurring after mine action. But due to their significance as an opportunity for learning for mine action stakeholders in Afghanistan and globally, land rights issues were drawn on as a foundation for this article. And while the evaluation was conducted before the Taliban takeover in 2021, the examples of land disputes are pertinent to conflict- and post-conflict mine action operations globally, from the mountainous jungles of Colombia to South Sudanese marshlands, urban areas in Iraq, and farmland in Laos.

The topic of mine action and land rights has featured in several mine action studies, guides, and research projects. In 2010, the Geneva International Centre for Humanitarian Demining (GICHD) initiated a project on land rights and mine action in conflict-affected contexts. One of the outcomes was an article published in a 2011

On the road to conduct community interviews on mine action for a HALO Trust Afghanistan evaluation, Kabul Province.
Courtesy of Nicholas Ross/Samuel Hall.

edition of this Journal. Unruh, Chaizy, and Naidoo outlined how mine action organizations come into direct contact with land-rights issues through priority-setting, survey, and clearance. *The Journal* article also explored how mine action organizations can better address land issues given how critical an issue it is for humanitarian response, peace-building, and economic development.[4]

Other research from related studies includes a GICHD policy brief in 2010[5] noting that mine action organizations are never neutral when it comes to land rights, with land release inevitably involving land rights issues. The GICHD and UN-HABITAT published a report on land rights and mine action in Afghanistan in 2012, with analysis of land-related conflict alongside practical guidance on how mine action operations can take into account land issues and *do no harm*.[6] In the same area of research, GICHD released a report for frequently asked questions in land rights and mine action in 2012, with topics spanning why land matters for mine action, land rights and land release, what mine action organizations can do, and where organizations can obtain additional information and support.[7]

A 2014 GICHD report, "Doing no harm? Mine action and land issues in Cambodia," develops a series of recommendations on good practice and systems-strengthening, which include improving coordination between mine action and land actors (discussed in this article as links to the HLP space); provision of land rights training; enhancing post-clearance monitoring and evaluation; and improving funding flexibilities.

Finally, the GICHD 2014 "Guide to Mine Action" contains specific sections related to land rights and mine action.[9] Chapter 9 on Mine Action, Security and Development outlines how "land and access to other natural resources are common drivers of conflict" and how land release can have unintentional negative consequences. Additionally, the guide outlines mitigation measures under the humanitarian principle of *do no harm*, with practical remedies to address obstacles at different stages of mine action.

IDENTIFYING LAND DISPUTES LINKED TO MINE ACTION: A TYPOLOGY OF LAND RIGHTS ISSUES RELATED TO MINE ACTION

> **"We were satisfied with the mine clearance. There was a dispute over land between us and another tribal elder… [The other tribe] constructed a township on this land, while we have a land certificate from Ghazi Amanullah Khan's era [1919 – 1929] and have submitted pastureland tax to the government."[10]**

~ Focus group discussion participant, 2021 MAPA Evaluation

Land disputes and contestation over natural resources linked to that land, such as water or minerals, are a major factor in intracommunal and intercommunal conflict globally. In Afghanistan for instance, land disputes have been recognized as a "primary driver of conflict" in the country.[11] Because clearance of EO changes the status and value of the land, mine action can potentially create new disputes, or can accentuate preexisting disagreements.

Land rights issues are particularly pronounced in conflict and post-conflict contexts—another factor linking land rights to mine action—with much EO clearance and land release occurring in these settings. Areas with current or recent experiences of conflict often lack law and order, allowing disputes to escalate, as well as the proliferation of corrupt or criminal activities, including land-grabbing and confiscation. The lack of law and order also means that the enforcement of land title deeds can be difficult. The land title deeds system itself often lacks transparency, not being fully established and lacking effective administration. Legal systems are often in flux, with informal legal systems, competing legal systems, and changes in legal systems based on the larger conflict. A MAPA official noted land deed issues in the 2021 Evaluation:

> **"We ran into all kinds of issues around the deeds, it is very complicated. We already started looking into what land we are clearing, whether it is public or private. But that is an oversimplification of land usage in Afghanistan. Government-owned land is often seen as community land and used in a communal way. But not always."[12]**

~ UNMAS Afghanistan, key informant, 2020

There are numerous types of land rights issues and types of land disputes. The typology is not exhaustive. Nor are the types mutually exclusive. Participants in one community in the 2021 MAPA evaluation reported tribal clashes over cleared land; disputes between the government and *kuchi* nomadic groups;[13] and attempts at land confiscation, all within one community. Even within an issue type, there is much diversity, a confluence of changing social and historical factors, different drivers, and divergent actions and repercussions. The variation suggests that land disputes can be highly localized and dependent on social dynamics related to specific communities.

Intracommunal land disputes:

- **Between individuals or families:** A farming area adjacent to two family compounds has been unusable for thirty years due to EO. Both claim ownership.
- **Marginalizing women from land rights:** Not including women in land release handover, ownership, and access further compounds patriarchal power structures and entrenches lack of rights and land access for women.
- **Land-grabbing or appropriation within the community (i.e., by powerful people or groups, such as community leaders):** The local strongperson and self-proclaimed community leader seize released land for themself and their family.
- **Migration: Families returning home:** People are able to return to their village because of mine action, after living in displacement for decades. Their historical homes have been claimed by those who remained behind.
- **Migration: Arriving migrants and people who considered themselves historic owners of the land:** There is high migration to a safe and economically growing area being cleared of landmines. The historic owners of the land are upset at the influx of settlers who are accessing and looking to buy cleared lands.

Intercommunal land disputes:

- **Settler-nomad conflicts:** Recently cleared lands are being used by farmers for crops, but seasonally nomadic pastoral groups claim the land has been their pastureland for generations.
- **Disputes between different social groups tribes, ethnicities, communities:** Two tribes have long-running disputes over land custodianship and access to resources on that land, including forest products and mining claims. Clearance is taking place in lands without clear demarcations.
- **Government and people:** The government claim recently cleared areas are public land. The local community say they have had traditional ownership over that land and have a fractious relationship with the central authorities in the capital.

A DEEPER LOOK AT NOMAD-SETTLER CONFLICT

Each type and category can be extended for better understanding of specific land rights and dispute dynamics. For example, mine action and land release can lead to disputes between nomadic groups and settled populations. Nomadic groups, often pastoralists, such as *kuchi* nomads in Afghanistan, are at risk of marginalization from rights to land after clearance and release. Nomadic rights to land are often not solely related to ownership rights, but also to important right of way and easement rights.[14] While referring to urban expansion, Giustozzi notes that increases in land prices creates incentives for grabbing pastures, with nomadic populations and settled communities competing with each other and among themselves to appropriate pastures, leading to conflict.[15] EO clearance often results in land value and price increases in a similar vein to urban expansion.[16] Since nomadic groups are usually not permanently located at sites, they may be missed during mine action communication, including in prioritization, survey, community liaison, handover, and post-handover activities. Nomad-settler conflict illustrates how mine action stakeholders can consult different groups to **a)** discover potential disputes and conflict related to mine action and **b)** understand potential conflict from different perspectives.

Grazing land cleared of EO in Samangan Province, northern Afghanistan

Courtesy of Nicholas Ross/Samuel Hall..

PRINCIPLES, APPROACHES, AND STRATEGIES TO MITIGATE LAND DISPUTES: DEMONSTRATED BENEFITS OF INCLUSIVE AND WIDE CONSULTATIONS

Nomad-settler conflict, as well as other types of land right issues such as land-grabbing, demonstrate that there is little use in only consulting with community leaders or a select group of potential mine action beneficiaries. Narrow communications and consultation could mean that potential conflicts remain hidden, with land disputes associated with mine action linked to dynamics of power and social hierarchy.

Significantly, in the 2021 MAPA evaluation, there was not one example where 100 percent of a community sample reported mine action-related land disputes (out of twenty-four communities surveyed, four of which had noteworthy numbers of people reporting land disputes). This indicates that there was a diversity of understanding and opinions. Even in the community with the highest proportion of respondents stating there was conflict, 40.48 percent of those surveyed in that same community responded that there was no conflict. Three other communities had citizens reporting land disputes: One community (23.91 percent) reported land disputes resulting from mine action, another 19.05 percent, and another 11.28 percent. All seventeen other communities had under 10 percent reporting land disputes.[17]

The heterogeneity of community members reporting land disputes in both quantitative and qualitative research in the MAPA evaluation illustrates the need for inclusive consultations with different groups of people. Mine action organizations should gather information from and consult with a diversity of sources, not just community leaders or officials. This includes with women, different tribes, nomadic groups (where relevant), and different households within communities, including poorer households.

A village cleared of EO in a mountainous district in Kabul Province. Kuchi nomads regularly traverse through the district
Courtesy of Nicholas Ross/Samuel Hall..

DO NO HARM

In addition to inclusive consultation, the principle of *do no harm* is a core strategy in helping the mine action sector navigate land rights and disputes. *Do no harm* means to prevent and mitigate any negative impacts of mine action. It entails examining the broader context of humanitarian mine action and constant work towards avoiding potential negative effects.

MAPA holds a *do no harm* approach. Notably, MAPA does not conduct mine action if there are any known disputes over specific land. Unruh, Chaizy, and Naidoo held up MAPA as a positive example in their 2011 Journal article[18] and the policy has continued to the present day, with MAPA officials describing policies on cessation of mine action until land disputes are resolved.[19] The MAPA evaluation found that MAPA stakeholders made conscious efforts to document and mitigate negative externalities of its activities.

The *do no harm* principle forms the cornerstone of a series of strategies for the successful preclusion and mitigation of land disputes and conflict related to mine action.

"There are do-no-harm considerations. If there are community tensions, we do not clear… We leave and come back when the issue has been solved. That could take one month, or it could take a decade. The disputes can be tribal, or family feuds. I would not be surprised if we never found out about most disputes about demined lands."[20]

– MAPA Key Informant, 2021 MAPA Evaluation

IMPLEMENTING CONFLICT SENSITIVITY TO LAND ISSUES

Closely linked to *do no harm* is the conflict-sensitive approach. Conflict sensitivity is the practice of

1. **understanding how aid interacts with potential conflict in particular contexts,**
2. **understanding these contexts including intergroup tensions and divisive issues, as well as**
3. **how to mitigate potential issues and unintended negative effects.**[21]

For the mine action sector, one of the divisive issues is land (alongside other potential issues including employment among particular groups and not others, lack of inclusive communication, unintended damage to property, and issues between employees and local citizens). Conflict-sensitive operations would mean that mine action centers and organizations maintain a robust understanding of different groups, their relations, and potential conflict-driving issues. This should occur across different levels, including international (clearance in contested borders), national (what clearance means for government and non-state armed actors), regional or provincial (various types of intercommunal conflict), all the way to the local level where clearance is to take place (various types of intracommunal conflict). At all levels, conflict sensitivity should appraise hidden power structures and complex local dynamics.

DEVELOPING PARTNERSHIPS BETWEEN MINE ACTION AND HOUSING, LAND AND PROPERTY (HLP)

One way to support conflict-sensitive approaches and local understandings is to leverage conflict-expertise in humanitarian contexts through partnerships between mine action and HLP. HLP is an area of humanitarian practice related to immovable property in emergency response. There are often dedicated United Nations HLP sub-clusters comprised of organizations dedicated to HLP in the many contexts where mine action occurs. HLP practitioners can often provide specialized understanding and support on land tenure, rights, access ownerships, documentation, and dispute resolution. One example is the Iraq Protection Cluster which issued a Guidance Note on Mine Action and HLP in 2019.[22] The Guidance Note includes recommendations that mine action organizations should link into and inform the HLP sub-cluster and key HLP partners; that mine action organizations should ensure compliance in HLP Due Diligence; and that mine action organizations should refer to relevant standards, strategies, and guidance regarding mine action activities and cross-cutting HLP issues. The Guidance Note also includes an HLP Due Diligence Process Map.

HARNESSING THE POSITIVE IMPACT OF MINE ACTION ON LAND RIGHTS

Mine action can also reduce tensions over land, in contrast to the exacerbation of land disputes discussed thus far. Since EO clearance can release and make available productive lands, social conflict over scarce land and resources can be reduced. The MAPA evaluation found that "the presence of explosive ordnance had been eroding the social fabric and sparked tensions. Mine clearance attenuated tensions between different groups, including settled farming communities and kuchi nomadic pastoralists."[23] In a global Samuel Hall evaluation for The HALO Trust in 2021, mine action was understood by community members to preclude former pretexts for disputes and conflict.[24] This included social blame over casualties and greater social cohesion resulting from development and employment opportunities. Realizing the benefits of mine action on land rights is still reliant on principled action, robust safeguarding, and other strategies to mitigate land disputes.

Land cleared of EO in Samangan Province, northern Afghanistan. Community leaders noted that the land was technically owned by the government, but the community could use it as free land for grazing.
Courtesy of Nicholas Ross/Samuel Hall.

CONCLUSION

Mine action organizations do not conduct EO clearance and land release in a social vacuum. Cleared lands can lead to social friction, competition, and potential conflict.

There is wide diversity in how mine action land rights issues can occur. For example, a dispute over cleared land between nomadic pastoralists and a settled farming community will differ between Somaliland and Afghanistan. Even within Afghanistan, the same type of land rights issues will entail different dynamics and courses of action in different locations and at different times. Yet with mine action organizations' expertise and local knowledge, integrating an understanding of land rights may help mitigate land disputes across different contexts globally.

The intersection of mine action and land rights would benefit from further research. The typology of land rights issues outlined in this article could be extended and deepened with the experience and learning from mine action organizations globally. Furthermore, how these land rights issues occur in different contexts, with different local dynamics, would bolster this area of research further. A better understanding of how mine action attenuates tensions over land would also help stakeholders understand the different benefits of mine action. Finally, further work on the preventative strategies, such as inclusive consultation and conflict sensitivity, would sharpen the various tools mine action organizations can employ in their operations. Mine action and land rights are intrinsically linked and must continue to be understood as such, shaping mine action for the better.

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COMPUTER VISION DETECTION OF EXPLOSIVE ORDNANCE:

A High-Performance 9N235/9N210 Cluster Submunition Detector

By Adam Harvey [VFRAME] and Emile LeBrun [Tech 4 Tracing]

The detection of explosive ordnance (EO) objects is experiencing a period of innovation driven by the convergence of new technologies including artificial intelligence (AI) and machine learning, open-source intelligence (OSINT) processing, and remote mobility capabilities such as drones and robotics.[1] Advances are being made on at least two tracks: in the automated searching of photographic image archives, and in the real-time detection of objects in the field.[2] Different technologies are responsive to different types of EO detection challenges, such as objects that are buried, semi-buried, or partially damaged.

Computer vision—a type of artificial intelligence (AI) that enables computers and systems to derive meaningful information from digital images, videos, and other visual inputs, and take actions or make recommendations based on that information—is a promising AI technology that can greatly enhance humanitarian mine action (HMA), as well as support evidentiary documentation of the use of EO that are prohibited under international humanitarian law. This article describes a computer vision algorithm creation workflow developed to automate the detection of the 9N235/9N210 cluster submunition, a heavily deployed munition in the Ukraine conflict. The six-step process described here incorporates photography, photogrammetry, 3D-rendering, 3D-printing, and deep convolutional neural networks.[3] The resulting high-performance detector can be deployed for searching and filtering images generated as part of OSINT investigations and soon, for real-time field detection objectives.

9N235/9N210 SUBMUNITION

The 9N235 and 9N210 are nearly visually identical high-explosive fragmentation submunitions (i.e., the explosive elements of cargo rocket-delivered cluster munitions). Upon detonation, the explosive payload blasts metal fragments in all directions, indiscriminately killing or maiming bystanders, including non-combatant civilians. The munition has been widely documented in the Ukraine conflict.[4] While neither Russia nor Ukraine are party to the *Convention on Cluster Munitions*,[5] they are both bound by the Additional Protocol II of Geneva Conventions, which prohibits indiscriminate attacks.[6]

Figure 1. 3D visualization of finalized 9N235 photogrammetry model.
Figure courtesy of Adam Harvey.

Based on these considerations, the distinctive visual appearance of the 9N235/9N210, and the fact that the object has a well-documented design flaw that leads to frequent failed detonation resulting in widespread unexploded ordnance (UXO) contamination,[7] VFRAME selected the 9N235/9N210 as a candidate for object detection development.[8] To test the hypothesis, we built and evaluated an object detector.

BUILDING A DETECTOR

The initial challenge for building a computer vision-based object detector for this munition was a lack of a sufficient number of diverse reference photographs of the object. While the number of online photographs of the 9N235/9N210 has increased in 2023, they still only reach the hundreds, with many duplicates. After splitting the remaining pool for training, validation, and test datasets, there is insufficient data for training a robust object detector.

An innovative approach to building neural networks using art-driven, data-centric development, developed by VFRAME, overcomes this challenge. Instead of scraping biased images online or setting up sterile laboratory experiments, data is generated from the ground-truth up using an interdisciplinary combination of photography, photogrammetry, 3D-rendering, 3D-printing, custom software, and artistic replication. Using this approach, a high-performance 9N235/9N210 detector was developed with almost no data from online sources, except for use in the final benchmarking dataset to evaluate the algorithm's performance.

The first step bypasses the Internet as a source of data and instead uses access to the real submunition as the ground-truth source of data as a 3D model, using photogrammetry.

STEP 1: PHOTOGRAMMETRY

Figure 2. Capturing the original 9N235/9N210 submunition using photogrammetry with an automated turntable and DSLR camera.
Courtesy of Adam Harvey.

Photogrammetry is the process of using multiple high-resolution photos to reconstruct an object's 3D geometry and surface texture, via the structure from motion (SfM) technique. Creating 3D scan models of physical objects has become increasingly simplified over the last decade, but there are many trade-offs between different software, camera, and capture approaches. There are also dedicated handheld 3D scanners and smartphone devices that simplify the process further by integrating high-end depth sensors with on-device photogrammetry processing.[9] There is no single best approach. For this project, the goals were high-accuracy, portability, and the ability to utilize existing hardware, in this case a digital single-lens reflex (DSLR) camera and graphics processing unit (GPU) workstation.

The most important aspect is not the technology but finding safe access to a free-from-explosive (FFE) munition. The munition must be undamaged, as damaged areas will become part of the ground-truth geometry, representative of the object as it appears in conflict zones, and not significantly altered during the FFE conversion.

To access the 9N235/9N210 submunition, VFRAME partnered with Tech 4 Tracing, an international, non-profit partnership of arms control and new technology experts working to apply new technologies to arms and

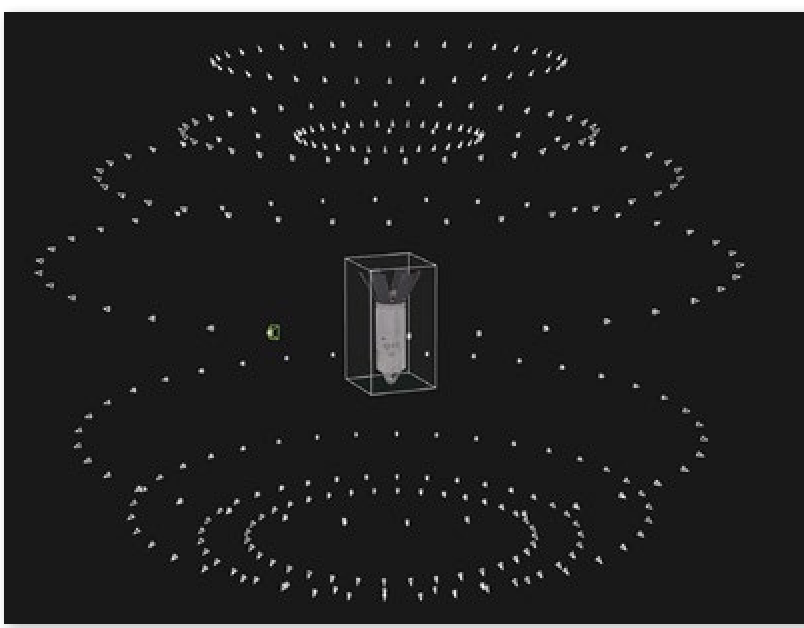

Figure 3. Photogrammetry scan of the 9N235 submunition by VFRAME in collaboration with Tech 4 Tracing.
Courtesy of Adam Harvey.

ammunition control.[10] In the early spring of 2022, both teams traveled to an armed forces explosive ordnance disposal (EOD) center in Europe and carried out the photogrammetry capture. In total, about 200 high-resolution photos were used to create the 9N235/9N210 3D model using an automated turntable to expedite the process. Each marker in Figure 3 shows the camera position for each photo.

After post-processing the photos and completing the 3D reconstruction process, the final result is a sub-millimeter-accurate 3D model. This becomes an ideal ground truth for generating synthetic training data.

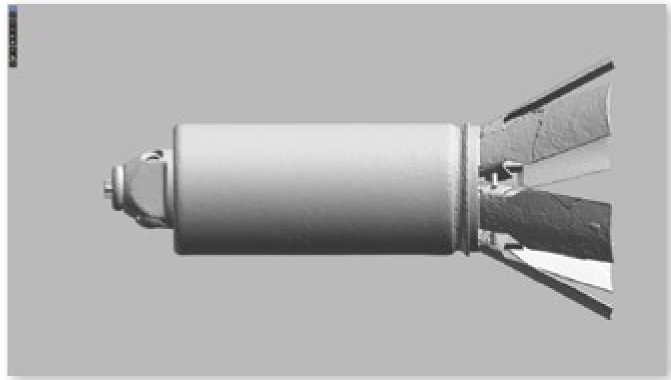

Figure 4. Rendering.
Courtesy of Adam Harvey.

STEP 2: 3D RENDERED SYNTHETIC DATA

Typically, training images for computer vision detection are gathered from online sources or from existing imaging systems, such as closed caption TV. Images are then manually annotated in-studio or outsourced to image annotation services in foreign countries. But this methodology creates multiple issues, among them data security, data bias, labor exploitation, cost, and the possibility of errors.

The use of synthetic data solves many of these problems because the annotations are automatically generated by software, diversity and bias can be controlled for, weather conditions can be programmed, and it can lower the overall cost. For these reasons, it is a transformative technology, especially for detecting rare and dangerous objects such as cluster submunitions.

To develop the 9N235/9N210 synthetic training dataset, over 10,000 unique images were rendered using various lighting environments, scene compositions, dirt variations, damage variations, and camera lenses—each of which can be deliberately controlled. This is achieved using a custom software application based on the Blender 3D rendering software.

Using synthetic image data, the way the object appears matches observations from the preliminary research: it reflects how the submunition lands, the material properties and weathering effects, and the terrain in which it is documented. Often, the submunition is lodged into a soft ground surface with all six of its black tail fins pointing upright. Sometimes the tail fins will break, leaving a metal tube with various permutations of one to

Figure 5. 3D-rendered image with a 9N235 submunition used in the training dataset.
Courtesy of Adam Harvey.

Figure 6. Auto-generated mask and bounding box values for training data.
Courtesy of Adam Harvey.

six integral or partial fins visible, or none. These variables can also be modeled. But at some point, either through extensive damage or majority occlusions, the object is no longer integral and should not be detected, for example when only a minority of the metal is visible and with no fins. Controlling confidence levels for false positives is also important, especially for large-scale OSINT analyses.

The example images were rendered using a simulated 40mm lens on a DSLR type sensor with F5.6 aperture using afternoon lighting and center-focused on the 9N235 with all six fins intact. To improve diversity, every image is procedurally randomized and then manually reviewed to ensure the training data aligns with the expected outcomes. This is merely one of over 10,000 randomized training images created for the training dataset.

STEP 3: 3D-PRINTED SYNTHETIC DATA

Figure 7. 3D printing multi-part 9N235 submunition replica for use in simulated benchmark photos and videos.
Courtesy of Adam Harvey.

With enough work, 3D-rendered images can achieve convincing photorealism but still contain artifacts of a simulated world and risk overfitting if the target objects are too rigid or lack diversity, such as occlusions, corrosion, or observer biases. There is a growing field of research that explores how to bridge the gap between simulation and reality, also referred to as the domain gap. However, this approach assumes that the simulated or rendered world is significantly different from the "real" world. Instead, the VFRAME project employs the concept of mixed reality data and hybrid training based on the idea that all worlds contain artifacts, which all need to be aligned toward the target domain for successful model development. Based on our research carried out over the last several years, object detection algorithms trained on synthetic data will always overfit and produce overconfident and misleading results if only 3D-rendered synthetic images are used in the test dataset. This is logical because the test dataset is comprised of the same synthetic features and textures used in the training images. It is not an inherent problem of 3D-rendered synthetic data, rather of basic overfitting. To overcome this problem, VFRAME has pioneered a hybrid approach that uses 3D-printed data to generate synthetic images in the "real world." This enables the neural network to learn important features from both worlds during training.

Figures 8 and 9. Real and replica 9N235/9N210 submunitions.
Figures courtesy of Adam Harvey.

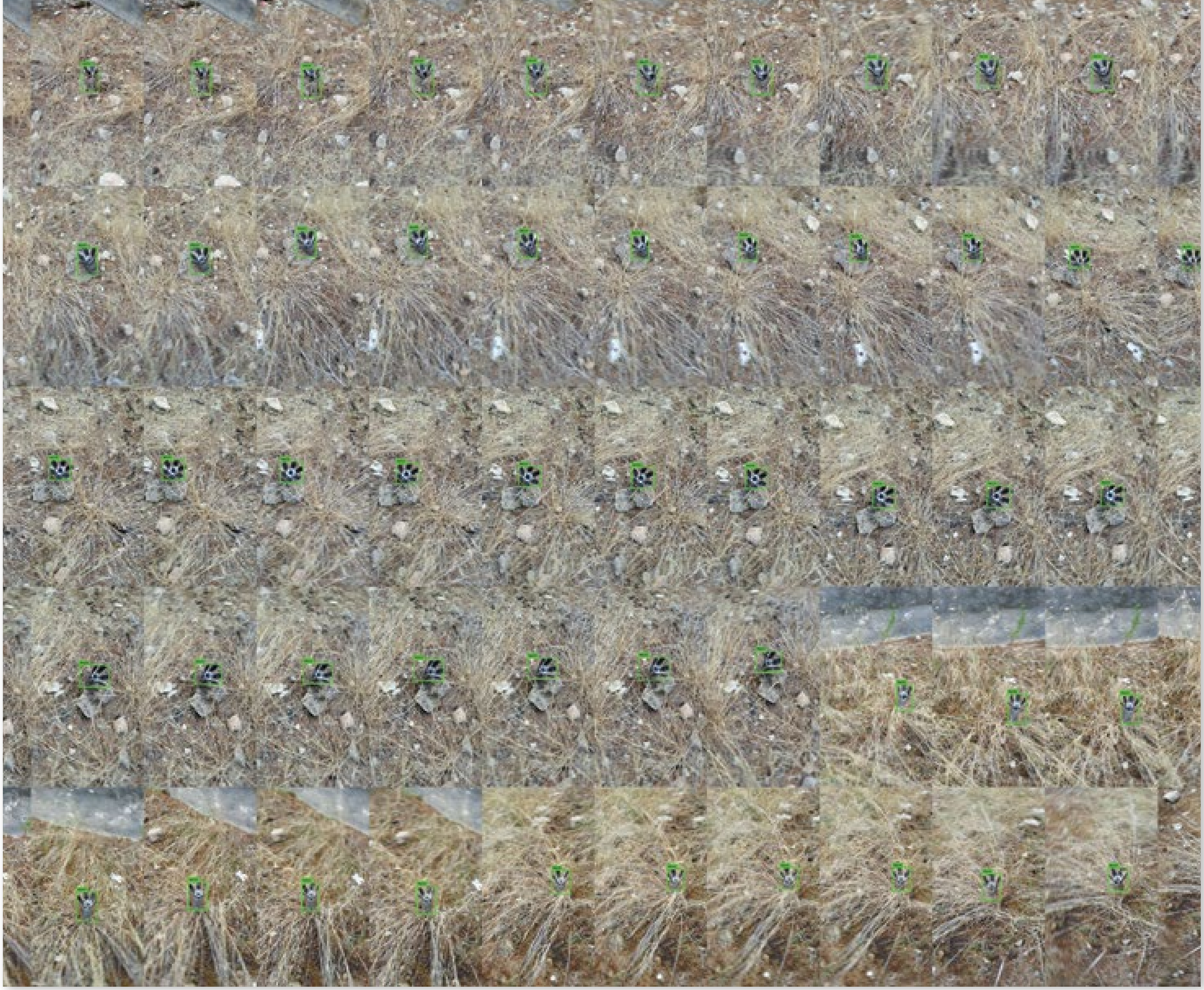

Figure 10. Sixty-four images from the 9N235 benchmark dataset created using the 3D printed replica. *Courtesy of Adam Harvey.*

3D-printed synthetic data (or just 3D-printed data) refers to the process of creating a 1:1 physical replica of an object using 3D-scanning, 3D-printing, and artistic replication. By recreating the digital surrogate object in the real world, this process escapes the limitations of 3D-rendered worlds and bridges the gap toward a "more real" reality. In other words, the 3D-printed replica can now be placed in a controlled staging environment to create scenes that would otherwise be too complex or costly to 3D model.

Another significant advantage of using 3D-printed data for submunitions is safety. Obtaining submunitions always involves risk, and removing the explosives material to make it FFE involves further risk for EOD personnel. The 3D-printed replicas are inert, hollow, plastic, and can be made using environmentally responsible bioplastics like polylactic acid (PLA).

The results can be convincingly real. Figures 8 and 9 are photos of 9N235/9N210 submunitions. One is real and one is a replica. Both are covered in mud and photographed with the same camera in wet forest terrain.

STEP 4: BENCHMARK DATA

With the submunition 3D-modeled, synthetic images 3D-rendered, and 3D-printed models photographed, the next step is to curate the object detection benchmark dataset to evaluate how well the neural network can detect the object. Benchmark data is essential for understanding the accuracy of the trained object detector. An easy benchmark dataset yields unrealistic expectations for what the detector is capable of. To overcome bias in benchmark data, it is helpful to make use of data generated across many seasons, terrain, contributors, and hardware. Images should contain easy, medium, and difficult scenarios. Not only is diversity useful for the model metrics, but it helps communicate to end users how well the detector can be expected to perform when, for example, a munition is partially exploded, broken or partially buried, or when it will trigger false positives on similar looking objects. This is especially important for objects that pose safety and security risks for field operators.

The results also help guide the thresholds settings for "greedy" or "conservative deployments," where false positive rates are balanced with higher true positive (recall) rates. Because the output is always a probabilistic determination, the actual deployment thresholds must be customized to the target environment. For example, a million-scale OSINT video analysis project could first triage everything above 90 percent accuracy, then look deeper at lower confidence (79 percent) matches when time permits. The more permissive threshold will usually locate more objects, but at the expense of more false positives. In another example, an aerial survey of an attack site could start with a low-confidence threshold because the environment is more constrained and any object slightly resembling the target munition could be analyzed further by zooming in.

Current VFRAME 9N235/9N210 image test. dataset by instance and source:

- **72:** Photos and video frames with mixed replica and FFE
- **606:** Photos and video frames with only replica
- **727:** Photos and video frames of real FFE
- **44:** Photos from social media
- ***2,099: Total 9N235/9N210 benchmark annotations***

STEP 5: MODEL EVALUATION METRICS

The model is trained using synthetic data but evaluated using multiple types of real data, including images sourced online. The most common metrics are applied to measure how well it can detect the true positives (recall), how well it ignores the false positives (accuracy), and how precise the bounding boxes are. The two most important metrics for OSINT—precision and recall—are combined into one score called the F1 metric to broadly summarize expected model performance on other datasets.

For this 9N235/210 model, the F1 score is 0.98 at 0.641 confidence. This means that when setting the confidence threshold in the processing software, one should expect high-accuracy results, with only a few images missed. To detect more true positive objects, thereby increasing the recall, the confidence could be dropped toward 0.0, but this would trigger more false positives and decrease accuracy toward 0.2, which could be acceptable in certain scenarios.

An important caveat here is that these numbers are entirely dependent on the quality of a test dataset that is not transparently disclosed. This points to a larger issue with evaluating AI tools for mine and EO object detection: without officially recognized and accessible benchmark data, developers can too easily claim high success rates, overhyping technology and potentially eroding trust if the results do not deliver as advertised.

To promote transparency and benchmark dataset integrity, the VFRAME project and Tech 4 Tracing are working toward the establishment of a voluntary and collaborative multi-party oversight committee to ensure AI models can be fairly evaluated through certified benchmark datasets. Until then, computer vision model metrics should not be entirely dismissed but rather be understood as a limited window of visibility into future real-world performance.

This limited window is still an important and widely used starting point to understand models. And the VFRAME 9N235 test dataset does include many diverse samples of objects in real situations from current conflicts sourced both online, from mine clearance operators, and from our own field missions. Sharing benchmark data from each source has a different set of issues: synthetic

Figure 11. An example image from the VFRAME 9N235/9N210 benchmark dataset showing a partially exploded 9N235 photographed while on a field mission to Ukraine in 2023.
Courtesy of Adam Harvey.

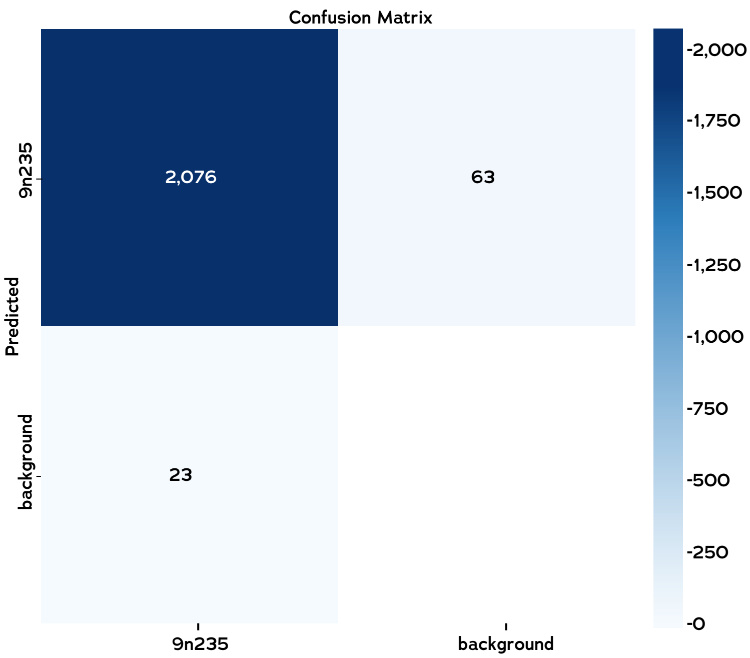

Figure 12. Confusion matrix for the 9N235/210 detector trained with the YOLOV5 framework.
Courtesy of Adam Harvey.

data could fuel misinformation and lower trust in OSINT documentation; data collected in the field could reveal sensitive geographic information; and data from mine-clearance operators in an active combat zone raises other security issues.

With these caveats in mind, the test dataset model metrics can still provide helpful insights. The confusion matrix shows the number of true positive detections (2076) compared to the false negative (23) and false positive (63). For objects like the 9N235/9N210 that can be significantly damaged and appear in multiple parts, there will always be small amount of variance in the metrics resulting from the intentional non-detection of shrapnel to avoid false positives. For example, the 9N235/210 tube without the nosecone or fins simply becomes a metal tube. This would be impractical to detect for OSINT tasks but would likely be useful for mine clearance. Detecting or avoiding metal tube detections is a result of tuning the threshold and the training dataset for the target domain.

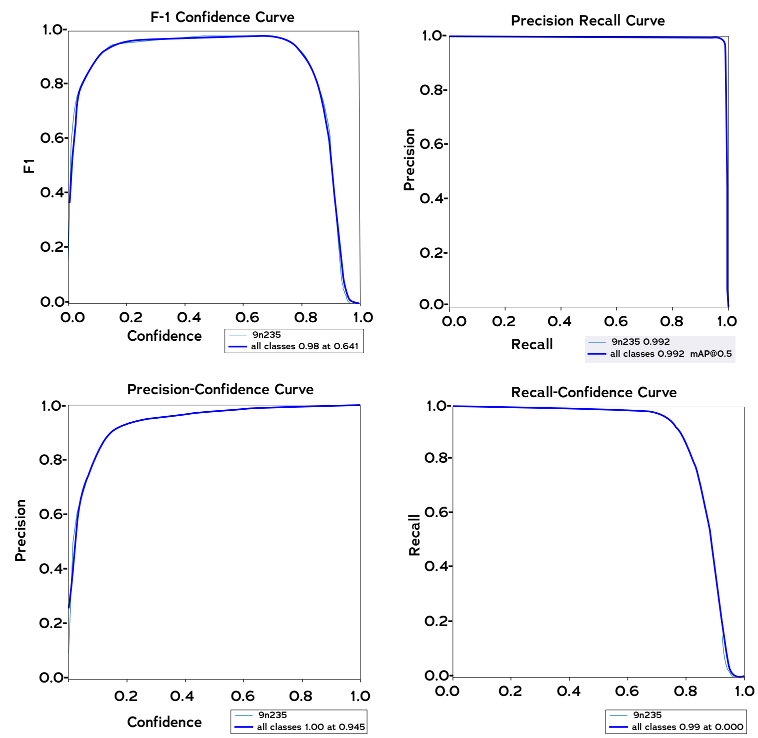

Figure 13. Model metrics for the 9N235/210 detector trained with the YOLOV5 framework.
Courtesy of Adam Harvey.

STEP 6: TEST IMAGES

In Figure 14, an example scene was constructed to check how well the detection algorithm differentiates from similar looking objects. The objects in the scene were made of the same material (false positives) yet were all successfully ignored while the submunition replicas (true positives) were correctly detected. These types of test images are useful not only during technical evaluation but also for visually communicating how well the detector can be expected to perform in similar scenes where similar looking objects are likely to appear.

Figure 14. Test on low quality camera with motion blur using real FFE and 9N235/9N210 surrogate (replica) fabricated by Fenix Insight.
Courtesy of Adam Harvey.

Finally, Figures 15, 16, and 17 illustrate expected performance in the OSINT domain, using images from the social media test set partition. Consider that these images were taken using different cameras then compressed during publication to social media platforms. Because the detection algorithm was trained specially to handle watermarks, lens distortion, and compression artifacts, the results are still accurate even when the submunition is partially occluded and still lodged inside the carrier rocket.

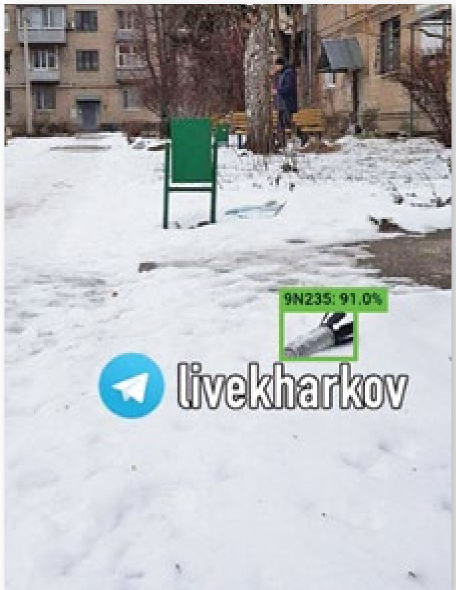

Figure 15. Detection results on social media reference imagery.
Courtesy of https://bit.ly/3Mtw9Pl.

Figure 16. Detection result on social media reference imagery.
Courtesy of https://bit.ly/3ZKxxQI.

Compared to previous conflicts analyzed with the VFRAME software, the images and videos from Ukraine are measurably higher quality and higher resolution. Understanding how resolution shifts in different regions, and will continue to increase in the future, aligns well with the synthetic training workflow which can be customized to generate compressed lower-resolution imagery to match older conflict zone media or used to generate sharper higher-resolution training data for current and future conflict zone analysis.

Figure 17. Detection result on social media reference imagery.
Courtesy of https://bit.ly/417PUQH.

PERFORMANCE

The YOLOV5 model is trained from scratch in multiple architectures with an aggressive custom augmentation process and then exported for deployment on workstations or mobile/edge devices. Running on a HEDT (high-end desktop workstation), it achieves a maximum 187 FS with the nano architecture and the full performance (recommended) model reaches forty-three FPS (see Figure 18).

CONCLUSION

The multi-step process described here has shown success in detecting an EO object with distinctive features in photographic and video images exhibiting a wide range of lighting and weather conditions and object orientations. Its high performance makes it suited for detecting the 9N235/9N210 in OSINT applications given typical source image artifacts including watermarks, compression, and light motion blur, and various image ratios. With support from the European Commission,[12] the next phase of this initiative will focus on optimizing a version designed for aerial deployment in drones, building a library of other priority EO object detector models, and the design of a mobile application for real-time field documentation and data collection. Eventual systematic deployment should also meet accountability principles for security uses of artificial intelligence and best practices for image authentication and digital evidence standards to ensure that detection data is admissible in legal accountability mechanisms.[13]

This project is an example of new technology-based innovations that will continue to improve mine action and humanitarian and human rights investigators' ability to detect a range of conventional arms and ammunition in a variety of contexts and thereby help save lives and hold perpetrators accountable for the misuse of prohibited weapons.

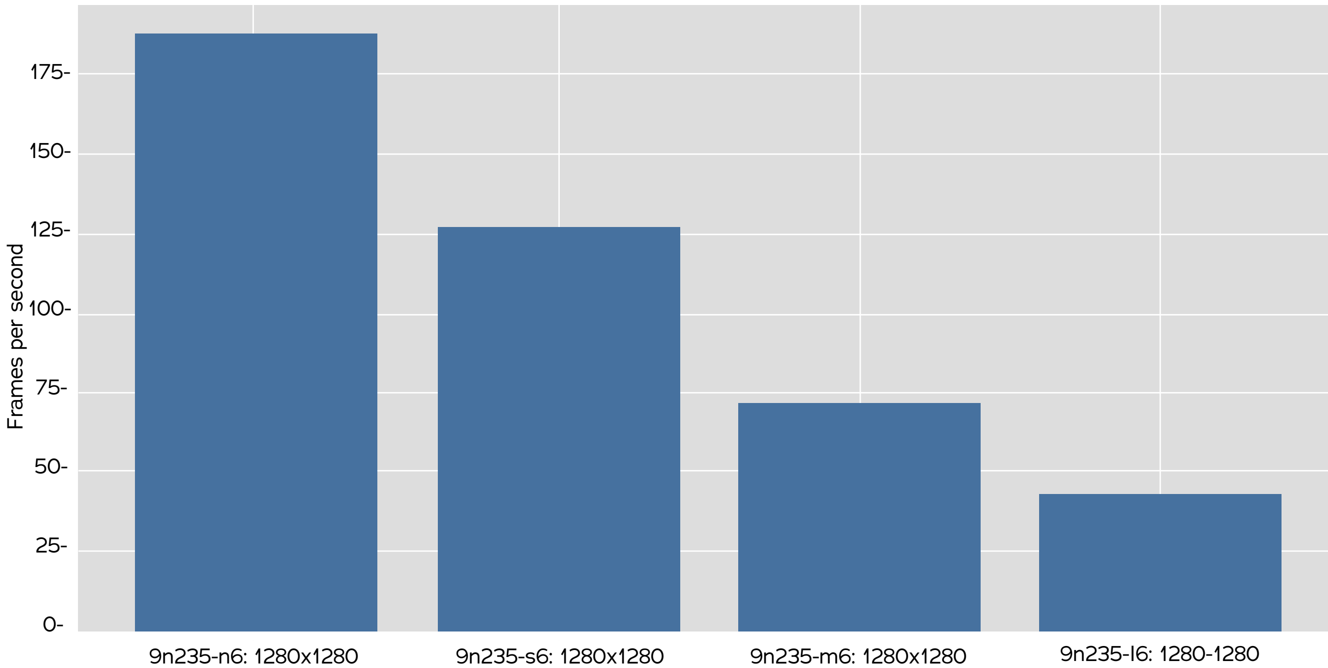

Figure 18. Frames per second on NVIDIA 3090 at 1280 pixels inference size averaged over one hundred iterations for nano, small, medium, and large YOLOV5 architectures at batch size eight using .pt model format.
Courtesy of Adam Harvey.

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See endnotes page 71

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Adam Harvey operates VFRAME, a computer vision project that develops open-source technology for human rights research, investigative journalists, and conflict zone monitoring. After several years of research and development into synthetic data fabrication techniques using 3D-rendering and 3D-printed data, this is the first publication of an object detection algorithm that uses all combined methods, as well as sufficient benchmark data to confirm the results.

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ENDNOTES

IMAS: An Overview of New and Amended Standards by Hartley, Pechera, and Logie [from page 6]

1. www.mineactionstandards.org
2. Competency describes the desired knowledge, skills, and attitudes of people in a given setting.
3. The desired knowledge, skills, and attitudes of people in a given setting.
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Mine Action and Food Security: The Complexities of Clearing Ukraine's Agricultural Lands by Shindler and Connell [from page 13]

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How UAV Mounted LiDAR Imaging Can Locate and Map Battlefield Remains in Cuito Cuanavala, Angola by James, Riemersma, and Pacheco [from page 40]

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Land-Grabbing, Tribal Conflict, and Settler-Nomad Disputes: Land Rights in Mine Action by Ross [from page 52]

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Computer Vision Detection of Explosive Ordnance: A High-Performance 9N235/9N210 Cluster Submunition Detector by Harvey and LeBrun [from page 60]

1. See Baur, J., Steinberg, G., Nikulin, A., Chiu, K., & de Smet, T. S. (2020). 'Applying deep learning to automate UAV-based detection of scatterable landmines.' Remote Sensing, 12(5), 859; and Dorn, A. W. (2019). 'Eliminating hidden killers: How can technology help humanitarian demining?' Stability: *International Journal of Security and Development*, 8(1).
2. See issues 25.3 and 26.1 of the *Journal of CWD* for reports on the use of infrared sensors and open-source intelligence mapping of explosive ordnance in Syria and Ukraine.
3. Deep convolutional neural networks are a class of artificial neural network commonly applied to analyze visual imagery and are also known as Shift Invariant or Space Invariant Artificial Neural Networks (SIANN).
4. See https://armamentresearch.com/russian-9n235-submunitions-documented-in-ukraine-2022. The investigative group Bellingcat has determined that the 9N235/9N210 is "the most common type of cluster munition" used in the Ukraine conflict. See https://twitter.com/bellingcat/status/1502237551146459137.
5. As of late March 2023, the *Convention on Cluster Munitions* had 111 States Parties and 12 Signatories. See https://www.clusterconvention.org/states-parties.
6. See Protocol Additional to the Geneva Conventions of 12 August 1949, and relating to the Protection of Victims of Non-International Armed Conflicts (Protocol II), 8 June 1977. See https://ihl-databases.icrc.org/en/ihl-treaties/apii-1977 (Protocol II text) and https://ihl-databases.icrc.org/en/ihl-treaties/apii-1977/state-parties (States Parties and Signatories).
7. For a discussion of the failure rate and resulting UXO caused by this submunition, see https://www.gichd.org/en/resources/publications/detail/publication/explosive-ordnance-guide-for-ukraine-second-edition.
8. Further documentation of this munition in Ukraine and in Syria is collected on the VFRAME website. See https://vframe.io/9n235/.
9. As part of a 2023 grant from the European Commission, Tech 4 Tracing and VFRAME will be conducting a feasibility study of the use of different scanning and photogrammetry techniques for creating benchmark data for EO object detection.
10. More information at www.tech4tracing.org.
11. Figures 14–16 sources: Sources: https://twitter.com/olehbatkovych/status/1498285374153633797, https://twitter.com/Ukrain_War/status/1499628097208868869, https://twitter.com/eod205/status/1503387454258266118
12. EU contract NDICI/2022/441-494 awarded to Tech 4 Tracing in March 2023.
13. Examples include the Accountability Principles for Artificial Intelligence in the Internal Security Domain (2022) and the European Network of Forensic Science Institutions' Best Practice Manual for Digital Image Authentication (2021).
14. For the latest models and updates on the development process described here, please visit the VFRAME research page at https://vframe.io/9n235/.

CALLS FOR PAPERS

THE JOURNAL of Conventional Weapons Destruction

27.3 FALL 2023

SUBMISSION DEADLINE: JULY 15

Ukraine

For the 27th edition, *The Journal* is accepting articles on a rolling basis about MA operations in Ukraine.

Topics of interest include survey, open-source research, clearance, survivor assistance, environmental considerations, and risk education.

Explosive Hazards Clearance and Debris Disposal

With the need for battle area clearance and debris disposal in the Middle East and Ukraine, what challenges do urban settings and destroyed buildings present for detection, clearance, and disposal activities?

Courtesy of The HALO Trust.

Environmental Management and Sustainable Development

How is mine action positively contributing to the protection of natural resources, creatively contributing to local socio-economic development, and improving environments once contaminated with explosive hazards?

Gender and Age in CWD

How can the community employ gendered analysis when planning for activities within the PSSM framework? How have organizations worked to employ women in these activities and what have the effects been on the programs as well as the local population?

History of SA/LW & PSSM: Lessons Learned and the Way Forward

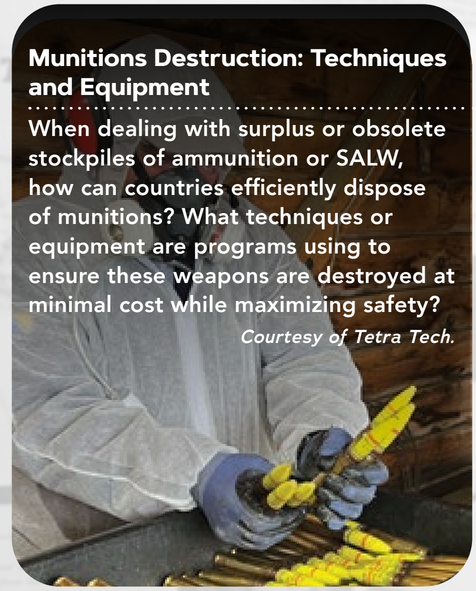
How has PSSM evolved over the past decade? Has the process for risk assessments changed? What have organizations learned about accountability/inventory systems, training/risk assessments, maintaining physical infrastructure of storage sites, or destruction of surplus and obsolete stockpiles?

Legal Considerations for Remote Sensing and Artificial Intelligence in HMA

With the ever-evolving nature of artificial intelligence (AI), what measures are in place and/or necessary for organizations using AI? Is there a need for standards within IMAS? How are organizations using this technology working within national and international legislation?

The Blurred Line of Humanitarian Aid in Conflict Settings

When MA organizations find themselves in areas with immediate security concerns, does the scope of their activities change? How do priorities shift to the protection of staff, and how can organizations ensure the safety of their personnel while mobilizing critical resources to still pursue humanitarian objectives?



Munitions Destruction: Techniques and Equipment

When dealing with surplus or obsolete stockpiles of ammunition or SALW, how can countries efficiently dispose of munitions? What techniques or equipment are programs using to ensure these weapons are destroyed at minimal cost while maximizing safety?

Courtesy of Tetra Tech.

Linking Explosive Hazards Clearance and Industry

In post-conflict scenarios, key infrastructure with known explosive hazards is prioritized for clearance. However, in situations where large-scale contamination impacts critical industries such as agriculture and energy, how should mine action organizations allocate their resources?

Quick Reaction/Response Force

What kinds of resources can the global community employ to quickly address high-risk explosive contamination to civilians and ongoing recovery efforts? Whether it's BAC or PSSM, how are organizations using best practices and cost-effective measures to protect civilians and infrastructure?

Reporting and Terminology

From terminology to record-keeping, how can we improve the community's reporting of improvised mine casualties so that transferring data between different organizations is seamless and the likelihood of errors is minimal?

Direct inquiries or submissions to
cisr-journal@jmu.edu

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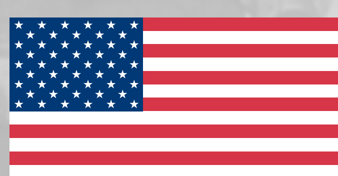

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