Issue 26.1 & 26.2 | Fall 2022

THE JOURNAL of Conventional Weapons Destruction

UKRAINE

Through the eyes of the people

FEATURING:

- Open-Source Research
- Northeast Syria
- History of MDD
- Aleutian Islands
- PSSM Partnerships
- Digital EORE
- Making Items FFE
- MA and Sustainable Development
- Environmental Consequences of War

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ISSUES 26.1 and 26.2, Fall 2022

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The Journal of Conventional Weapons Destruction is a professional trade journal for the CWD community, including but not limited to humanitarian 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 Journal Editorial Board reviews all articles for content and readability, and reserves the right to edit accepted articles for readability and space, and to reject articles at will.

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: MAG (Mines Advisory Group), photojournalist Sean Sutton captured the devastation in Ukraine during his visit in April 2022. See page six for his extended photo essay from the trip.
Image courtesy of MAG/Sean Sutton and embellished by CISR.

COMING WINTER 2023

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

- **Ukraine: For the 27th edition, *The Journal* is accepting articles on a rolling basis about MA operations in Ukraine**
- **Mine Action and the Triple Nexus**
- **Innovations in Environmental Considerations**
- **Improving PSSM**
- **Accessible Technology for MA**
- **Underwater UXO Survey and Remediation**
- **Colombia**
- **From Beneficiaries to Partners**
- **IED Clearance: Revising Practices and Lessons Learned**
- **Mobile SAA (and SALW) Disposal**

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A message from the interim director

Since our last publication, we at CISR have had the opportunity to meet with our colleagues again, attending the Mine Action Symposium in Croatia, Explosive Ordnance Seminar in Montenegro, and the APMBC Intersessional, National Directors Meeting, and the MSP for the CCM, all held in Geneva, amongst other domestic and international conferences. It has been wonderful to reconnect with our colleagues, discussing programs and planning ahead for the many hurdles presently facing the mine action community.

In this issue of *The Journal*, you will find a number of articles focused on Ukraine, including Sean Sutton's poignant photo essay reflecting on the people he met and the devastation he encountered while working in the country in April 2022. Additional topics discussed include capacity building in Syria; historical perspectives on mine action; the use of open-source research to identify explosive hazards in conflict areas; gender and diversity initiatives in mine action; and the corresponding relationship between mine action, the environment, and sustainable agricultural development.

- **Use of Open-Source Information:**
  - » Hampton Stall, Evan Leendertse, Han Prasad, Chris McNabe, Rana Shabb (The Carter Center), Jennifer Hudson (University of Central Florida), and Jonathan Robinson (Brown University Center for Human Rights and Humanitarian Studies) discuss their new open-source weighted estimate approach to capture unexploded ordnance (UXO) concentration in Syria.
  - » Andro Mathewson from The HALO Trust describes how they have harnessed open-source research to better plan for and conduct survey, clearance operations, and explosive ordnance risk education (EORE) across Ukraine.
- **Environment and the Triple Nexus:**
  - » Katarina Balić (Swiss Foundation for Mine Action) discusses the link between mine action and sustainable development goals through their "Clear then Grow" program linking mine action and agricultural recovery in Northeast Syria.
  - » Linsey Cottrell, Eoghan Darbyshire (Conflict and Environment Observatory), and Kristin Holme Obrestad (Norwegian People's Aid) warn readers of the heavy environmental toll explosive weapons are taking on civilian and industrial infrastructure in Ukraine.
- **Historical Perspectives of Mine Action:**
  - » Professor of Political Science at James Madison University, Ken Rutherford, presents his findings on remaining UXO and explosive remnants of war (ERW) contamination resulting from fighting between Japanese and Allied forces in the Aleutian Islands during World War II.
  - » Roly Evans from the Geneva International Centre for Humanitarian Demining (GICHD) provides a historical perspective on the contribution of mine detection dogs over the past eight decades by looking at where they add significatvalue while also understanding their limitations.
- **Digital EORE:** Robin Taol (MAG, Mines Advisory Group) discusses how the COVID-19 pandemic and recent conflicts have required organizations to adapt their EORE to a digital means of delivery to access hard-to-reach individuals and communities affected by explosive ordnance.
- **Gender and Diversity in Mine Action:** Raphaela Lark, David Hewitson (Fenix Insight Ltd), and Domonic Wolsey (GICHD) present results from their study of gender and operational efficiency in field-based mine action roles, addressing the stereotypes and assumptions that may still exist regarding women's performance and availability to work.
- **Free From Explosives (FFE):** In his article about making explosive items FFE/INERT for training and demonstration purposes, Roly Evans (GICHD) discusses the issues encountered when assessing or making items FFE, and argues that there needs to be consistent procedures and processes employed by the mine action sector when making explosive items FFE.
- **Physical Security and Stockpile Management:** Lee Moroney (Golden West Humanitarian Foundation) and Mark Veneris (US European Command) discuss the evolution of physical security and stockpile management, analyzing how methods have changed from "first-aid fixes" to more holistic, capacity-building approaches.

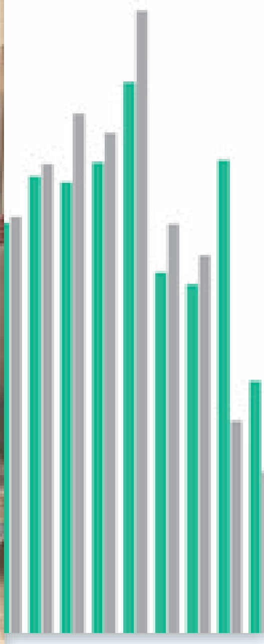
We sincerely appreciate our contributors' time in writing and willingness to share their research and program work, as well as the successes and challenges they have encountered in their operations over the past year. As we look ahead to our 27th edition of *The Journal*, we encourage the community to continue to share their reflections, experiences, and lessons learned—perhaps even more important than ever as the sector looks toward conducting operations in Ukraine, the South Caucasus, and Syria. With this in mind, please review our new calls for papers, highlighting the interconnectivity of the mine action sector and evolving global events, environmental concerns, and reflection of societal changes through diversity and inclusion initiatives.

Sincerely,

Suzanne Fiederlein, PhD







IN THIS ISSUE

Special thanks to our contribing organizations:

BROWN

THE CARTER CENTER

Conflict and Environment Observatory

FENIX INSIGHT

GICHD


Photo from Attu Islan
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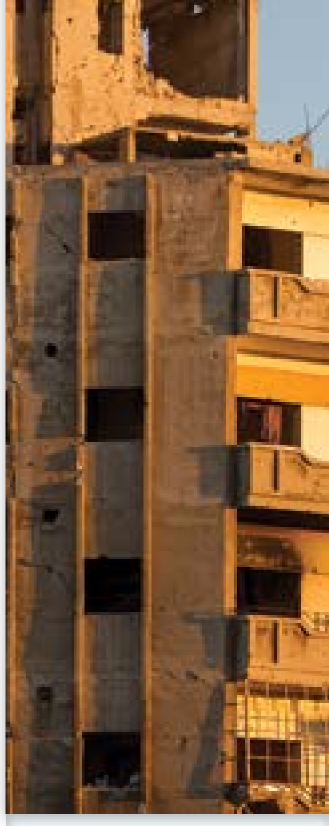


UKRAINE:
Through the eyes of the people

By Sean Sutton [Mines Advisory Group]

I have seen first-hand the long-lasting destruction that can be caused by explosive weapons and landmines across the world. My trip to Ukraine in April 2022 was no different. Ukraine has been ravaged by conflict for more than eight months. During my time there, I found many examples of makeshift signs warning returning civilians that strategically planted explosive weapons were somewhere inside or nearby. Written in bold, the signs serve as a warning for all types of unexploded ordnance (UXO) such as bombs, booby traps, and landmines.

Entrance to the fields blocked by a landmine warning sign. Anti-vehicle mines were suspected in the area.
All images courtesy of Sean Sutton/MAG.

LVIV

People arrived at Lviv railway station after a long night of traveling from Zaporizhzhia. Lena fled with her family from Orikhiv, which is southeast of Zaporizhzhia, close to the front line. “The town has been mostly destroyed with bombs landing every day. The explosions bow in the windows and the doors. We have small children, and we couldn’t cope. The children couldn’t sleep, and we were all terrified. We are all so stressed.”

A train transporting civilians from Lviv was damaged by Russian rockets soon after leaving Zaporizhzhia. Serhi, the train manager, explained:

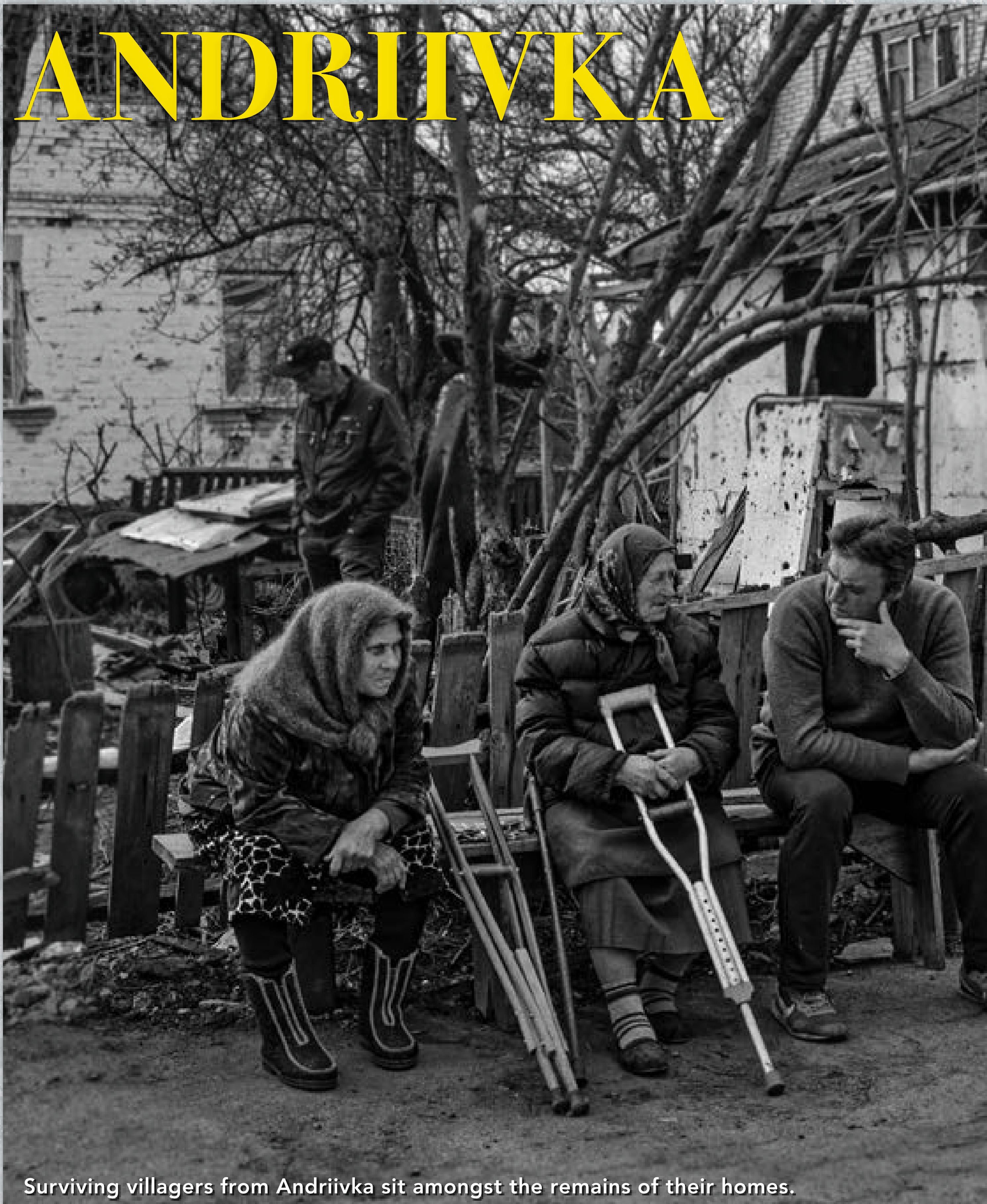
It was the most difficult day in my career. We left at twelve mid-day and just arrived here at 3:30 p.m. the next day—more than twenty-seven hours later. Soon after we left, as we were crossing the bridge to Khortytsia island, two missiles exploded. The blast took out many windows and did a lot of damage, but because we always have the blinds down, no one was injured. It was a miracle. Four of the carriages had to be changed at the next station.

As people arrived by train to Lviv from the areas under attack, such as Mariupol, volunteers were at hand to assist.

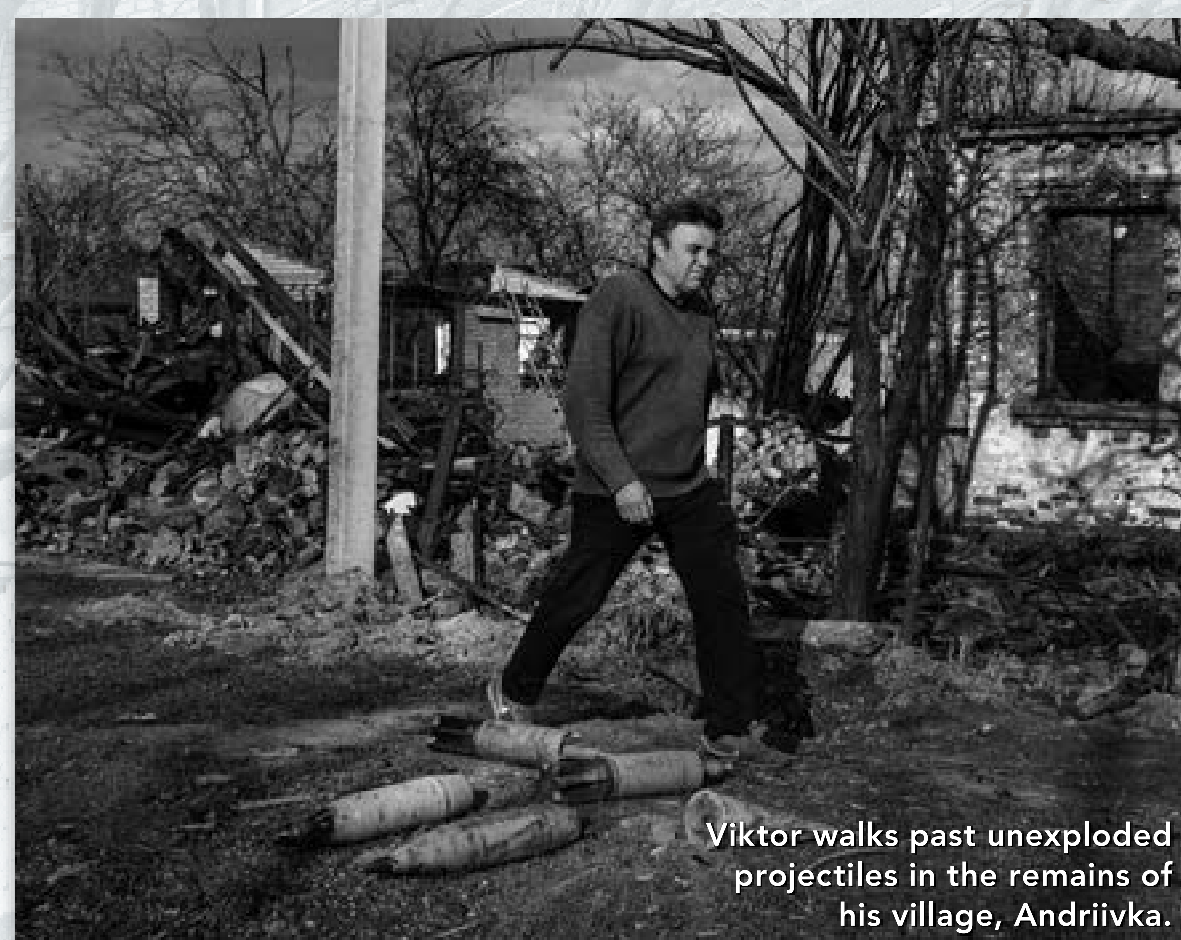
Vera fled with her husband, Evan, and their three children. They came from Molochansk, near Zaporizhzhia.

We left in an organized convoy. There were burning tanks and bodies on the street. Unexploded bombs were lying around. There are landmines in the fields. It was terrible. We had to go through ten checkpoints. Our car broke down, so we were separated from the convoy. My husband was repeatedly strip searched. We had to go because soldiers were going house-to-house to check people. They killed anyone with links to the military. Because my husband was a soldier before, we had to flee. We are lucky to have managed to escape.

ANDRIIVKA



Surviving villagers from Andriivka sit amongst the remains of their homes.



Viktor walks past unexploded projectiles in the remains of his village, Andriivka.

The village of Andriivka was occupied by Russian forces for thirty-five days. The main road linking Borodyanka to Makariv runs through it. Tanks were positioned between the houses on one side and Grad rocket launchers were stationed between the houses on the other side. Grigory, one of the villagers, described his experience:

Different groups of Russians stayed here. Some were okay, others were not. Some people managed to leave before they came here. Forty of us survived—we are all over fifty. People were killed by the Russians in the village or the shelling—we have lost fifty-three people that we know of. They came with nothing—no food and little ammunition. They didn't know that they were coming here to fight. They thought they were just coming on an exercise. A few days before they left, they started packing everything from the village—they took everything. The soldiers took ten 6x6 Ural trucks to a field nearby and unloaded all their grad rockets. They blew them up in a big explosion and then filled them with washing machines and everything else.

Russian soldiers had a Grad multi-barrel rocket launcher positioned near Viktor's house (image above). It was damaged by Ukrainian shelling. The Russians were trying to fix it when they were ordered to retreat from the area. They warned the villagers to keep away from the area early in the morning of 30 March 2022, and then blew the launcher up to stop it falling into Ukrainian hands.

MAG technical operations manager with Kornet anti-tank missiles. They have been partially burnt but still contain their explosive warheads.

MAG technical operations manager warns villages not to touch the explosive remains of a Grad rocket.

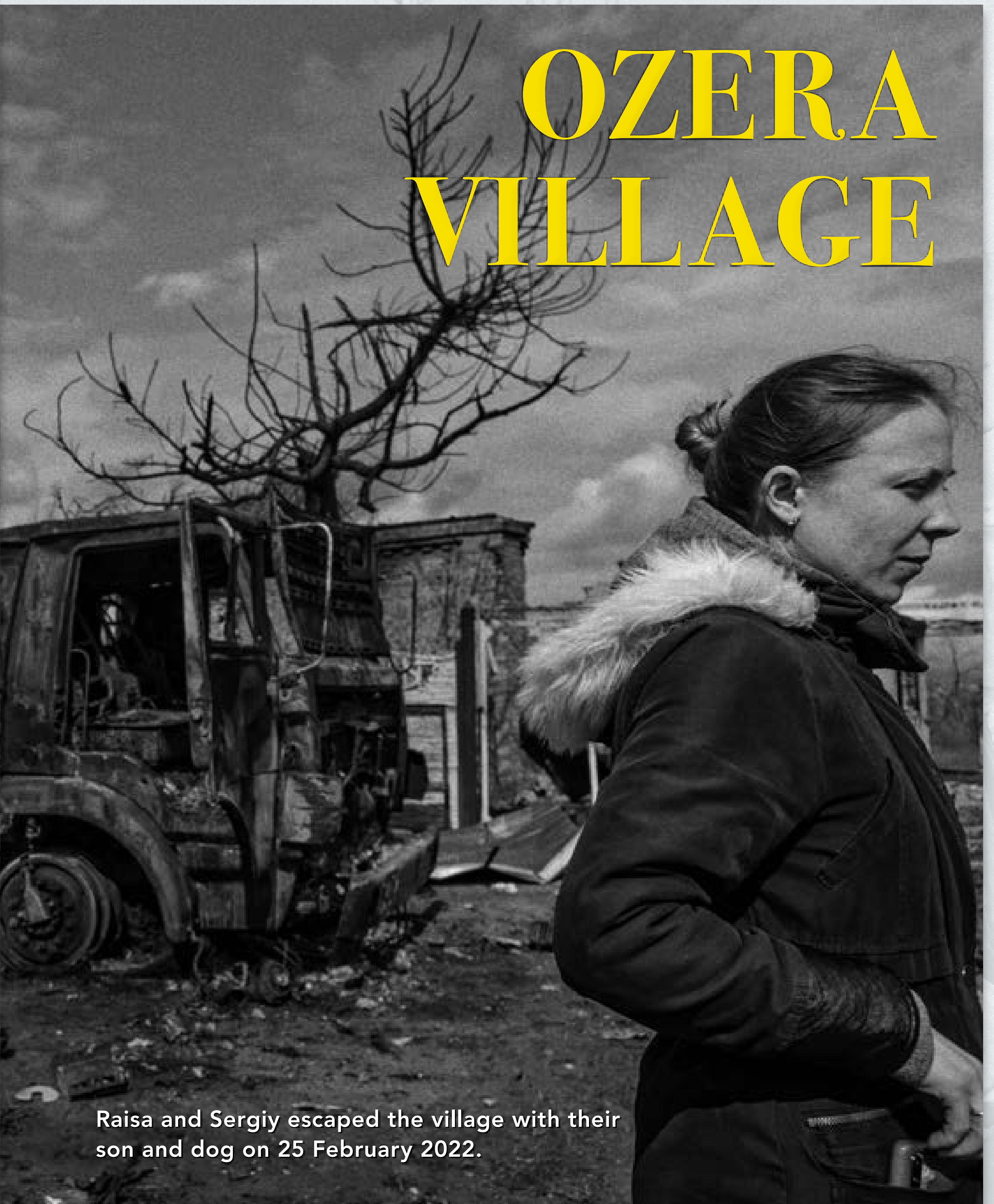
Mycola next to a mattress with the word "human" written on it and attached to the cellar door. He explained: "This is where I spent my time for thirty-five days. There was always shelling. One hit my cow shed and killed my cows."

There were five rockets still in the launcher when they blew it up," explained Viktor, *"The explosion destroyed five houses. How could they do that? There was no reason. They said that it was the Ukrainian Army's fault for damaging it, so the villages should suffer. My mother was injured and is still in hospital with leg injuries. I spent ten years building my house and I am a pensioner with nothing. What can I do? The authorities say there will be no compensation until after the war.*

The village has suffered a lot during the conflict.

There were tanks placed between the houses and they fired all the time … they killed our animals and took our food … they have planted landmines near here. Deminers cleared landmines from the area and told people it was safe. But after they let the cows [out] two of them died. It wasn't safe at all. They didn't find all of them [landmines] obviously.

OZERA VILLAGE



Raisa and Sergiy escaped the village with their son and dog on 25 February 2022.

A destroyed car and a child's toy in Hostomel.

Ozera village was on the front line close to Hostomel and its strategically important airfield. Taking the base was a key priority for the Russians and the airborne assault was one of the first major operations undertaken. The assault failed. Ozera changed sides several times resulting in the destruction of much of the village.

Raisa and Sergiy escaped with their son and dog from the village on 25 February 2022, and said that they were extremely lucky, twice:

We made a quick decision and put what we could into the car and fled. It was very frightening, there was fighting and bombing everywhere. We almost ran out of petrol. The car stopped just next to the first petrol station we came to.

The quick decision they made probably saved their lives. Sergiy's sister's family tried to escape later. Her husband was shot and died and then the car was hit by a rocket and their mother and father were killed.

Their family went back to the village to find that their house had been further demolished. The remains of a Ukrainian army truck had been there before, along with lots of explosive ordnance (EO) spread out from the explosion. The truck had been full of ammunition. The army explosive ordnance disposal (EOD) team placed all the shells in their basement and then blew them up. The explosion has left a huge hole in the ground.

Before, the house was destroyed but the foundations and basement were salvageable. Now there is nothing.

Abandoned Russian positions and minefields (right) in Hostomel.

Tanya, a villager, lost her house in the explosion.

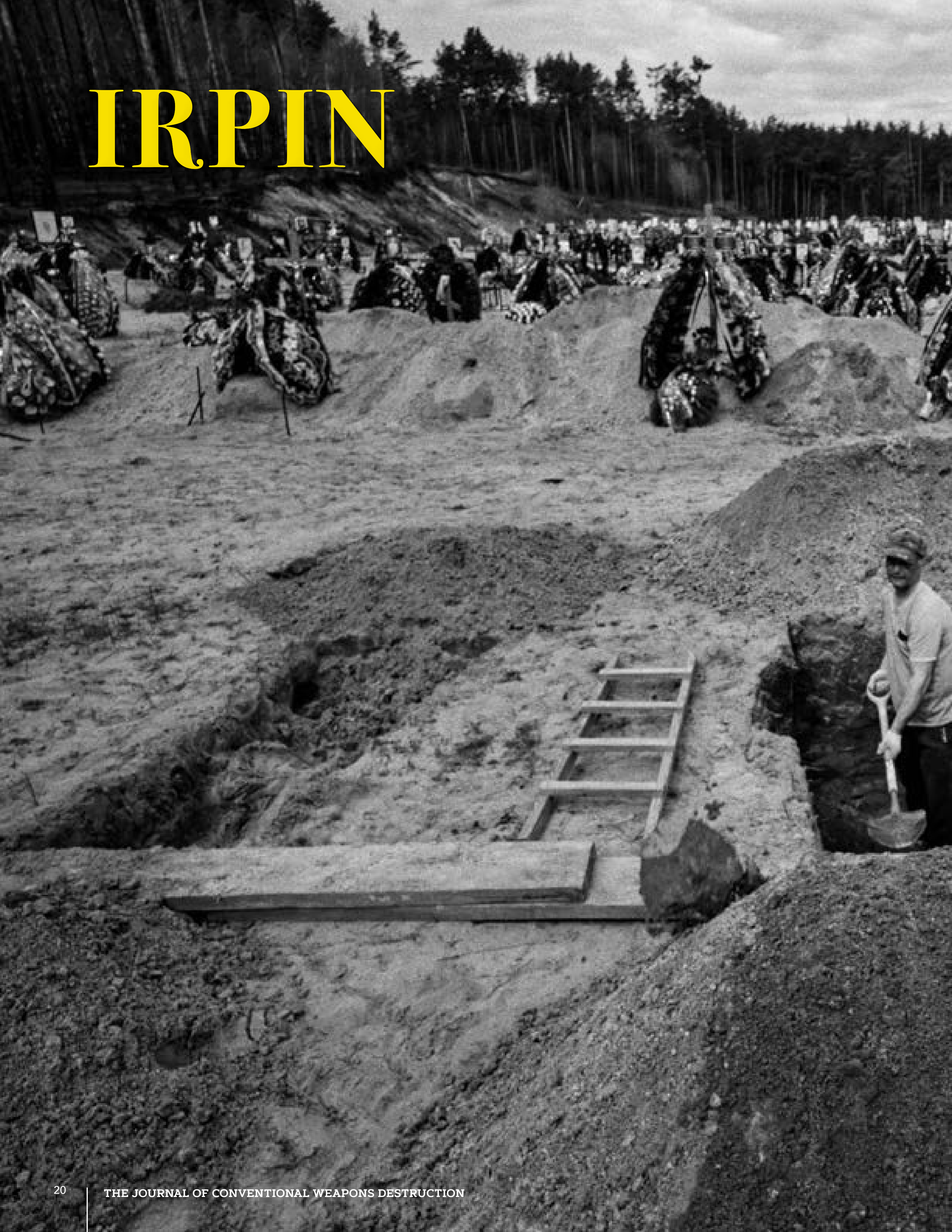
PEREMOHA VILLAGE

Peremoha village is situated east of Kyiv and is positioned close to a small river. The village was named Peremoha, which means *victory* in English, because of the military successes here in World War II. The same thing—victory—happened again explained Viktor, who remained in his village throughout the time of Russian occupation.

I watched everything. They came with great force three times to try and cross the river. But they were repelled by the Ukrainian heroes three times. The last battle was on 9 March. Many tanks and BMPs [a Russian infantry fighting vehicle] were destroyed. There were Russian bodies everywhere and pieces of bloody clothing. One young soldier called Zhenya, or Khak for short, is now a hero. He destroyed four tanks, three with Javelin missiles and one with a Kornet missile. When the tanks exploded parts fell all over the village—everywhere, boom, boom, boom. I used to hide in the grass and watch.

"The Russians put many mines in the village, even in the cemetery. Several deminers died here. One hit a mine in his jeep, then the next day another died. It was terrible."

IRPIN



Graves being prepared in Irpin.

Storefront in Irpin with the word "mine" written on a damaged door.

MAG technical operations manager points out dangerous items to soldiers manning a checkpoint. They said that people come with suspicious things. They report dangerous items to the army EOD teams but some items that were thought to just be scrap pieces in fact either contained explosives and or fuzes and were dangerous.

We were worried about the cats; we didn't know if they survived but thankfully they did. We fled when the building next to us was hit, killing many people. All our windows were blown out and we fled in terror. Bodies and flames everywhere. Our flats are damaged but okay, but in a neighbor's flat there is something suspicious.

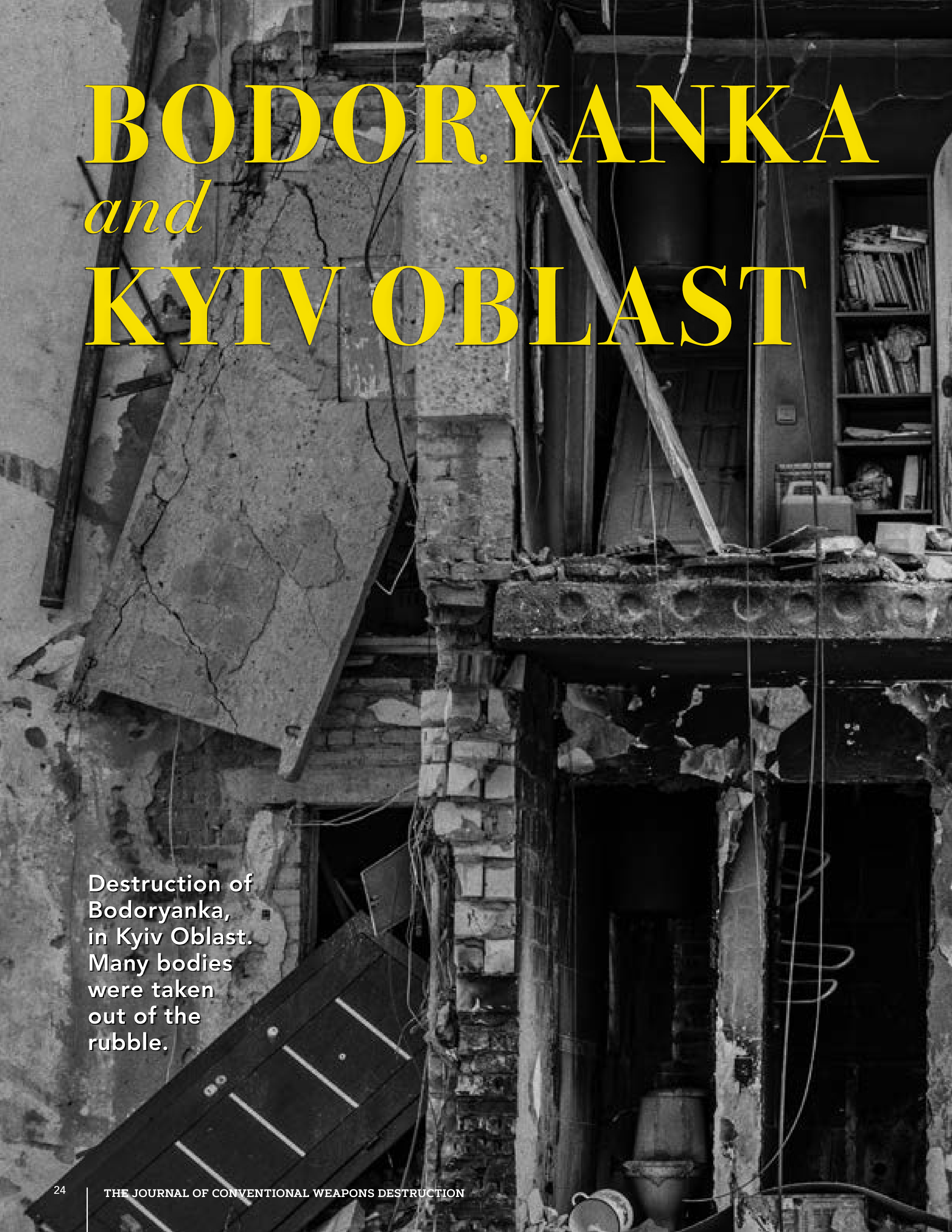
Through the crack of a blast-damaged door a hand grenade can clearly be seen. It has been placed on top of a large water dispenser. It could be a booby trap. Perhaps the water container has something other than water in it. Authorities were informed of the hand grenade. Booby traps have been widely reported in areas previously controlled by Russian forces.

Lindila and Tatiana came back to their flats in Irpin to check on their homes and their cats.

Possible booby trap.

A children's playground hit with cluster munitions. The unmistakable marks including fragmentation "splatter" can be seen all around the area.

BODORYANKA *and* KYIV OBLAST



Destruction of Bodoryanka, in Kyiv Oblast. Many bodies were taken out of the rubble.

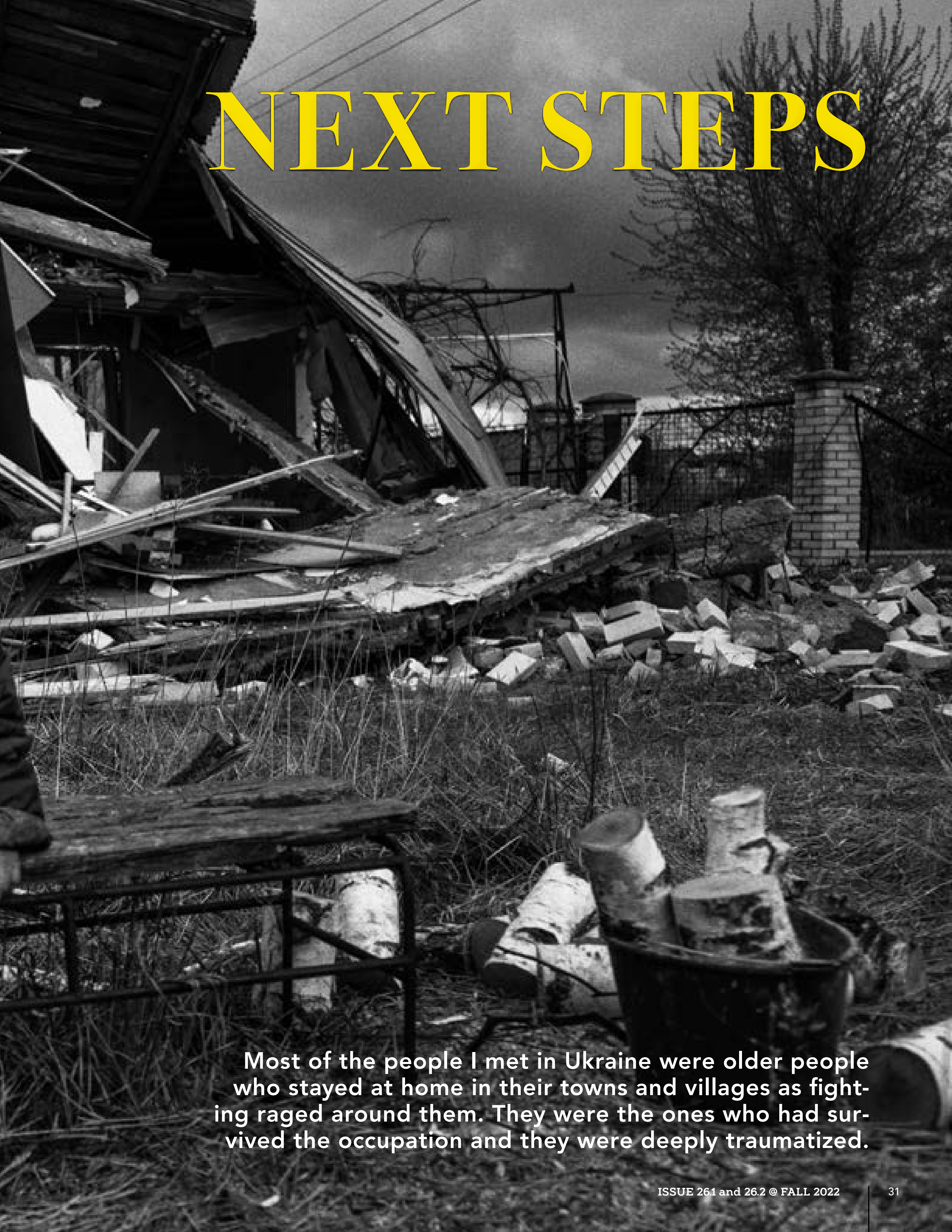
Large areas of Bodoryanka were destroyed during intense and sustained bombardments.

Sandbags protect entrances, and sandbagged positions, barricades, and hedgehog anti-tank obstacles are set up in many parts of Kyiv.

We have a big job on our hands. There is such a huge problem with explosives, and we are very busy. Some areas like Hostomel have a lot of landmines and we are finding a lot of boobytraps. In Bucha, bodies were booby trapped with hand grenades placed under their armpits. In two months, my team has dealt with more than twelve tons of ordnance in three villages.

There are rings of defenses inside and outside the city.

An army EOD team dealt with rockets and rocket pods from a downed Russian MI-8 helicopter. Four bodies were sprawled among the wreckage. The helicopter was shot down near Makariv by Ukrainian forces on 17 March 2022.



NEXT STEPS

Most of the people I met in Ukraine were older people who stayed at home in their towns and villages as fighting raged around them. They were the ones who had survived the occupation and they were deeply traumatized.

Rebuilding after the conflict.

Just days after the Russian troops had been pushed out, villages were being cleared by groups of volunteers traveling amidst the devastation. It is this resilience that stood out to me. This is but a brief snapshot of what I saw and offers only a glimpse of the enormity of the work that the mine action sector will face in the years to come.

Galina outside her flat.
The other side of the building
is completely destroyed.

We are survivors. Five of us stayed here during everything. It was terrible. Many died. Our building was repeatedly hit. Now we survive on the little food we have. There is no electricity, no water. We cook outside and collect river water. That's how we survive. Before we were neighbors, but now we are family.

Sean Sutton
Photojournalist and International Communications Manager
MAG (Mines Advisory Group)
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https://www.maginternational.org/

Sean Sutton is an award-winning photojournalist; his well-known pictures show the impact of landmines and explosive remnants of war on communities and have been published and exhibited all over the world. His book documenting how unexploded ordnance affects people in Laos was runner-up for the Leica European Publisher's Award. Sutton is MAG's International Communications Manager and has worked for the organization since 1997.

Mine sign, Ukraine, June 2022.
Image courtesy of The HALO Trust.

OPEN-SOURCE RESEARCH AND MAPPING OF EXPLOSIVE ORDNANCE CONTAMINATION IN UKRAINE

By Andro Mathewson [The HALO Trust]

Due to Russia's full-scale invasion of Ukraine, the scale of explosive ordnance (EO) contamination in Ukraine has reached unprecedented levels, necessitating new methods to assess and track the different types of ordnance and the level of contamination across the country. As the most documented, active war on social media to date, The HALO Trust (HALO) has successfully harnessed open-source research to better plan and conduct survey, clearance operations, and explosive ordnance risk education (EORE) across the country.

Russian's full-scale invasion of Ukraine, which began in February 2022, has become "the first open-source war," where almost every aspect of the conflict on the ground has an online counterpart—from logistics and guidance systems to humanitarian aid delivery and conflict mapping.[1] As the transport of supplies occurs on the ground, the plans thereof are drafted online. As the soldiers adjust the guidance systems of their weaponry on the frontlines, engineers online are solving issues that arise. As humanitarian aid is being delivered across Ukraine, teams of analysts are crunching data to prioritize the regions with the highest need. As the conflict progresses and frontlines move, researchers are mapping the conflict and its devastating effects on Ukraine, including the EO that is left behind in areas where the fighting has subsided.

TM-62M, first landmine found from latest war in Ukraine, 2022.
Image courtesy of HALO.

The scale of EO contamination in Ukraine has reached unprecedented levels, necessitating new methods to assess and track the different types of EO and the level of EO contamination across Europe's largest country due to its inaccessibility to organizations working in-country as a result of the ongoing conflict. Harnessing open-source research, satellite imagery, and online investigations, HALO is leading this effort and has been able to assess and map EO contamination across Ukraine for humanitarian end-purposes, allowing HALO staff working in Ukraine to better plan and conduct survey and clearance operations as well as EORE across the country.

HALO has been working in Ukraine since the end of 2015 in the government-controlled areas of Donetsk and Luhansk oblasts. Over seven years, HALO teams conducted non-technical survey (NTS), clearance, and risk education throughout the region, particularly along the contact line that existed until February 2022. Russia's full-scale invasion in February temporarily brought survey and clearance work to a halt, while staff focused on moving their families to safety in the west of the country and assisted with aid distribution, risk education, and first aid training. The Russian withdrawal from Kyiv, Chernihiv, and Sumy oblasts by early April 2022 provided a window for operations to resume safely and HALO relocated its operations to a base just outside Kyiv to be able to work in these three regions. Despite the uncertainty during the initial stages of the war before the partial Russian withdrawal, HALO wanted to be fully prepared for future operations and began using a "remote" approach to understand the type of EO used and the scale and impact of contamination within Ukraine. This article explains the path HALO has taken to track EO and explosive remnants of war (ERW) across Ukraine online using open-source research and mapping techniques. Such well-structured open-source research based on social media is becoming an increasingly important part of the desk assessment phase and contextual information required for NTS.[2]

The Context in Ukraine

By mid-July, Russia occupied approximately 126,610 square kilometers of Ukrainian territory,[3] almost twenty-one percent of the entire country, including areas in the east, south, and the Crimean Peninsula. Since the full-scale invasion started on 24 February 2022, the conflict has seen more than an estimated 100,000 deaths of soldiers on both sides, foreign volunteers, and civilians.[4] During the initial stages of the war in February and March 2022, Russian troops moved swiftly across northern, eastern, and southern Ukraine, encircling cities such as Kharkiv, Kyiv, and Mariupol. By April, Russian forces had retreated or been pushed back from most newly occupied areas, except along Ukraine's southern coast reaching Kherson in the west and large parts of Luhansk, Donetsk, Kharkiv, and Zaporizhia Oblasts, creating a frontline of approximately 2,000 kilometers long.

As with all conflicts that involve conventional military technologies and tactics, such as the use of heavy artillery and anti-personnel and anti-tank landmines for area denial, the war in Ukraine has led to vast amounts of EO contamination across the country, leaving civilians directly at risk. However, the situation is worsened by the indiscriminate use of cluster munitions and the presence of kicked-out munitions from destroyed military vehicles and ammunition depots, which also pose a threat to civilian bystanders. Understanding these different threats to civilians and the location of EO contamination is critical to effective and efficient humanitarian demining operations.

Figure 1. Assessed control of terrain in Ukraine as of 20 July 2022, 3:00 p.m. ET. © 2022. Institute for the Study of War (ISW) and American Enterprise Institute's Critical Threats Project made possible by the Dr. Jack London Geospatial Fund at ISW.
Figure courtesy of ISW.

9N255 cluster submunition in Ukraine, June 2022.
Image courtesy of HALO.

MRV-U impact fuzes for grad system.
Image courtesy of HALO.

Defining Open-Source Research

Open-source research is the process of collecting and analyzing legally gathered information from publicly available sources only, without the use of clandestine collection techniques and containing no information from private or classified sources. Open-source research can be conducted in a variety of ways depending on the scenario, information desired, and availability. In simple terms, it revolves around the collection of information, predominantly online but also via verbal or written communication, with the end goal of analyzing the collected data to extrapolate an analysis. Depending on the situation, the analysis can be used to inform the public about an important topic, advise public and national policies, or inspire a call to action.

Risk education, Ukraine, 2022.
Image courtesy of HALO.

While open-source research is frequently used in national security and law enforcement, with the expansion of the internet, smartphones, and social media, it has become an accessible tool used by non-governmental organizations and individuals alike.[5] Since the start of the Syrian civil war in 2011 and the conflict in eastern Ukraine in 2014, open-source research has also become a constant of modern warfare, helping to thin out the fog of war.[6] Many global organizations use open-source information, including the United Nations, to support peacekeeping operations and plan the delivery of aid during times of crisis or disaster. The war in Ukraine is by far the most active conflict on social media of all time, consequently allowing HALO to leverage the high volume of information using open-source research for the collection and analysis of data on EO contamination in Ukraine. This in turn has enabled HALO to better plan and conduct operations and carry out EORE activities more efficiently and effectively. This includes determining the priorities for the deployment of NTS and clearance teams, to informing the procurement of the most appropriate equipment for the expected threat.

Lipivka minefield clearance, Ukraine, 2022.
Image courtesy of HALO.

HALO's Approach to Open-Source Research

HALO has previously used open-source research for a small-scale project in Tripoli, Libya, where researchers focused on social media posts that were sharing photos and videos, indicating evidence of landmines and improved explosive devices. The exact locations of contamination finds were then placed on a map alongside the frontlines of the 2018 battle for Tripoli (see Figure 2). Plotting the locations of unexploded ordnance and battlefield frontlines enabled HALO to prepare for NTS—the process of identifying and marking suspected and confirmed hazardous areas—and prioritize areas with high levels of contamination and high levels of human activity. Since March 2022, this approach has been successfully applied to and expanded in the Ukraine context.

HALO's current open-source research methodology includes five central stages, as outlined in Table 1.

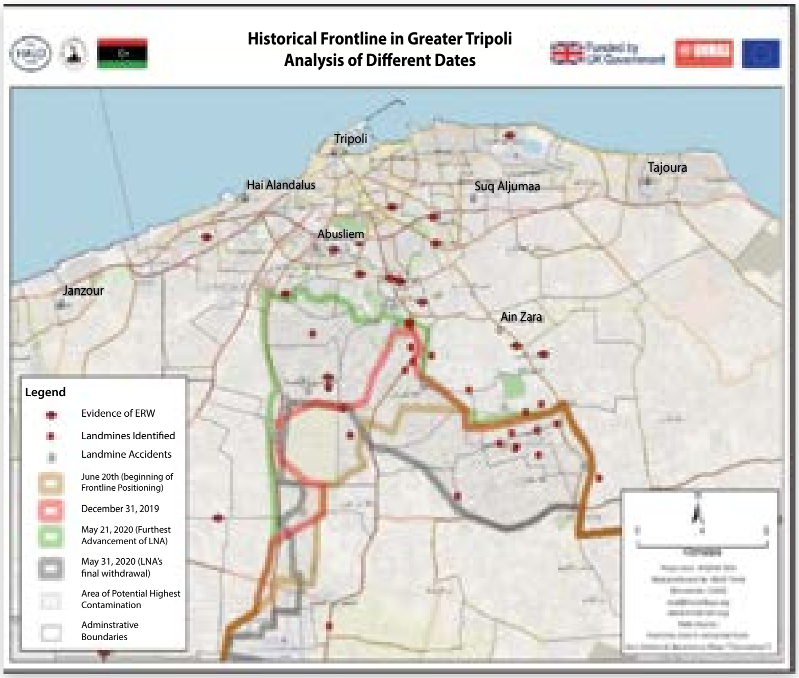


Figure 2. Historical frontlines and ERW locations in the greater Tripoli area.
Figure courtesy of HALO.

No.	Research Stage	Ukraine Context
1.	Determining end goals and focus of research	Map the EO contamination in Ukraine due to the Russian invasion, including the location of civilian accidents due to ERW (see objectives in Table 2)
2.	Identify sources	Social media (Telegram, Twitter, and Facebook), traditional media (Ukrainian and international news outlets), think tank reports, and research organizations (Live Universal Awareness Map and Armed Conflict Location Event Database (ACLED))
3.	Conduct searches online	Conduct deep-dive searches through online media for relevant events within set objectives (see Table 2)
4	Verify/geolocate events	Use verification and geolocation techniques to ascertain the veracity of reports and identify the precise location of events
5.	Mapping, collation, and analysis of data	Extrapolate information from the data to inform HALO's survey, planning, clearance operations, and EORE delivery

Table 1. HALO's open-source research methodology.
Table courtesy of HALO.

The first of these stages, determining the end goals and the focus of research, resulted in the identification of thirteen objectives with different purposes as outlined in Table 2.

Objectives/Categories	Purpose
Track the movement of frontlines	To locate areas with a high likelihood of EO contamination
Track areas of prolonged fighting	Provides evidence points for future NTS teams to investigate
Identify locations of cluster munition strikes	Provides evidence points for future NTS teams to investigate
Identify locations of any EO	Provides evidence points for future NTS teams to investigate
Identify locations of destroyed military vehicles	Provides evidence points for future NTS teams to investigate
Identify locations of air and missile strikes	Provides evidence points for future NTS teams to investigate
Identify all types of EO used in the conflict	Tailor EORE campaign and materials for items found in the region; Tailor explosive ordnance disposal (EOD) training ID guides; identify suitable procedures and EOD tools; inform all HMA actors of what to expect in the region; inform procurement of machines and detectors
Identify areas of landmine/improvised exposive device contamination	Provides evidence point for future NTS teams to investigate; information can be shared with other humanitarian actors enabling safer delivery of humanitarian aid
Identify any strikes on ammunition storage facilities	Provides evidence points for future NTS teams to investigate
Identify vehicles and weapon systems used in the conflict	Assists in defining what type of munitions could be used by these platforms, which then helps with EO recognition
Identify the location of civilian accidents and the number of casualties from UXO	Monitor the number of civilian casualties due to UXO; report this figure to other humanitarian actors; assist in planning or provision of victim assistance activities
Identify destroyed infrastructure	Critical information for wider humanitarian effort
Understand the causes of non-HMA demining accidents reported in the media	Provides evidence point for future NTS teams to investigate; assists in defining potential hazards to deminers in HMA.

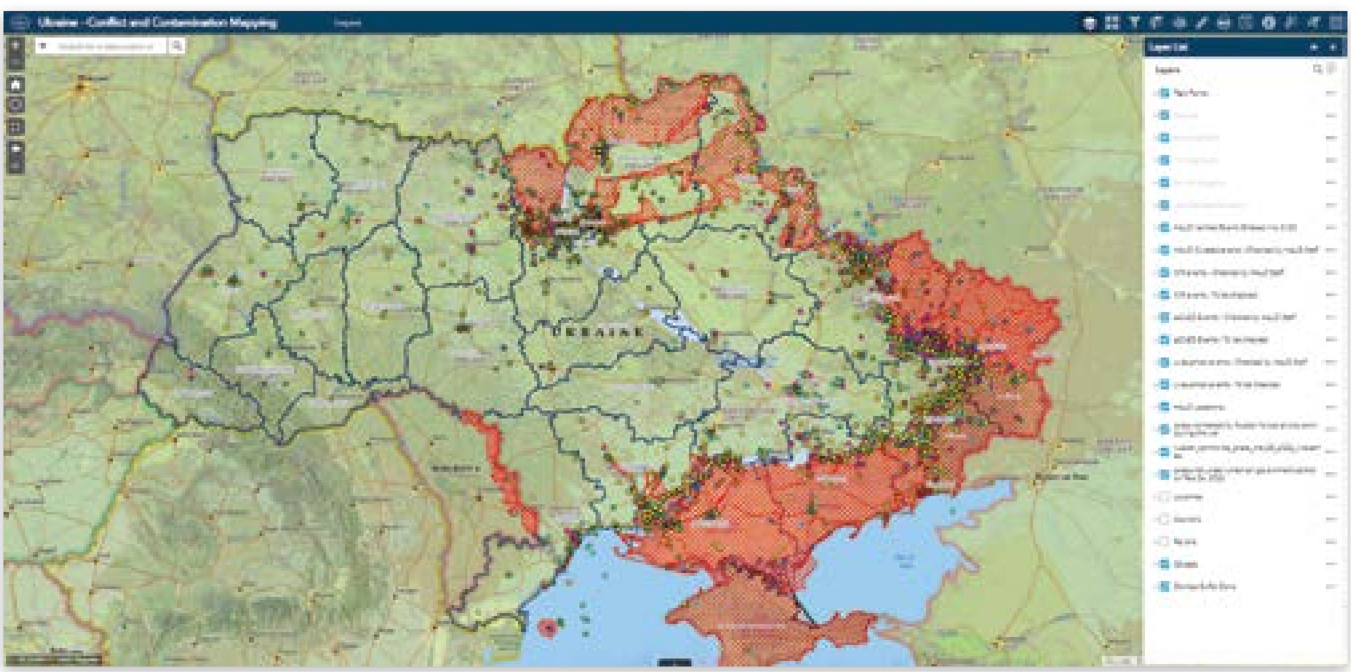
Table 2. Identified objectives.
Table courtesy of HALO.

Tank rounds, Ukraine, 2022.
Image courtesy of HALO.

The second step involves identifying publicly available sources to procure information. The majority of HALO's information stems from social media platforms, primarily Twitter, Telegram, and Facebook, but also Reddit and YouTube. HALO uses advanced search techniques such as boolean logic searches to filter content and find images and videos about the aforementioned categories. Another large source of information is local Ukrainian news and media outlets, such as Suspline Media, Unian, and RBC-Ukraine, as well as official press releases of Ukrainian local police forces or government officials. Finally, HALO also utilizes publicly available pre-collated databases with pertinent information, such as those by Live Universal Awareness Map, ACLED, the Center for Information Resilience, and volunteer groups, such as Geoconfirmed.

The third step of HALO's open-source research project is verifying the data that is discovered using the different sources previously mentioned. HALO follows a four-step verification process. This begins with assessing the originality of the image or video in question. If the image or the video was used before, it is frequently possible to trace it back to the original online posting via a reverse image and/or video search. There are a multitude of different tools online that allow such searches and will show if an image has been posted before the current post. This helps to minimize false claims of EO items apparently found in Ukraine, which might actually stem from other conflicts. After determining the originality of the content, the reliability of the source is assessed on a scale of low, medium, or high reliability. If the information stems from official Ukrainian government sources, a well-recognized media outlet, or social media account and can be corroborated by at least one other source, it is classified as "highly reliable." If it cannot be corroborated by other sources, it falls under the "medium reliability" category. The previous two categories are added to HALO's database and map, which is shared with other actors in the humanitarian mine action (HMA) sector. If it stems from a previously unknown source and provides little detail, it is classified under the "low reliability" category and not included in our public-facing datasets until it can be verified. The third step in the verification process is geolocating the image. Geolocation is the identification of the geographic location of an object in an image via a variety of data collection mechanisms, such as satellite imagery and GPS metadata. However, HALO only uses satellite imagery and other mapping tools to geolocate source material, as metadata is often sensitive and has restricted access. The geolocation of an image not only helps to ascertain the veracity of the content (e.g., does it depict an event within Ukraine or is it from another conflict), but it also facilitates HALO to create a detailed map depicting all events

Figure 3. HALO's conflict and contamination map as of 26 September 2022. Each dot corresonds to a unique event involving EO and the colors represent a different category based on HALO's project objectives.
Figure courtesy of HALO.



discovered by open-source research, creating a portrait of the conflict in Ukraine, as shown in Figure 3.[7]

This enables HALO to plot areas with high EO contamination (according to the previously mentioned objectives) and overlaps them with areas of high human activity, such as densely populated areas or farmland. This subsequently allows HALO to prioritize different survey, clearance, and EORE tasks. The final step of the verification process is assessing when the image or video was posted online. If it was posted before the annexation of Crimea and the occupation of the eastern reaches of Luhansk and Donetsk Oblast in 2014, the content definitively does not portray (new) EO in Ukraine.[8] If an image is posted post–2014, it increases the likelihood that it accurately depicts ERW in Ukraine.

The last stage of the open-source research process is to collate and analyze the data, which allows for the production of several different outputs, all of which help to inform either HALO's operations or HALO's donors and other humanitarian organizations. At the time of publication, HALO has gathered and verified 20,000 unique events, within the thirteen categories previously mentioned, showing the location of each event, including 196 accidents involving civilians (112 deceased and 257 injured).[9] These are depicted in Figure 4.

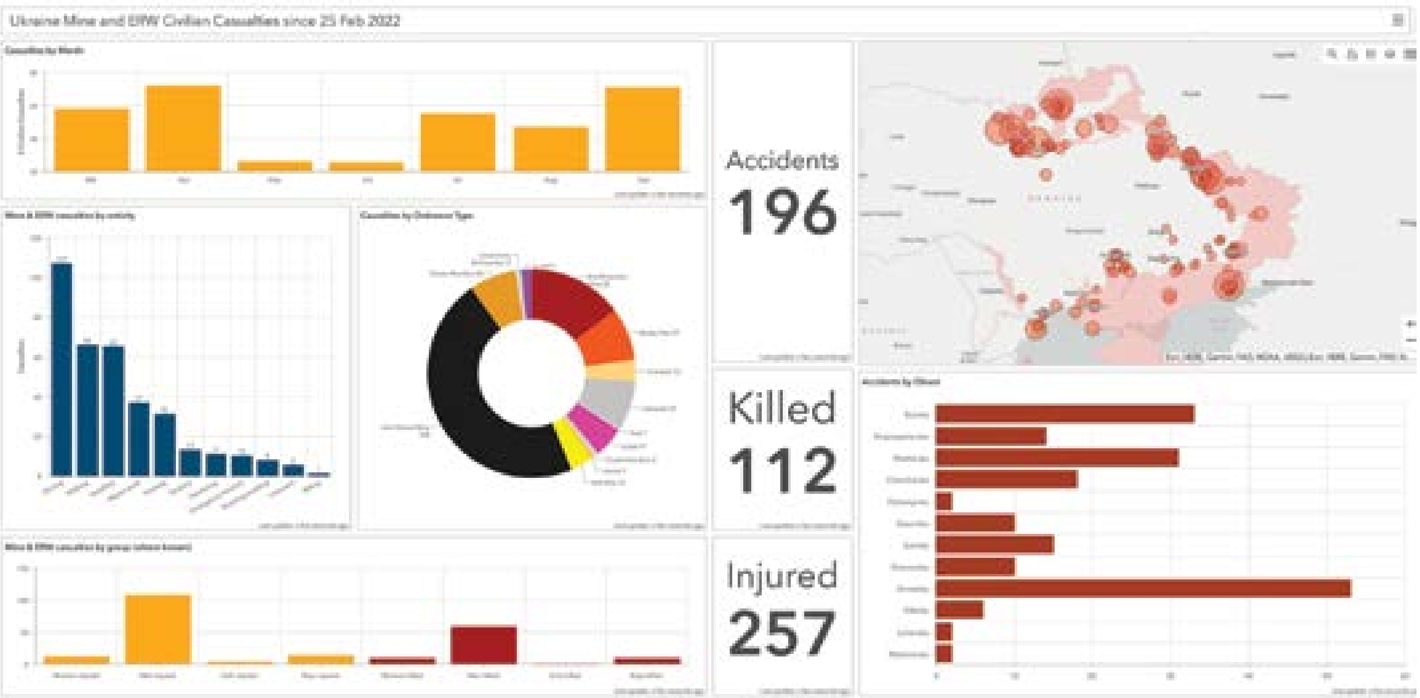
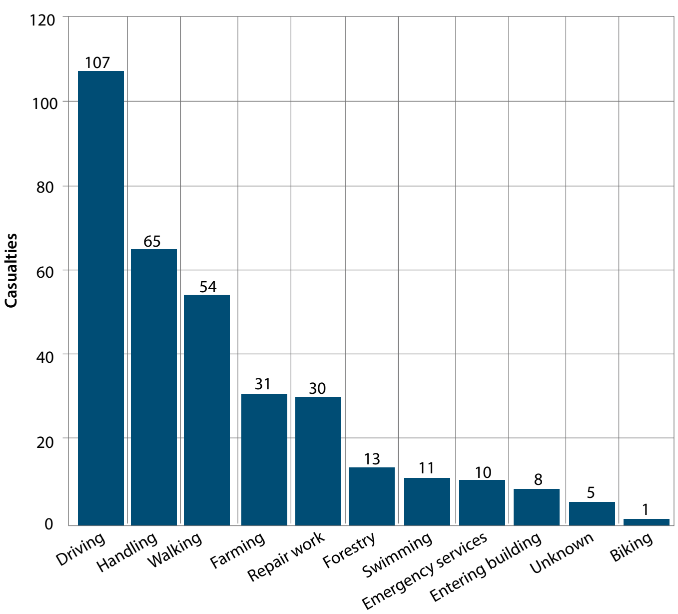


Figure 4. HALO's dashboard showing data gathered on civilian accidents due to UXO in Ukraine.
Figure courtesy of HALO.



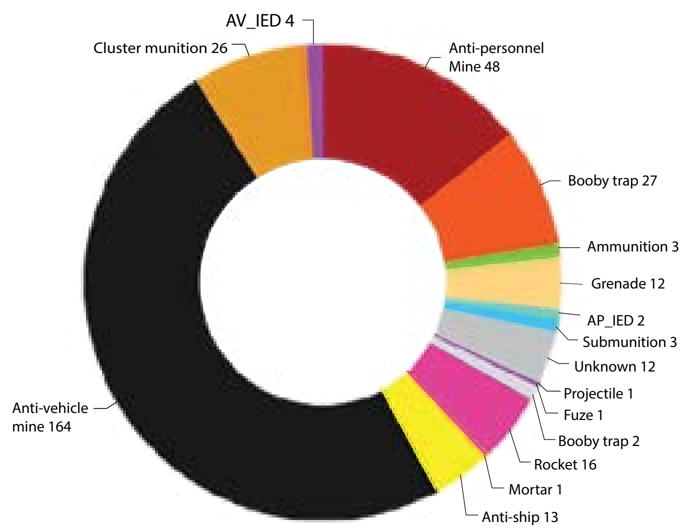


Figure 5. Casualties by activity (left); casualties by EO type (right).
Figure courtesy of HALO.

Anti-tank mine strike,
LADA Nova, Ukraine, 2022.
Image courtesy of HALO.

HALO's research has also identified 400 unique types of EO used in the conflict, primarily Russian or Soviet-made munitions but also many Western designs. HALO does not currently track different types of small arms and light weapons (SA/LW). However, the tracking of SA/LW represents a potential area of expansion for the project, especially to focus on Man Portable Air Defense Systems (MANPADS), which have been used extensively throughout the war. The knowledge accumulated through open-source research has allowed HALO to understand the EO contamination of Ukraine in-depth and has aided in the planning of areas of operations, prioritization of tasks, training of staff, equipment purchases, and risk education activities.

An example of HALO's open-source research leading to clearance operations is one of HALO's tasks in the region east of Kyiv, near the village of Hoholiv. On 5 April 2022, a tractor hit an anti-vehicle mine, resulting in the injury of the driver. This was reported in the local newspaper, the *Brovary Tribune*.[10] The site of this accident subsequently became one of HALO's first clearance tasks after the Russian withdrawal from Kyiv Oblast earlier that month, which allowed HALO to safely resume operations in the region.

While incredibly valuable to HALO, open-source research does come with its own set of unique challenges. One of the major challenges is the impossibility to collect all information on EO contamination across Ukraine. While the level of detail in reporting of the conflict is immense (to the level that it creates the issue of informational overload), there will be explosive events that remain unreported due to the fog of war and the immensity of the scale of Ukraine and the war itself. Additionally, the complete verification and precise geolocation of data is sometimes impossible, either due to the presence of misinformation or the lack of sufficient information associated with the imagery or in the image itself. Another challenge is the size of resultant datasets, numbering in the tens of thousands, which require cleaning while each data point requires verification.

A final challenge faced by HALO in conducting open-source research is the policies of many social media companies that remove content due to its graphic nature before HALO can access and archive it for verification and geolocation. Despite these issues, however, HALO's open-source research and mapping project has shown promise in helping to understand the progression of the conflict and its resultant effects on Ukraine.

300m 9M55 rocket, Ukraine, 2022.
Image courtesy of HALO.

Anti-tank mine strike near Hoholi, Ukraine.
Image courtesy of HALO.

Limitations of Open-Source Data

Both social media and news media tend to emphasize the new and unusual. For example, there has been extensive coverage of the use of the POM-3 scatterable mine and improvised munitions such as drink cans with explosives dropped by altered commercial off-the-shelf drones. Yet, the frequency of news reports does not match their prevalence on the ground, nor their impact on civilians.

Casualty data from open-source reporting, followed by the work of HALO's NTS and clearance teams, so far demonstrates that anti-vehicle mines—primarily the TM-62M variant—are causing the majority of accidents with the highest number of casualties. Clearing the land of anti-vehicle mines is subsequently where the bulk of HMA resources will need to be committed.

Armoured personnel carrier strike near highway and playground, Ukraine, 2022.
Image courtesy of HALO.

Moving Forward and Wider Use

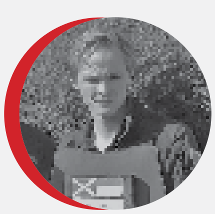
NTS team, Ukraine, June 2022.
Image courtesy of HALO.

Moving forward, HALO is looking to expand the scope of tools used in this project to reduce the amount of manual labor needed for the data processing aspects of the research. This potentially includes leveraging artificial intelligence to assist with both internet scraping and data cleaning tasks although these tools must be designed to work with original source data in Ukrainian and Russian to minimize the chance that any details are lost in translation.

As time progresses, HALO will begin to evaluate the effectiveness of the project, with a special focus on understanding its use for targeted EORE activities and assessing what proportion of recorded events have resulted in the subsequent creation of suspected hazardous areas or confirmed hazardous areas once followed up by NTS teams on the ground. Importantly, the use of such open-source research techniques is easily transferable to other locations and projects within the HMA sector and beyond, especially where in-country access is restricted for whatever reason or there is a lack of data regarding EO used in the conflict and the resultant contamination. The ability to conduct in-depth research online allows organizations like HALO to have a detailed understanding of the conflict even before stepping on the ground.

See endnotes page 105

HALO deminer, Kyiv Oblast, June 2022.
Image courtesy of HALO.



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EXPLOSIVE WEAPONS USE AND THE ENVIRONMENTAL CONSEQUENCES: Mapping Environmental Incidents in Ukraine

By Linsey Cottrell, Eoghan Darbyshire, PhD [Conflict and Environment Observatory],
and Kristin Holme Obrestad [Norwegian People's Aid]

All conflicts result in environmental impacts. The use of explosive weapons can cause massive damage to civilian and industrial infrastructure, resulting in the contamination of air, soil, and water resources. The war in Ukraine has highlighted the heavy toll on the environment, and the risk of significant environmental harm.

Chernihiv, April 2022.
Image courtesy of Oleksandr Ratushniak / UNDP Ukraine (flickr).

Ukraine has an extensive and diverse industrialized economy, including heavy manufacturing and nuclear facilities. As well as the environmental risks from existing contamination linked to its industrial heritage, the targeting and damage to commercial, industrial, and energy infrastructure has exacerbated these risks for civilians and the wider environment. This means an increased risk of exposure for people living within or near impacted areas, as well as for humanitarian and mine action workers delivering support to these communities.

Data is critical and it is important that environmental incidents and their significance are mapped and monitored.[1] This will help provide an indication of the geographical spread of environmental damage, and prioritize remediation needs. It is also important to communicate more widely the environmental consequences of conflict, which are often ignored or considered a low priority. This is despite the risk of environmental degradation undermining human health, livelihoods, and security, and despite the UN General Assembly declaring that everyone has the right to a healthy environment.[2]

Monitoring Conflict Pollution

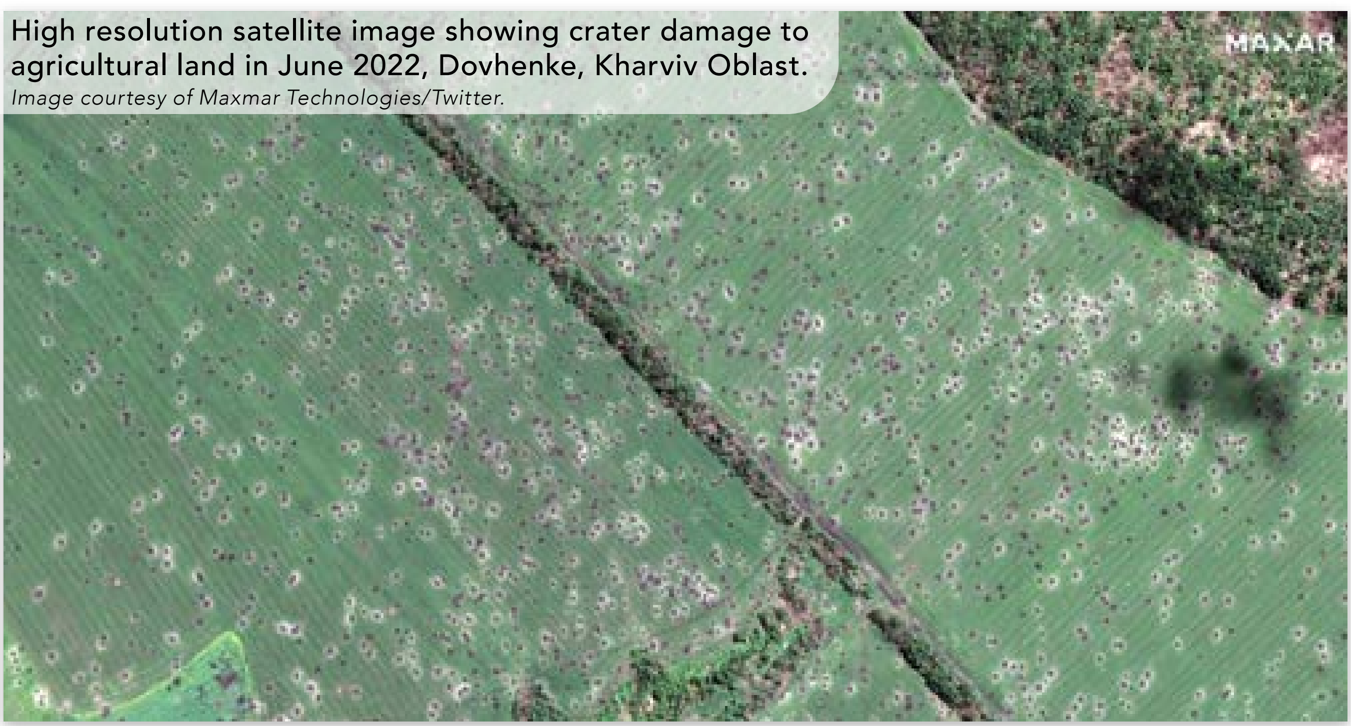
Conflict pollution describes the contamination caused by the direct damage to infrastructure, by the use of particular weapons, or from the absence or collapse of environmental governance during and after conflict.[3]

In conflict settings, collecting environmental data and monitoring the impacts of conflict pollution can be limited and extremely challenging. Satellite remote sensing can be used to fill the gap and a useful tool to monitor both short-term impacts and long-term environmental change.[4] But remote sensing has limitations; for example, the majority of satellite sensors rely on the sun's rays, and so cannot provide data when it is dark or cloudy. While radar imaging can overcome these challenges, it only orbits above many locations a few times each month, and so is of limited use for time-sensitive research. To fully understand the environmental risks, satellite data needs to be blended with more detailed information from the ground.

A range of data sources are required to generate robust remote assessments, which may include help to identify priority locations for remediation. The scale of environmental data collection in Ukraine is far beyond that of past and contemporary conflicts. International nongovernmental organizations (NGOs), including the Conflict and Environment Observatory (CEOBS), Zoï Environment Network, IMPACT, and PAX, have been collating data on environmental incidents to support agencies, and help inform the authorities and other humanitarian actors on follow-up sampling, evaluation, and remediation needs. Zoï Environment Network has used information primarily from government and traditional media sources to produce maps on its Ecodozor platform (see Figure 1).

The CEOBS database incorporates detail to enable an assessment of the environmental risk. The first step is to identify incidents. This is achieved via a semi-automated search of social media, in particular Twitter and Telegram, plus traditional media reports, tip-offs, or the use of pre-existing databases and monitoring networks. The next step is to collect and archive as much information on the incident as possible. This requires both the aforementioned sources and

High resolution satellite image showing crater damage to agricultural land in June 2022, Dovhenke, Kharviv Oblast.
Image courtesy of Maxmar Technologies/Twitter.



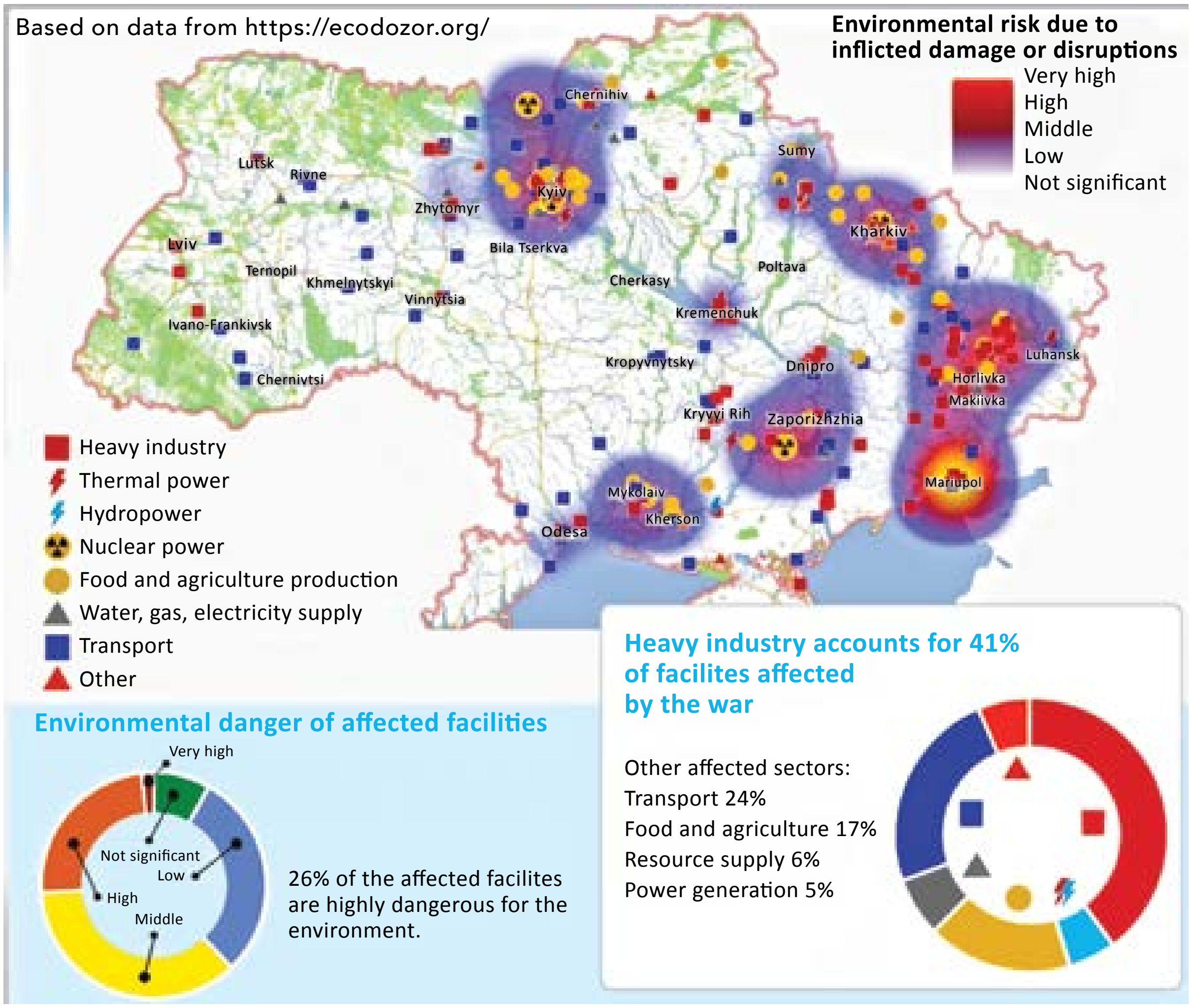


Figure 1. Mapping of environmental risks from damage to industry and infrastructure, based on data from https://ecodozor.org/
Image courtesy of Zoï Environment Network.

satellite data, such as before and after imagery[5] or active fire data.[6] By collecting and combining all this information, it is possible to locate precisely where an incident occurred, verify that it occurred and at the stated time, classify the incident type and severity of damage, and finally, assess the environmental risk. Verification is important given the potential for fake news, disinformation, or politicization.[7] The environmental risk is established via a simple qualitative score-card which takes into account air, water, and soil pollution, and proximity to dense populations or ecologically important areas.

Nature of Environmental Incidents

The war in heavily industrialized Ukraine has seen attacks on a wide range of industrial facilities and infrastructure. There are thousands of entries in the Ecodozor database, and this only includes those incidents for which there is reporting. The true number is likely much higher.

Figures 2, 3, and 4 illustrate examples from the CEOBS database that indicate the broad range of incidents taking place in Ukraine, which can give rise to short- or long-term environmental concerns. Many incidents will have direct consequences on humanitarian mine action operations, which must be addressed under the standard operating procedures and risk assessments of organizations deploying humanitarian and mine action staff.

Within urban settings, there are multiple potential sources of pollution and proportionately more people vulnerable to the risk of exposure to contaminants. With commercial and industrial units, utility infrastructure, filling stations, workshops, fuel storage, and garages all located in urban areas, the use of explosive weapons can result in contamination and the release of a host of toxic and hazardous chemicals from damaged buildings and infrastructure. This can create airborne contaminants and can contaminate water resources and/or underlying soils, negatively impacting human health through direct contact, inhalation, or ingestion of chemicals or contaminated soils. It can also create indirect pathways to exposure, for instance from leaching through soils, migrating to underlying groundwater, and flowing into streams or rivers.

Although not unique to the conflict in Ukraine, the anticipated widespread presence of asbestos within building fabric and conflict debris also presents a serious health and environmental hazard. Ukraine was a major producer of asbestos, with high rates of asbestos use in construction over many decades. Records on the location, nature, and distribution of asbestos-containing materials in Ukraine, however are unclear, meaning that response plans must take into consideration the likely presence of asbestos and take action to reduce the risk of exposure and harm.[8]

Other contaminants of potential concern include metals like lead and chromium, fuel oils, PCBs,[9] fire retardants, and explosives. Their presence will vary depending on location, urban setting, age, nature of construction materials, and the type of land uses. Some contaminants will disperse and eventually degrade in the environment, but many do not and will persist for years.

There are also the risks associated with the use of specific weaponry. It is currently unclear if, or to what extent, depleted uranium (DU) ammunition has been used in the fighting in Ukraine.[10] DU is both radioactive and chemically toxic. If the use of DU is confirmed, key potential exposure routes for people include contact, and the inhalation or ingestion of DU-contaminated soil or particulates.[11]

Facility #1: Agricultural warehouse, Dolgenkoe farm

Incident description: Fertilizer explosion (ammonium nitrate)

Impact: Significant physical damage and chemical release (including nitrogen oxides to air). No surface water in close proximity, but visible impact on soils.

Preliminary risk screening: Medium (overall)
- **Short-term – high risk:** physical injury from explosion, inhalation of toxic fumes and particulates
- **Longer-term – medium risk:** persistent ground contamination from combustion products, agrochemicals and fuels

Figure 2. Dovhenke, Kharkiv Oblast, May 2022.
Image courtesy of Pavlo Kyrylenko/Telegram.

Facility #2: Waste management facility

Incident description: Facility destroyed

Impact: Significant physical damage, but no obvious fire or release of chemicals. Nearby surface water feature and visible impact on soils.

Preliminary risk screening: Medium (overall)
- **Short-term – high risk:** contaminated discharge to nearby surface water
- **Longer-term – medium risk:** persistent ground contamination

Figure 3. Lyubotyn, Kharkiv Oblast, March 2022.
Image courtesy of Tpyxa News/Twitter.

Facility #3: Aistra petroleum storage and reserve

Incident description: Fuel fire

Impact: Significant physical damage, fire and chemical release. No obvious nearby surface water, but visible impact on soils. At least six fuel silos destroyed.

Preliminary risk screening: High (overall)
- **Short-term – high risk:** physical injury from explosion, inhalation of toxic fumes and particulates
- **Longer-term – medium risk:** persistent ground contamination from cobustion products, agrochemicals and fuels

Figure 4. Chernihiv, Chernihiv Oblast, March 2022.
Image courtesy of State Emergency Service of Ukraine/Facebook.

Within urban settings, there are multiple potential sources of pollution and proportionately more people vulnerable to the risk of exposure to contaminants.

Observations during survey and clearance operations by mine action operators on waste, debris, and other pollution can support remediation planning.
Image courtesy of CEOBS.

Support Through Collaboration

Impact monitoring is required to understand the on-going environmental risks and damage caused by conflict, yet challenging to conduct on the ground. Remote assessment databases are important, but these will not be comprehensive and incidents will be missed, particularly smaller incidents or those occurring in less populated areas.

As well as organizations collating data using remote tools, local actors are needed. Given technical and capacity constraints, collaboration and the provision of elementary environmental data and incident reporting by mine action operators and other civil society actors can be a useful, additional resource. Mine action operators could be an important part of such efforts in Ukraine, helping to report on-the-ground evidence or suspicion of pollution, or environmental damage (see Figure 5). Mine action operators are particularly well-suited to support this given their expertise in data management systems, evaluating risk, understanding risk priorities, and communicating these risks to local communities.

Supported by guidelines, such as a planned update to IMAS 07.13,[12] mine action operators could report and provide eyewitness accounts of conflict pollution incidents. At a minimum, actions should be in place to manage risks including:

1. **Non-technical surveys to consider the potential for chemical pollution to be present in or adjacent to task areas, with specific questions directed to the local community and local authority;**
2. **Health and safety files for task areas to include the potential for chemical pollution and control measures to be in place;**
3. **Site reconnaissance to include a visual inspection of ground conditions, including checks for the signs of environmental incidents and risk of environmental harm;**
4. **Provision of appropriate personnel protection equipment for field staff;**
5. **Site induction to inform all site staff of anticipated ground conditions and operating procedures;**
6. **Maintenance of appropriate records, detailing the date, location, nature, cause, and extent of the environmental incident and reporting action taken; and**
7. **Reporting of incidents to landowners or users, and, where possible, the local authorities or other agencies involved in post-conflict and field assessments.**

Mine action operators are not environmental specialists, and collaboration with environmental partners should be encouraged, both to allow delivery of competency training, where needed, and to disseminate data on conflict pollution. Environmental NGOs in Ukraine, such as Ecoaction and Environment People Law,[13] have been investigating and assessing the environmental impacts of the conflict and the wider environmental effects. There is also wide support across civil society organizations in Ukraine for a green recovery policy, acknowledging that the repeal or weakening of any environmental legislation in post-conflict recovery would be unacceptable.[14] Additional measures may be required, when pollution-impacted areas are identified or suspected. Under such circumstances, operating in these areas may require specialist environmental support or advice, including the development of task-area specific operating procedures (for example for the control of excavated materials, waste, dust, and drainage) and enhanced local engagement.

Figure 5. Examples of evidence of environmental incidents or damage. *Image courtesy of CEOBS.*

To fully support the resolution of the UN Environment Assembly addressing conflict pollution,[15] data will be needed to inform the environmental assessments, target remedial action for higher risk sites, and enable reconstruction. Pollution can inflict physical, psychological, socioeconomic, and cultural harm on individuals and communities, and an inadequacy of data is one of the barriers to assisting victims either in Ukraine or elsewhere.

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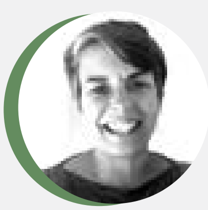
The remote environmental incident monitoring in Ukraine undertaken by CEOBS to date has been supported by the CEOBS and Norwegian People's Aid partnership agreement with the Norwegian Ministry of Foreign Affairs and by the United Nations Environment Programme.



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Kristin Holme Obrestad is the Senior Climate and Environmental Advisor at Norwegian People's Aid (NPA), responsible for developing NPA's approach to climate, environment, and conflict on a policy and operational level, and greening the organization. Holme Obrestad has a Master's in Political Science and has an extensive background from policy, mine action, and environment work.

A BRIEF HISTORY of Mine Detection Dogs

By Roly Evans [Geneva International Centre for Humanitarian Demining]

Since their first use in World War II, the use of Mine Detection Dogs (MDDs) has been subject to ongoing debate. How effective are they really in finding mines? Are they really worth the expense they entail? As with so many aspects of modern survey and clearance operations, many of the lessons we continue to learn today have already been learned in the past. A brief history of the contribution of MDDs over the past eight decades can help us put their performance into perspective and understand where they can add significant value, while also appreciating their limitations.

A Belgian Malinois MDD during a quality control task on the Rejaf road south of Juba, South Sudan, 2010. Quality control using MDDs was conducted after mechanical processing and manual visual search.
Image courtesy of Mikael Bold.

World War II

While mines had been used before, World War II was the conflict that saw the landmine coming of age as a major weapons system. The first documented use of MDDs during the Second World War is not clear. One French source states that the Russians were first, claiming "that as many as 100,000 mines were detected by these animals on roads, in towns and villages, and at bridgeheads," and, incredibly, "one especially talented dog located almost 2,000 mines in one three-week period."[1] There is little to corroborate these extravagant claims.

The United Kingdom probably led the way in the early development of a MDD capability. From 1942, the development of mines with reduced metal content, even the simplest models, such as the Schützenmine 42, presented a significant detection problem. The available metal detectors could not be used to reliably detect these models, especially in heavily metal-contaminated conditions.[2,3] Within this context, trials commenced in early 1943 at the new Obstacle Assault Centre (OAC) where much of the UK research into mine detection took place. The last of these trials involved searching a 1 kilometer stretch of road using three MDDs. The road was also searched by a sapper with a No.5 detector. The mine targets were emplanted twenty-four hours before the trial. The dogs took thirty-two minutes to complete the task, slower than the sapper with a detector at twenty-two minutes. However, the dogs found nine out of ten targets, the detector just four out of ten. Notably, the detector could not find Schützenmine 42s, that in the context of the detectors of the day, were deemed a minimum metal mine.[4] The demonstrated potential of the MDD was enough for four Royal Engineers Dog Platoons to be formed in April 1944 for subsequent use during Operation Overlord in Normandy and thereafter.[5]

The record of the Royal Engineers Dog Platoons, from the initial deployment of No.1 Dog Platoon in June 1944 until the end of the war in northern Germany, was mixed. During clearance of Carpiquet Airfield, to the west of Caen, between July and August 1944, an inauspicious start saw the MDDs miss numerous mines and the platoon commander losing his foot in a demining accident.[6] MDDs frequently failed to reproduce the capability demonstrated in training in actual field conditions. The heat and the dust of the former battlefield was deemed particularly challenging for the dogs. The disappointing performance was acutely felt since the uneven surface made mechanical roller attachments ineffective, and the extensive metal contamination, standard for areas that had seen heavy fighting, made electronic detectors ineffective.[7]

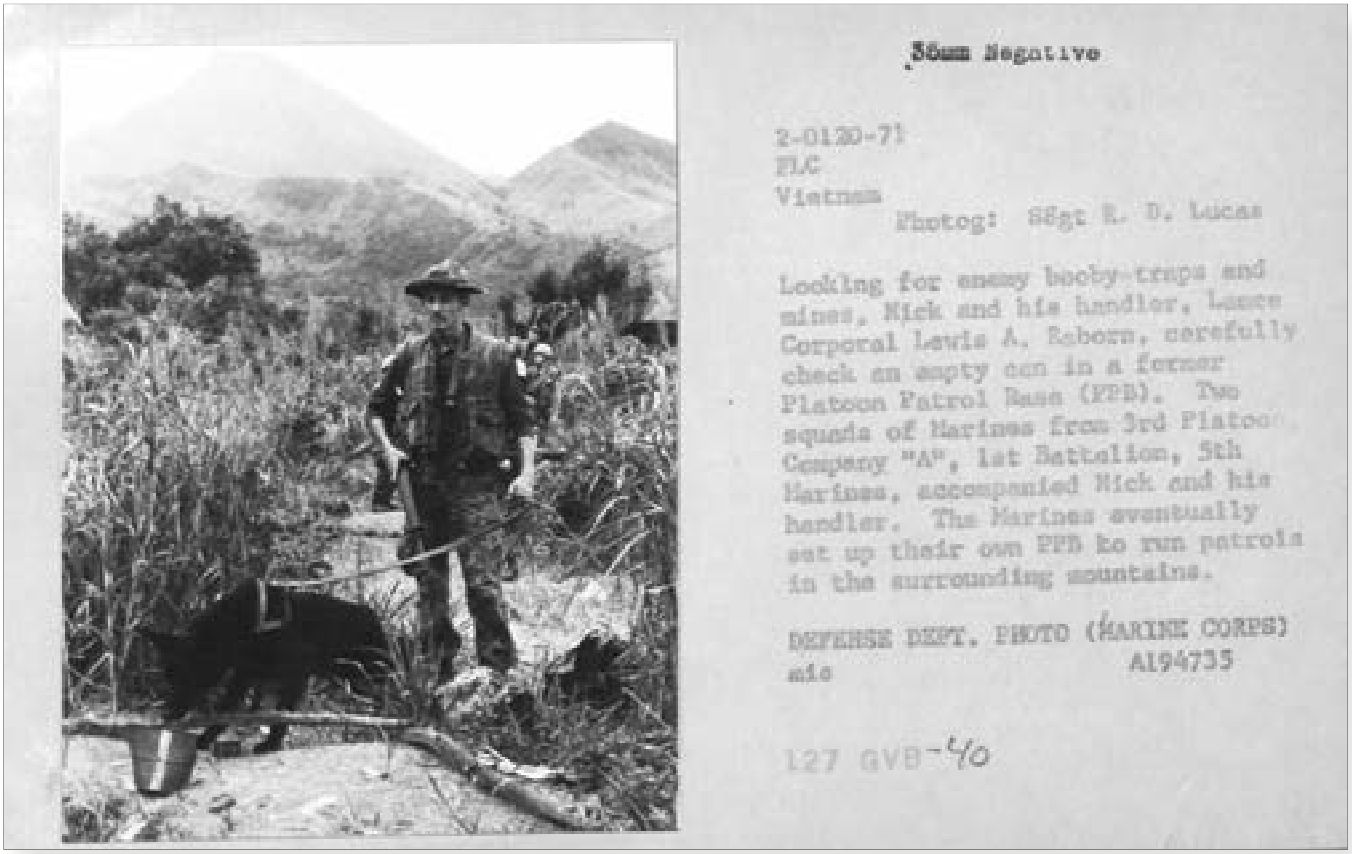
In November 1944, the Dog Platoons moved to the Netherlands where eventually all four would work over the winter of 1944–45. While the Dog Platoons demonstrated their usefulness, they were deemed "not 100% effective."[8] It was decided that the dogs were not reliable enough to be used on known minefields but were better suited for "routine checking of suspect areas and the proving of and delimiting of areas in which mines were rumored to exist." To this end, 155 miles of railway line, 73 miles under high-tension cables and 77,000 square yards, were searched by 'war dogs' with twenty-nine mines located. Building on the lessons of Normandy it was reconfirmed that using dogs was "fully justified on large areas of non-metallic anti-personnel mines."[9,10,11] As the Chief Engineer of the Second Army wrote in December 1944, MDDs "provide the quickest method of locating minefields and subsequently defining their limits."[12] Identifying individual mines within a minefield, however, was less certain. One example of this was a clearance task in February 1945 where No.2 Dogs Platoon supported 19th Field Company, Royal Engineers in the clearance of a minefield containing mines and what could be deemed improvised mines known as "Picric Pots," named after the main charge used in the mines. The dogs found only 112 of the 545 picric pots, and one hundred of the 333 other mines.[13] The importance of the relationship with the handler was repeated consistently in operational reports. Mines laid more recently were deemed more detectable by dogs.[14] Many of these basic lessons concerning the employment of dogs remain relevant today.

"Bobs," a black labrador from No.1 Dog Platoon searches for mines in Bayeux, Normandy, 5 July 1944. The white cones on the handler's belt are used to mark where the dog has indicated for subsequent investigation by a detector and excavation. The Royal Engineers Dogs Platoons in Normandy did not perform as well as had been hoped during their training.
Image courtesy of the Imperial War Museum (B.6501).

The United States also sought to develop what was termed an M-Dog program in 1943. A number of training methods were tried, including positive and negative reinforcement. The immediate results were not promising. A demonstration at Fort Belvoir, Virginia, resulted in the "M-Dogs" missing twenty percent of the mine targets. The dogs also indicated incorrectly where there were no mines another twenty percent of the time.[15] Consistent with later experience the dogs did, however, indicate on the general presence of a mined area emplaced eight months previously. On this basis, 228th Engineer Mine Detection Company deployed one hundred dogs to the Fifth Army in Italy in June 1944.[16] Unfortunately "substantial" casualties and unsatisfactory further training and testing led to the withdrawal of the company by September 1944 and its disbandment in February 1945, even though the use and impact of mines in all theatres was increasing. Almost three decades later, the US Army would continue to assess these efforts as flawed, "Due to a lack of knowledge of animal behavior, training and employment technique, the concept failed to work in combat."[17]

A labrador from a Royal Engineers Dogs Platoon checking the railway line between America and Deurne in eastern Holland, 25 November 1944. MDDs were deemed more effective at searching areas with suspected nuisance mining rather than finding individual mines in a minefield. MDDs were partially effective at detecting individual minimum metal mines not laid in a pattern.
Image courtesy of the Imperial War Museum (B.12078).

How MDDs should be trained was and remains an area of debate. In the United States, pain was used as a means of conditioning the dogs not to touch any potential hazard. This was sometimes referred to as the "repulsion" method,[18] also referred to as "aversive control."[19] In the United Kingdom, the War Dogs Training School course at Melton Mowbray, focused on conditioning behavior by means of reward over a four-month program.[20] Even today, although the principles of canine learning are more generally accepted, how those principles should be applied is not fully agreed.[21] Which breeds were most suitable was also subject to debate during the war. A 1947 British Army report stated "that from the experience of Officers and men in the Dog Platoons, that for mine detection, Labradors and Labrador Crosses are likely to be the best type, other things being equal."[22] One principle that was agreed at this time was the "One Man, One Dog" rule, where individual dogs would only work with the same handler.[23,24]



Lance Corporal Lewis Raborn and his dog 'Nick' search for mines and booby traps in Vietnam in 1971. The United States had used "War Dogs," including "Scout Dogs" in a range of roles, but the use of dogs as a means to detect mines and booby traps came relatively late in the conflict and with mixed results.

Image courtesy of the US Department of Defense.

Post-War

The continuing problem of finding landmines meant that research and debate continued during the decades following the Second World War. In 1946, the UK Ministry of Supply Committee recognized that "land mines were likely to be extremely difficult obstacles in future land warfare,"[25] largely due to the fact that "direct detection" was "extremely difficult."[26] The British efforts were eventually led by anatomist Sir Solly Zuckerman and those of the United States by Joseph Banks Rhine, the founder of the discipline of parapsychology. Zuckerman concluded that MDDs would not be of practical use for landmine detection. Rhine concluded that MDDs did potentially have utility but the US Army Engineer Research and Development Laboratory at Fort Belvoir, Virginia, ceased funding in 1953 in order to concentrate on mechanical methods.[27] There is evidence that MDDs were used to a limited extent during the Korean War, for example by the Australian Army.[28]

Vietnam

By 1967, mine and booby traps were causing an increasing proportion of casualties among US ground troops in Vietnam.[29,30] In May 1967, the Chief of US Army Research and Development tasked the US Army Limited War Laboratory (U.S.ALWL) to re-examine the feasibility of using dogs to detect mines and booby traps in combat conditions.[31] The United States' use of MDDs in part grew out of a more general use of "Scout Dogs." These were originally used to track the scent of an individual laying a mine or booby trap. While it was hard to prove, at least some elements of the military also believed that dogs could use their vision to detect trip wires, and some asserted that dogs were able to detect trip wires on touch without initiating. One captain commanding C Company, 1st Battalion, 52nd Infantry, believed labrador retrievers used as tracker dogs often were able to detect trip wires.[32] (Trip wire detection by MDDs was also claimed during the Second World War.)[33] From January 1967 to May 1968, it was reported that of 119 dogs killed during operations in South Vietnam, "only seven were killed by boobytraps."[34] Within the 9th Infantry Division operational area on the Mekong Delta, one study claimed that scout dogs had a distinguished record alerting for booby traps. During a four-month period from October 1968 to January 1969, scout dogs were used on a total of 771 missions on the ground. The dogs alerted to booby traps fifty-three times. The report writer estimated this saved 127 casualties. Such evidence alongside a pressing need to find any and every means available to reliably detect mines and booby traps was enough to justify a renewal of systematic training and deployment of MDDs in the US military.[35]

The United States started actively training and using dogs to detect mines and booby traps in Vietnam in 1969.[36,37] Not all were convinced. In October 1969, Major General Williamson of the 25th Infantry Division, known as one of the most conscientious units when it came to mines and booby traps, noted that "in an effort to detect mines, rather than detonating them, the Division tested various devices of dubious value. Presently undergoing evaluation is the performance of mine and tunnel detector dog teams."[38] Nevertheless the trial of "mine and tunnel" dogs in the 25th Division was deemed a qualified success.[39] Just as in other military and humanitarian operational environments, dogs were found to be a useful tool when partnered with experienced handlers but were never a full solution. In Vietnam, MDDs tended to be used primarily for daily route searches but were also employed in tunnels. While they could help identify hidden arms caches, they were understandably not effective in identifying when those caches were booby trapped, most likely due to a confuzed scent picture. It was also suspected that MDDs could struggle to differentiate between the odor of a large anti-tank mine and any anti-personnel mines positioned around it. This was assessed to have led to a handler initiating an anti-personnel mine in the autumn of 1971.[40] It was also found that dogs were unlikely to indicate on items placed by the Viet Cong in saturated potholes. During the rainy season this method of nuisance mine laying was a substantial problem. This experience was underlined by a 1971 assessment entitled "Mine Dog Successes and Failures" that listed individual case studies from the field. One case study incorporated examples of success and failure during the same search task:

"On 03 June 1971, Abby, 7k39, while clearing a trail for B/3-5 alerted. An 8 inch HE artillery round connected to a tripwire was found approximately 25 meters down the trail. Approximately 50 meters further down the trail Abby failed to alert on a 35-pound anti-tank mine, that was submerged in a mud puddle. The mine was visually detected by the coverman. Approximately 75 meters further down the trail Abby alerted and detected a buried 81 mm HE round. Finally, after moving only approximately 25 meters down the trail, Abby alerted and refuzed to continue. A thorough search revealed a concealed 500-pound bomb about 10 meters off the trail."[41]

Such mixed results were not always presented unvarnished in Washington. In June 1971, Dr. John S. Foster Jr., Director of Defense Research and Engineering, attempting to secure the 1972 budget allocation before the Subcommittee of the Committee on Appropriations for the House of Representatives, claimed that "dogs have proven to be superior time and time again."[42] However the truth of the matter was that no means of reliable detection for the variety of mines and booby traps in the range of operational environments existed, whether it was electronic metal detectors or MDDs. The Assistant Division Commander of the 1st Marine Division concluded after their 1969–1971 deployment that "the 1st Marine Division's strenuous efforts—including troop indoctrination, landmine warfare school, contact teams and mine and boobytrap dogs—did not solve the problem. The best we can conclude is that these efforts greatly reduced what might have been the casualty figures if they had not been vigorously pursued."[43] Two years later, after almost a decade of attempted counter-mine innovation during a counter-insurgency, the truth remained that "a need exists to develop an easily applied, reliable, and effective means to detect mines and boobytraps hidden or camouflaged in field environments."[44] Arguably that remains just as true today.

After the withdrawal of US ground combat forces from Vietnam by 1973, the United States sought to build on the hard-won lessons of Vietnam and did not disregard MDDs as had largely been the case after World War II. In March 1973, Field Manual 7-41 Mine and Tunnel Dog Training and Employment was published.[45] The publication underlined the need to select dogs with suitable temperaments, and the importance of the partnership between the dog and the handler. Notably the publication claimed that MDDs were suitable to detect trip wires[46] whereas now this is often considered ill advised.[47,48] The manual also rather hopefully asserted that "handlers should be able to effectively employ their dogs over all types of terrain,"[49] while both during World War II and today it

"On 03 June 1971, Abby, 7k39, while clearing a trail for B/3-5 alerted. An 8 inch HE artillery round connected to a tripwire was found approximately 25 meters down the trail. Approximately 50 meters further down the trail Abby failed to alert on a 35-pound anti-tank mine, that was submerged in a mud puddle. The mine was visually detected by the coverman. Approximately 75 meters further down the trail Abby alerted and detected a buried 81 mm HE round. Finally, after moving only approximately 25 meters down the trail, Abby alerted and refuzed to continue. A thorough search revealed a concealed 500-pound bomb about 10 meters off the trail."[41]

is recognized that certain terrain pose a challenge for MDDs. For example, when searching railway lines, the aggregate could cumulatively damage the dog's paws. MDDs can also struggle within vegetation, not only due to inhibiting line of sight contact with a handler, but also because certain vegetation can hurt dogs. Thorn bushes in Afghanistan were known to be "no-go" for MDDs. In humanitarian mine action (HMA), MDDs tend to work land that has been processed, often with all vegetation removed.

In 1974, one study posited that dogs responded to a range of cues including ancillary human scent and disturbed earth. It was believed this was why dogs, at least in test conditions, would miss few mines in their path but why they would also give frequent false alarms.[50] The US Army Mobility Equipment Research and Development Command in Fort Belvoir, were tasked to develop techniques and procedures for the use of "landmine and explosive boobytrap detector dogs."[51] An extensive three-year program was completed in 1976. "For practically all tasks to which highly trained canines may be assigned, the importance of the handler/dog team concept cannot be overemphasized. This concept is of particular importance in land mine and booby trap detection applications where neither dog nor man can operate effectively alone."[52] The handler's visual sense, combined with sufficient knowledge of the mines and booby traps they were looking for were deemed essential, especially when dealing with threats such as trip wires. This approach still endures in the US military. In 2004, all Military Working Dogs (MWDs) were still viewed as a means to "produce a highly sophisticated and versatile extension of a soldier's own senses."[53]

MDDs and HMA

One of the first known uses of dogs in HMA was by the commercial company RONCO, which had facilities near Peshawar in Pakistan in early 1989.[54] In time, the United Nations established "Mine Dog Groups" that incorporated four dogs and handlers along with a section of deminers. The main benefit was the elimination of areas suspected to be mined but which were shown to contain no explosive hazards. Many of the early principles of using dogs in HMA were established in Afghanistan, including using at least two different dogs to search an area in order to increase confidence that there were no mines present.[55] Among the results claimed, it was reported that from a pool of fourteen German Shepherds, along with their Afghan and Pakistani handlers, 137 kilometers of road around the town of Urgun in Patika Province were searched, and 734 mines were removed and destroyed.[56]

As the number of demining projects grew throughout the 1990s and 2000s, MDDs would be found in most countries where there were programs, including in Bosnia and Herzegovina,[57] Cambodia,[58,59] Angola, Lebanon, and Sudan. In 2002, the Geneva International Centre for Humanitarian Demining (GICHD) estimated that 750 dogs were at work in the mine action sector in twenty-three countries.[60] By 2005, that estimate had changed to 1,000 dogs in twenty countries.[61] HMA programs tended to favor Belgian Malinois and German Shepherd breeds,[62] although labradors and spaniels were at one time preferred as explosive detection dogs (EDDs).[63] In time, Belgian Malinois would also be increasingly favored for military improvised explosive device (IED) detection tasks.[64] By 2003, the GICHD, recognizing that "the use of dogs for mine detection has expanded dramatically in the last ten years,"[65] developed a number of International Mine Action Standards (IMAS) covering general use, procedures, and accreditation. Some ways of employing MDDs,

A member of the 577th Engineer Battalion conducts quality control of an area of mechanically processed land near Bagram Airbase, Afghanistan, 2004. The MDD, 'Cinda' is on a long leash. MDDs are often used to confirm or at least give a degree of confidence of where mines and explosive remnants of war (ERW) are not.
Image courtesy of the US Department of Defense.

A Norwegian People's Aid Belgian Malinois on a long leash checking part of a hazardous area between the minefield pattern and the minefield fence after manual clearance has finished, Jordan, April 2014. MDDs performed a useful role searching areas where no pattern minefield was suspected but where a few mines might have been moved from the main pattern over time. Belgian Malinois have become increasingly preferred for both mine and IED detection roles. *Image courtesy of the GICHD.*

such as the use of Remote Explosive Scent Tracing (REST),[66] where dogs would check filters that captured odors from locations in the field, only partially caught on, and were later abandoned.

In 2005, the GICHD published a study "designed to address the overall question: 'why do dogs miss some mines?'"[67] Based on a trial near Kabul, Afghanistan, in 2002 and 2003, the study remains impressive in its effort to recognize ongoing debates about MDDs and find evidence to provide answers. The factors studied included weather variables (temperature, wind, humidity, rainfall, and ground saturation), mine depth, mine size (explosive charge size), vegetation density, and time of indication. The trial confirmed that "humidity is a key factor influencing the success of mine detection by dogs."[68] "Find rates through the morning were linked to humidity…although the relationship was complex. Humidity declined steeply from dawn until about midday. Find rates were high around the time that the sun first hit the ground (when overnight moisture was evaporating from the ground surface). Find rates were lower through the rest of the morning but increased as humidity declined."[69] While similar challenges were apparent for IED detection dogs, the scent of homemade explosive presented an extra problem.[70]

In 2015, one demining organization pointed out that the use of MDDs had not been successful in locating anti-vehicle mines in Herāt, Afghanistan. After the original use of MDDs, it was stated that a total of seventeen accidents occurred, killing sixteen and injuring fifteen people up to November 2010.[71] It has been asserted that "MDDs have a poor record in Afghanistan for clearing anti-vehicle mines. They were used in Jebrail in Herāt Province where minimum metal mines were missed. Although numerous reasons have been identified for the mines being missed, the environmental conditions in Afghanistan are challenging for MDDs and tests have shown that their performance can be inconsistent."[72,73] Nevertheless, in 2018, the IMAS Review Board approved a revised Animal Detection Systems (ADS) IMAS that confirmed two separate searches by an "ADS unit" would be sufficient to consider an area as clear.[74]

More recently the term MDD has been subsumed into a wider term, ADS.[75] The IMAS that used to refer to MDD now refer to ADS. GICHD assessments continue to acknowledge the "benefits and limitations" of ADS.[76] Innovation continues, with the Swiss organization Digger developing the SMART MDD system, which consists of an embedded global positioning system (GPS) and audio system on a harness, enabling free running MDDs to work off leash. Use of unmanned aerial vehicles to provide visual oversight of the dog, alongside recording the track of the dog by GPS, have also been trialed in order to try to allay concerns about the dog covering the ground correctly.[77]

An MDD and handler conducting a QC search on a long leash in Tajikistan, June 2013. The relationship between the MDD and their handler is essential for MDDs to be effective.
Image courtesy of the GICHD.

Conclusion

In 1946, a post-war report on the British use of MDDs stated that they were "not a satisfactory or complete answer to the problem." However, the report also emphasized the limitations of "electronic detection" and "prodding," and states that "there is at present no real answer" to the problem of finding mines.[78] Today, in areas of heavy metal contamination, and especially when clearing minimum metal mines, we are still reduced to conducting laborious and slow full excavation of ground. Within this context, where we lack the means to reliably detect and discriminate mines, MDDs remain a valuable tool for demining operators. Just as in the 1940s, MDDs form part of a team with a handler. Both require careful selection, training, and accreditation, and the dogs also require significant additional logistical support from kennels to veterinary care. MDDs will also always be limited by weather conditions, whether it is humidity, wind, or heat. Certain environments with a range of scents will also be difficult for MDDs. Even today it is not categorically confirmed whether the dog only discriminates scent or whether it is a combination of cues.[79] As a US Army Engineer report stated in March 1945, after a visit to the British War Dog Training Center, "No dog can guarantee to work perfectly at all times."[80]

MDDs have undoubtedly made a significant contribution to the effort to find and remove mines. It could be reasonably argued that this contribution is more concerned with giving confidence of where mines and ERW are not, or indicating a general area where mines are, such as a minefield edge, rather than specifically identifying where individual mines are in a minefield. This contribution can of course save significant time and money, but it should not be misrepresented. MDDs remain part of the solution, but they are not the solution. As the US military itself concluded in 2004, "MDDs must not be seen as a fail-safe panacea…It must be understood that MDDs are merely an additional tool to enhance the productivity of mine clearance operations…MDDs are not a stand-alone system for conducting mine clearance operations."[81]

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A Belgian Malinois MDD during a quality control task on the Rejaf road south of Juba, South Sudan, 2010. Quality control using MDDs was conducted after mechanical processing and manual visual search.
Image courtesy of Mikael Bold.

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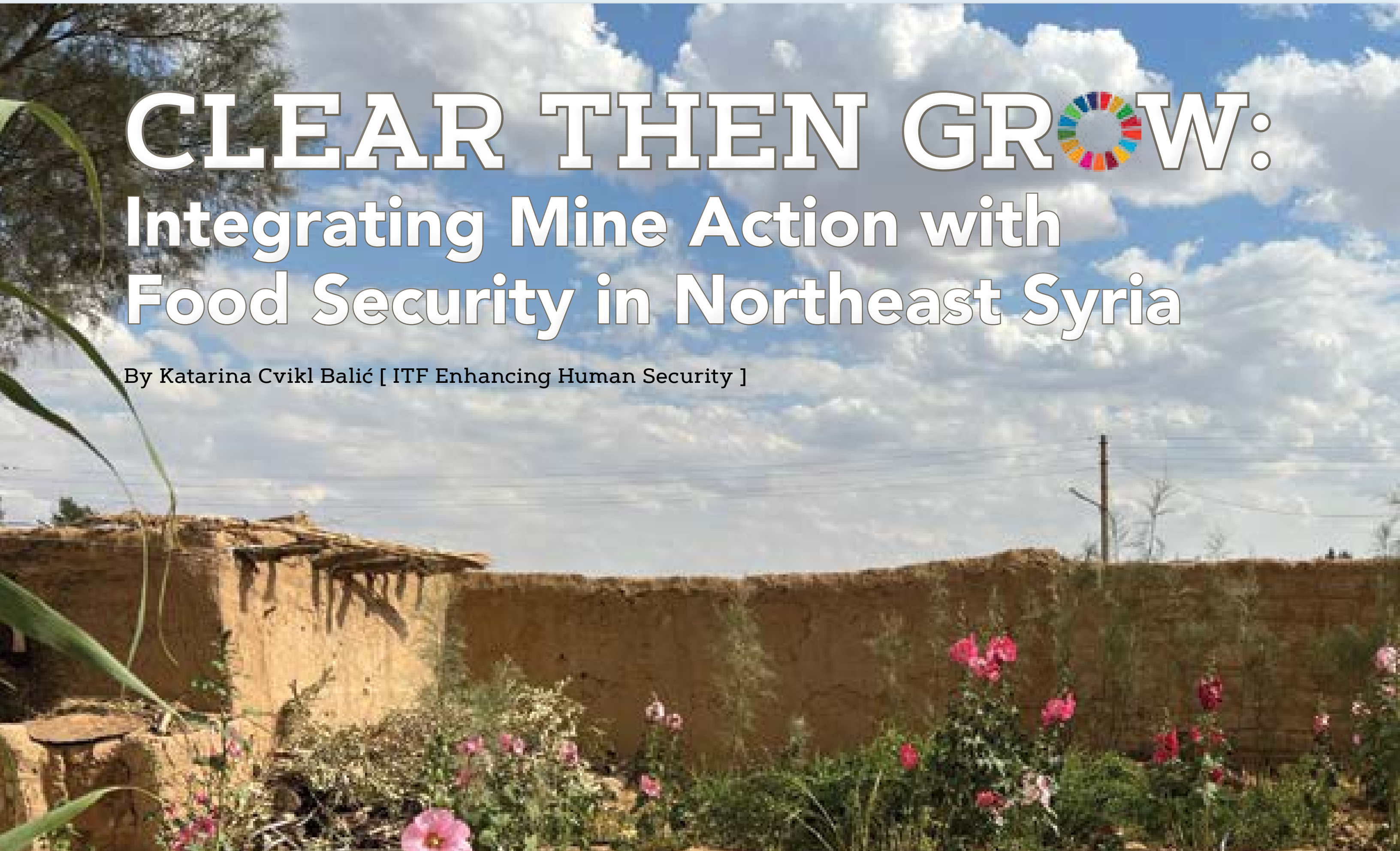
CLEAR THEN GROW: Integrating Mine Action with Food Security in Northeast Syria

By Katarina Cvikl Balić [ITF Enhancing Human Security]



A vegetable garden in early spring in Northeast Syria.
Image courtesy of ITF.

Over the past several years, considerable attention within the mine action community and in the wider development sector has been devoted to conceptualizing mine action interventions within the broader sustainable development goals (SDGs), or more recently, the so-called triple nexus.[1] Aiming to find linkages between, for instance, clearance efforts and food security is not a new concept. This article, however, looks at the operationalization of these links through an integrated mine action and agricultural recovery program within Northeast Syria (NES).[2]

The mine action community, including mine action organizations and traditional mine action donors, has invested considerable efforts into understanding how mine action can support the SDGs[3] or the humanitarian development peace nexus. Also, it has been well-noted that mine action should not exist in silos but should seek to leverage its operations in collaboration with broader sustainable development and peace efforts.[4] However, moving from a conceptual understanding of this idea to implementation has not been without its challenges. This is due in part to several factors, including the continuation of strongly-rooted practices within mine action, which are based on decades of expertise and strong relations within the community of practice, both internationally and in local capacities, but with limited outreach to the broader development sector. Additionally, limited mandates of mine action organizations make it difficult for operators to build internal expertise around the triple nexus, justify engagement in activities that traditionally are outside the scope of mine action, or make it difficult to partner and coordinate with other sustainable development or peace-focused organizations. Furthermore, donors specifically operating in mine action and those operating in the development sector may view their activities as autonomous and may have competing priorities.

Before the emergence of the SDGs, ITF Enhancing Human Security (ITF)[5] had adopted this innovative thinking and attempted to reconceptualize seemingly "hard" mine action operations into "soft," people-centered approaches, focusing on community needs more holistically. For years, ITF has worked to mobilize resources and address a wide array of donors and supporters whose interests lie in human security more broadly, rather than strictly within the mine action sphere. This multidimensional approach paved the way for ITF's development of the "Clear then Grow" model, bringing together mine action response and agricultural recovery. The Clear then Grow model was developed specifically for the NES context between 2018 and 2019, shortly after the liberation from the ISIS occupation, and ahead of the October 2019 Turkish military action along the Operation Peace Spring border areas,[6] as well as the global COVID-19 pandemic. The integrated model aims to present mine action as an enabling factor for sustainable development activities and long-term peace. Although developed for NES, it may be particularly relevant for other countries such as Ukraine where food security is of global concern.

An explosive item identified in a former agricultural field in immediate proximity to cultivated land.
Image courtesy of ITF.

Clear then Grow

The Clear then Grow project started in 2019 with financial support provided by donors usually operating outside of mine action, namely the Austrian Development Agency, the Slovenian Ministry of Foreign Affairs, and the Knights of Columbus. The three donors have generously supported this project in a phased approach since its inception in 2018. Phase I focused on setting up the mine action side of the project (clearance/explosive ordnance risk education (EORE)) while in phase II, an agricultural component was added to complement the mine action response. The project's phase II ended in August 2022, and ITF may continue with phase III, which will seek to expand and build on lessons learned thus far.[7]

ITF communicated extensively with other mine action actors and stakeholders operating in NES and conducted field visits and surveys, finding that there were significant aspects in which mine action efforts in operation between 2018 and 2019 could be complemented with sustainable development activities. Contamination in NES is found in both urban and rural areas and includes improvised explosive devices (IEDs) and unexploded ordnance contamination located in border areas[8] or where battles to expel ISIS were fought. Considering the absence of a national mine action authority at the time[9] and lack of a centralized prioritization system or tasking, mine action activities in NES were mainly coordinated through the NES Mine Action Sub Working Group between mine action organizations,[10] and locally through civil councils at city levels and the *komin*,[11] or commune at community levels. In the absence of a formal mine action center, the coordination process depended on individual mine action organizations working in NES, with their own policies and procedures.

For ITF, strong community liaison and participation was seen as essential to a successful integrated project; not only to obtain or cross-check information on potential contamination and appropriate additional support, but also to garner community acceptance. Until 2019, relatively speaking, significant international attention and clearance priorities in NES were devoted to urban clearance and clearing vital infrastructure. However, as re-confirmed recently by Humanity & Inclusion's Syria report, over a third of explosive accidents occurred in agricultural areas.[12] As of 2022, the full extent of contamination in Syria, including NES, remains unknown.[13] It is estimated, however, that over 27 million square meters of land in NES are contaminated with explosive hazards, and this does not consider re-contamination in Operation Peace Spring areas.[14] Furthermore, explosive hazard contamination is often found in agricultural land, preventing its use and development. ITF's exchange with local counterparts and their active participation resulted in numerous requests to focus on agricultural areas—areas of contamination that had not yet been prioritized.

Looking more in-depth into the opportunities and threats related to agricultural contamination, context analysis confirmed NES's importance to the country's agricultural output and the debilitating effects this sector has suffered due to the ISIS occupation. A majority of the population in NES continue to base their livelihoods on agriculture. Previously referred to as the breadbasket of Syria, NES used to account for seventy percent of Syria's wheat and grain production.[15]

Bread is a staple of Syrian cuisine and inaccessibility of wheat, bread, or bakeries is often linked with food insecurity and poverty. The ISIS occupation had a multifaceted impact on agricultural livelihoods. ISIS looted and destroyed agricultural tools and equipment, cut down or burned orchards, forests, wheat fields, and other crops, and rendered agricultural land inaccessible with the laying of IED belts. Furthermore, irrigation pathways were interrupted by conflict and with dry, hot summers and cold winters, the land had become inaccessible, drought-ridden, and had not been cultivated for several years. By engaging a local partner and relying on local expertise, an agricultural and food security assessment was carried out to identify the best approaches that would help to reinvigorate the affected areas and assist the affected rural communities.

It was at the intersection of these findings that the Clear then Grow approach was developed with the purpose to maximize the impact of clearance efforts in NES. Given the particularly

Community members during a training on sustainable agricultural practices.
Image courtesy of ITF.

"Clear then Grow" would not be possible without constant coordination with local communities.
Image courtesy of ITF.

gruesome legacy of the ISIS occupation and profound and multifaceted humanitarian crises, it became evident that the sustainable development impact of mine action itself would be lacking without follow-on activities. Put simply, the beneficiaries of mine action efforts—especially clearance efforts—would be unable to utilize the released land productively or grow crops without external assistance due to a lack of financial resources. Even the simplest and cheapest agricultural inputs had become unaffordable.

The context, however, drastically changed in autumn 2019 with the onset of Operation Peace Spring, when all clearance efforts in NES were suspended. The suspension and evacuation of mine action organizations was prolonged due to the security risks. Just as organizations were planning their return to the area in 2020, the global COVID-19 pandemic halted these plans. These developments exacerbated humanitarian needs in NES and underpinned the need for an integrated approach in which the local population depended less on humanitarian assistance and increased their resilience. Although a very challenging time, the ITF project team was able to work with donors and adjust its response, namely ensuring the project relied on local assistance and expertise, with the long-term goal of national ownership.

Explosive hazards found and removed in Northeast Syria.
Image courtesy of ITF.

The integrated Clear then Grow response was first and foremost, people-centered, and focused on extensive dialogue and outreach with local communities involving *mukhtars*,[16] village elders, vulnerable groups, *komin*, civil councils, and special interest groups. Additionally, mine action operations including EORE and non-technical survey were a crucial part of the integrated approach. The ITF project team, including expat staff, devoted considerable time to building local relations based on appropriate risk assessments—living with the community as closely as possible, splitting bread and drinking chai. Trust was built over time, and this also paved the way for a local partner with existing expertise in food security and livelihood support to develop a context-specific agricultural recovery intervention.

With agricultural needs assessments in the planned area of operations showing that the two main impediments to farming were contamination (confirmed or suspected) and a lack of financial resources and/or available agricultural inputs (e.g., seeds or seedlings, fertilizers, water, farming tools), it was important for agricultural recovery to encourage income generation within the community. The value chain approach to agricultural recovery, which followed clearance efforts, included provision of support to barley farmers, sheep herders, and homeowners with vegetable gardens. This was implemented in recently cleared areas or areas impacted by explosive hazards contamination, following close coordination between the mine action team and the agricultural team. Direct support to farmers was provided in the form of know-how and technical knowledge (e.g., pest management or animal-friendly sheep rearing), but also basic agricultural inputs. Following ISIS occupation, countless farmers did not have shovels and hoes, and providing them with these tools was invaluable. Farmers were also provided with seeds, fertilizers, and means for pest management, or with sheep and adequate fodder, depending on their family's livelihood.

This approach also included supporting small agribusiness development to boost sustainability within the community. Vulnerable populations living below the poverty line, including internally displaced persons (IDP) populations living in informal settlements, were provided with vouchers that were redeemable at local small businesses. This brought significant engagement and resources into communities that were previously living with the debilitating impact of explosive hazards, inaccessibility of their land, and the psychological impact of living in contaminated areas. Although the scale of contamination in the areas ITF worked in was not large, accidents that had occurred previously continued to instill fear within the community and prevented civilians from working their land. Overall, 340 families in two communities affected by explosive hazards were provided with support to help them rebuild their agricultural livelihoods. Over half of the families that received support were households headed by women, often supporting their extended families.

Clearance staff ensure that explosive hazards are removed and temporarily stored safely.
Image courtesy of Arne Hodalič/ITF.

Challenges

The scale of the Clear then Grow project was relatively small, and may not have been broad enough to achieve full self-sustainability within the targeted communities. Additional support in the forms of establishing or refurbishing silos and mills, and ensuring reliable irrigation pathways is still required. Yet, the project did ensure that hundreds of families have directly improved food security and are able to subsist on agriculture again. A more in-depth impact analysis is ongoing, but regular monitoring and follow-up mechanisms have so far indicated that for many of the families, the support provided means that there is no longer the need to resort to negative coping strategies: borrowing money, selling the few assets they own, consuming low-quality food, reducing the number of meals per day, and stopping schooling of family members. With improved economic outlooks, extremist groups hold less appeal and this in turn leads to decreased violence.

With implementation of the Clear then Grow project, ITF encountered challenges and gained valuable lessons learned, all of which may help inform similar, future interventions.

1. **Resource mobilization for such initiatives is not without its challenges.** In contrast to focusing on traditional mine action operations, and engaging with an agricultural partner that would ensure their own funding under a separate but complementary initiative, ITF's approach was to do it "under one roof" and to ensure funding for the entire intervention—from clearance to agricultural initiatives. Trying to align separately funded organizations through mine action and non-mine action components would present an even bigger challenge with competing timelines, funding cycles, and/or unpredictable or contradictory donor requirements, etc.

2. **The disproportionality of costs between mine action and/or clearance efforts vs. agricultural support must be addressed.** One of the challenges ITF experienced in its efforts to secure financial resources for the Clear then Grow program was the perception of costliness of mine action efforts (especially clearance) as compared to follow-on, development activities. While this may not be a new challenge for the mine action community, it becomes even more pronounced when raising funds for a joint program. An important part of the solution lies in continued awareness raising among donors, highlighting the complexities of mine action and why the costs of clearance efforts are relatively high, while at the same time ensuring that funds are used as efficiently and transparently as possible.

3. **There needs to be closer cooperation between the mine action and wider humanitarian and development sectors.** There can be a disconnect between organizations clustered under the humanitarian and development sectors. Mine action is typically organized as the sub-cluster to the protection cluster in a humanitarian response. In order to ensure optimal efficiency, from initial planning stages to conducting operations and follow-on development activities, it would be beneficial for all actors involved to be in close communication and cooperation from the outset. This is especially true in areas of operation where there are no mine action centers or authorities, as other operators in the area may have information pertaining to potential contamination. Mine action partners, on the other hand, could share their work on agricultural lands for further food security/livelihoods initiatives. Regular exchange between organizations working locally could help bridge the gap in developing relevant partnerships and may enhance mine action's integration into triple nexus initiatives.

4. **Local partnerships and expertise are key. Local knowledge on everything from potential contamination to cultural dynamics is vital for a program's success.** These can include knowledge of local grievances or tensions that may exist between host and IDP populations, local tribes, or other population groups. Engaging local partners that do not, for example, acknowledge the different needs of host and IDP populations or demonstrate an understanding of the need to "do no harm," may further exacerbate intracommunal grievances that inadvertently result in the escalation of tensions within the community. This can have a major impact on a local community's acceptance of an organization and influence future mine action operations and programming. It is also important to understand what the partner(s) can or cannot bring to the table. As experienced by ITF, there needs to be more rigor in measuring an integrated approach impact and the mechanisms and tools that need to be applied.

Beneficiaries of Clear then Grow.
Images courtesy of ITF.

While ITF implemented the Clear then Grow program specifically in NES, we believe that the program could be applied in other regional contexts where contamination is impacting agricultural communities. Additionally, ITF considers that this is only one example of how mine action organizations and donors can look toward more integrated approaches. The Clear then Grow program is a model that encourages other actors to begin practically addressing not only the challenges, but also the opportunities presented by integrating mine action into the wider development sector in the interest of future mine action operations and for the benefit of the communities we aim to support.

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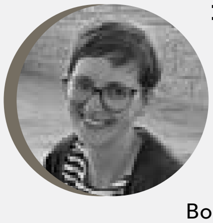

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GENDER and OPERATIONAL EFFICIENCY

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This study explores the relationship between gender and operational efficiency in the context of staff in field-based mine action roles. The aim of the study is to address stereotypes and unproven assumptions that may still exist in the mine action sector regarding women's performance and availability to work in certain field-based roles. Operational efficiency was investigated using two key indicators: individual operational productivity and availability to work. Operational and human resource data was collected from fourteen country programs from four separate mine action organizations across four continents. A quantitative analysis of the data found no meaningful difference in operational productivity or availability to work in field-based roles in mine action based on gender.

Introduction

The participation of women in mine action activities has increased substantially over the last decade. Mines Action Canada conducted a study which collated data from twelve operators in 2019 showing that globally, around 20 percent of mine action staff are women.[1] However, there is still a long way to go to increase gender balance in mine action in line with the Women, Peace, and Security (WPS) Agenda's participation call and Sustainable Development Goal 5.[2] In the same study published by Mines Action Canada, gender balance was described as "significantly better" in headquarters, finance, and administrative roles as opposed to clearance roles.[3] This is in line with other research, which points toward clearance as being the most male-dominated pillar of mine action.[4]

Stereotypes and unproven assumptions about women's performance and availability in certain field-based roles persist in some parts of the sector. Arguments are made about women's physical strength relative to men, slower clearance, or time taken off work, which are then cited as potential downsides to the recruitment of women in deminer or searcher roles. It is sometimes assumed that women in the mine action sector take more time off because of maternity leave or other caregiving responsibilities. These claims limit progress toward increasing women's access to employment in mine action. Furthermore, although anecdotal, evidence indicates increasing global recognition that employing women can be beneficial to land release activities, data has not yet been formally analyzed to investigate this until now. This study aims to address this gap by exploring the relationship between gender and operational efficiency in the context of field-based staff.[5]

Defining Operational Efficiency

Efficiency is generally defined as the ratio between the level of effort put into an activity or process and the level of output generated by that activity or process.[6] For the purposes of this study, the process of interest is the one in which the threat of mines or other explosive ordnance (EO) in a hazard area is reduced to an acceptable level through technical survey or clearance activities. More specifically, this study looks at whether there is any difference in the performance of men and women in implementing technical survey and clearance activities that rely on human effort, such as the use of detectors, locators, excavation, and raking methods.

The output of the land release process is "land" usually measured in square meters. The input effort is measured in the amount of time spent by the deminers engaged in clearing that area.[7] One of the most common indicators used to measure human performance in land release work is m^2/deminer/day. The indicator is itself a measure of efficiency—m^2 is the output; a deminer-day is a measure of input effort. A deminer who consistently delivers a higher number of m^2/day can be said to be more efficient than another who delivers less output in the same amount of time.

It is important to recognize that the speed with which land is checked can be one measure of success, but it is more important that such land is clear of explosive hazards. A deminer who clears land quickly but misses threat items would be failing to meet basic quality requirements. While such a statement is obvious and important, it should also be noted that it is uncommon for such a situation to arise in most mine action organizations. Each square meter is re-checked, often more than once, as part of internal supervisory and quality management processes. It is also important that the rate of progress is not prioritized over the safety of deminers. The organizations providing data for this study are all recognized as meeting international standards, including applying rigorous internal quality and safety checking procedures. For the purposes of this study, it was assumed that the square meters reported in the provided data met quality requirements.

There are many dimensions of efficiency that can be investigated, including those relating to cost. This study has not attempted to disentangle the many facets of direct and indirect cost and the allocation of those costs to mine action operations. This is partly because of the difficulty in doing so, and in obtaining agreement among operators on these questions, but more so because any analysis of efficiency in relation to survey and clearance must, at its base, engage with the issue of practical productivity. If one deminer clears more land faster than another, for a similar cost, then they must be more cost efficient. By focusing on this fundamental aspect of operational efficiency, the results of this study will inform other researchers who may wish to engage more fully with economic or social aspects of the employment of men and women.

In terms of output, the more deminers are available, and the more days of effort they deliver, the greater the total area of land that they will deliver. In simple arithmetical terms, the fundamental production relationship can be described as:

Production (P) = Number of productive resources (N) x Unit productivity (U) x Working time (T)

For there to be a difference in the productive output of one deminer (N = 1) compared with another, one deminer would have to either deliver higher productivity (U) within a similar time to the other or be available to work for more time (T) at a similar level of productivity, or a combination of the two. This study investigates both factors—whether there is any evidence to suggest that there is a difference in individual productivity between men and women, and whether there is any difference in the availability to work between men and women. To do so the project focused on two key indicators: *1)* daily output measured in m^2 and *2)* the proportion of workdays available for work, both of which are routinely measured, recorded, and reported by mine action operators (MAOs).

The two research questions that were addressed were:

Research Question (RQ) 1: ***Is there a difference in operational productivity between men and women?***

Research Question (RQ) 2: ***Is there a difference in availability to work between men and women?***

General Management of the Study

The study was managed in three phases. The first phase consisted of interviews with MAOs to establish their willingness to participate in the study and the likely availability of suitable data. Interviews were conducted with nine women and thirteen men from six different MAOs. Sample data was requested from participating organizations and initial analysis was carried out to improve understanding of the suitability and limitations of the available data, and to refine the study inclusion criteria and analysis methods. It was agreed that all operational data would be anonymized to maintain the confidentiality of MAOs, programs, and personnel.

The second phase consisted of the main data collection activity: re-engaging with participating MAOs to define the required characteristics of study data, to obtain the data, and to follow up with questions about any aspects of the data that were not clear. Data was collected from fourteen country programs from four separate MAOs. These country programs are situated in eleven countries spanning the Middle East and North Africa (MENA) region, Africa, Latin America, Asia, and Europe.

The final phase of the study involved analysis of the data that met the inclusion criteria, review of the results, and preparation of this report. The methodology for this study, including inclusion criteria for the data, is set out in detail in an annex available at the end of this article.

Research Question 1: Is there a difference in operational productivity between men and women?

By comparing the operational productivity of women and men at a deminer level, the first research question looks at U, the rate at which product is produced (usually known as "productivity"). Operational data from six country programs satisfied the inclusion criteria which considered differences between tasks, team composition, and minimum number of days worked.[8] Clearance methodologies include one deminer one lane (ODOL) with detector, sub-surface battle area clearance (BAC), and other mixed excavation and detection approaches. Within the data, twenty-three teams from six country programs yielded a total of 7,575 "person-day" values that met the inclusion criteria.

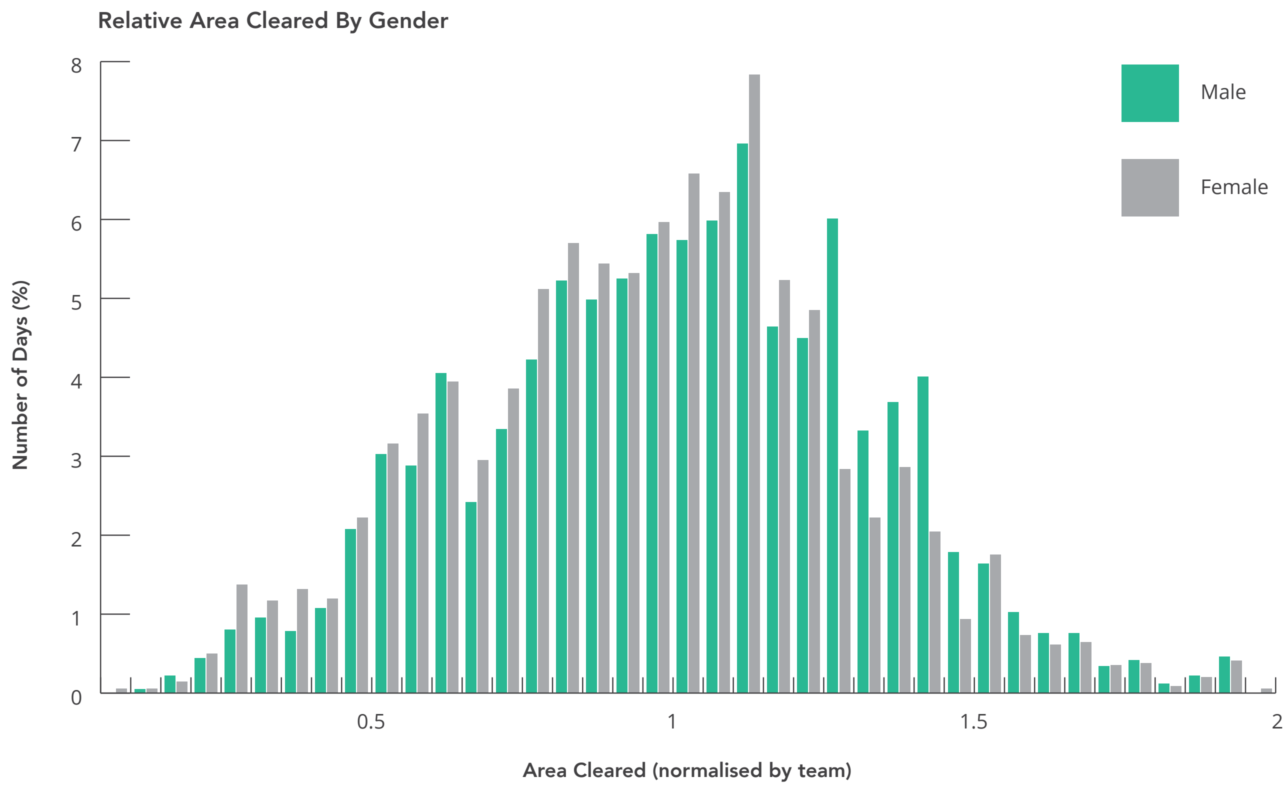

Figure 1: Percentage of days per gender by area cleared (normalized by team). The performance results for men and women approximate to a normal distribution curve in both cases (women: μ= 0.970, σ = 0.367; men: μ= 1.028, σ = 0.401). The difference between means (μ) is negligible, indicating that there is no meaningful difference in operational productivity by deminer based on gender.
All graphics courtesy of the authors.

Findings

Figure 1 displays the proportional clearance performance by gender. The productivity of each day is shown as a ratio of the average cleared area in a day per team. Subsequently, a result of 0.5 indicates that an individual deminer, on that day, at that site, produced fifty percent of the average output per deminer achieved by the mixed team on that day. Collation of the 7,575 person-day results that met the study inclusion criteria resulted in the distribution shown in Figure 3 (see annex). The x axis corresponds to the normalized performance.[9] The y axis represents the frequency of occurrence of this value as a percentage of the overall dataset of person-days.

For comparison, Figure 2 shows how the distribution would look if one group were performing at thirty percent less than the average deminer and the other at thirty percent above the average.

In Figure 1, the central portions of the curve (between 0.75 and 1.25 times the average) results for women are slightly higher than for men, but a small number of results between 1.25 and 1.5 times average, show a higher figure for men than women. Such variations are associated with a small number of sites and days when other external factors, that were not indicated in the records, may have been influential. Expansion of the analysis to more data meeting the inclusion criteria would be expected to bring the curves for both men and women closer to the underlying normal distribution already evident in Figure 1. There is no general pattern which suggests that operational productivity varies significantly between genders.

Country	Gender index[11]	Women deminers	Men deminers	Total	% Women	Months of data	Year
A	Low	140	187	327	43%	12	2019
B	High	129	202	33	39%	9	2021
C	Very high	36	135	171	21%	5	2021
D	Very high	36	151	187	19%	12	2021
E	Low	20	69	89	22%	12	2021

Table 1. Summary of HR data collected.

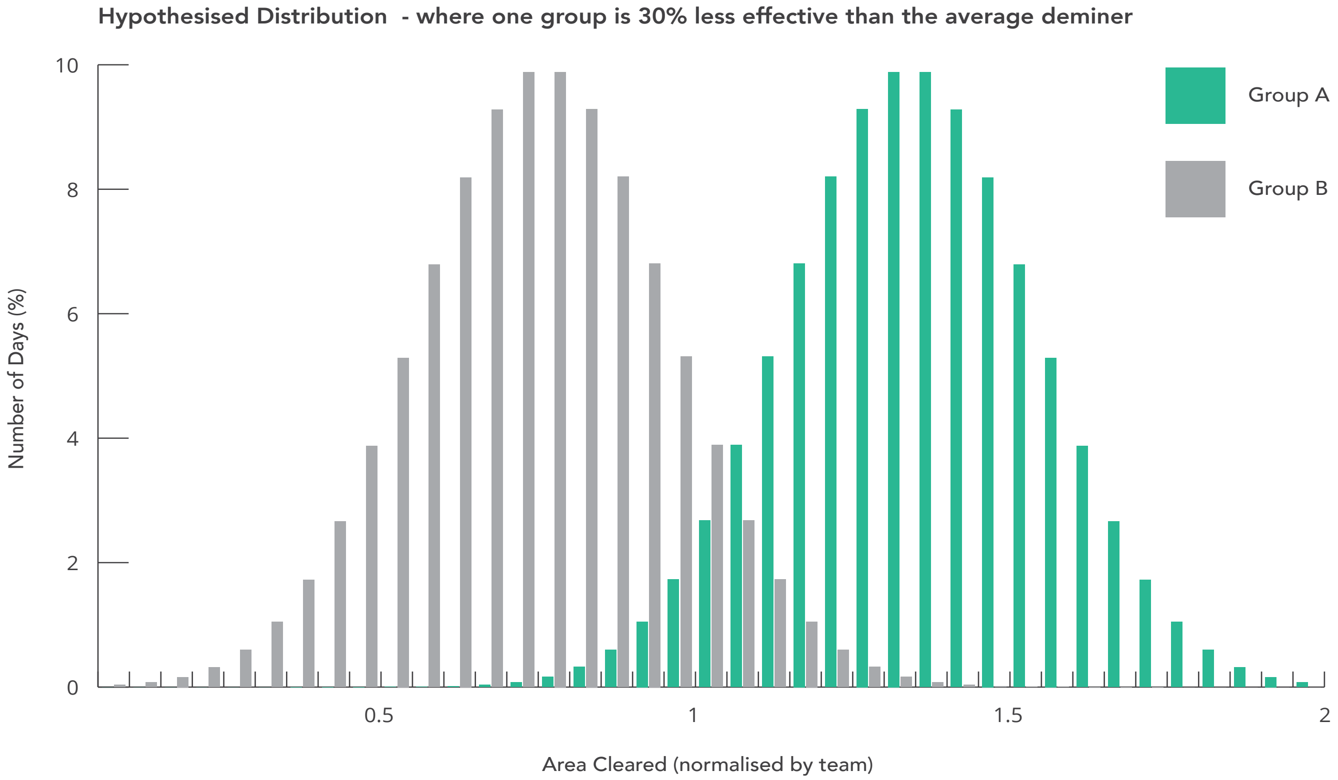

Figure 2: Illustrative histogram of the result should one group be thirty percent less effective than the average deminer. The data for Group A follows a normal distribution with (μ= 0,7, σ = 0.2), for Group B the parameters are (μ= 1,3, σ = 0.2).

Conclusion

The analysis indicates that within the study parameters there is no meaningful difference in terms of operational productivity between men and women working in technical survey and clearance. Both women and men are represented at the upper, most productive, and lower, least productive ends of the range, with no meaningful difference in distribution.

Research Question 2: Is there a difference in availability to work between men and women?

The second research question explores T (the working time variable using HR data). Table 1 represents a summary of the data collected. The table includes the OECD Social Institutions & Gender Index for each country as contextual information.[10] Notably, data was collected from countries with scores ranging from low to very high in the index.

Data Analysis

To conduct cross-comparison between country programs, leave types were grouped into larger categories: compulsory, sick, and parental leave, while other types were grouped into one remaining category ("other"). This ensured that only those leave types that were common across all datasets, such as sick and parental leave, were compared against each other.

Compulsory leave encompasses annual and compensatory leave as it is time taken off that is required by operators. Sick leave data was available in all five datasets. Parental leave data, which includes maternity and paternity leave, were available in four datasets (A, B, D, and E). Finally, all other types of leave which did not necessarily have an equivalent across country programs were grouped into the remaining "other" category.

The analysis therefore focused on sick, parental, and "other" categories of leave. Three sub-questions were explored in the analysis:

1. *What is the average time taken off for sick leave per deminer by gender?*
2. *What is the average time taken off for parental leave per deminer by gender?*
3. *What is the average time taken off per deminer by gender when excluding parental and compulsory leave?*

Country program C was excluded from the analysis in sub-questions two and three as the dataset only contained information on sick leave. Datasets relating to country programs B and C included data over a period of nine and five months, respectively, whereas country programs A, D, and E were collected over a period of twelve months. To compare them the results displayed in tables two and four were normalized to reflect the average time taken off over a period of a year.

Findings

Average time taken off for sick leave. The first sub-question looked at the average sick leave taken by gender. In country programs B, C, D, and E the annualized difference between men and women is a few hours. While noting that in country program A women take two and a half days more sick leave than men over that year, there is no general pattern across the different countries that indicates that there is a meaningful difference between men and women in time taken for sick leave. It is also worth noting that the total number of days of sick leave taken is generally very low in comparison to the typical working year of around 220 days.[12]

Parental leave. The second sub-question looks at the percentage of deminers taking parental—maternity and paternity—leave per country program. The average time taken off for parental leave is also calculated.

Analysis indicates that in country program A, ninety-six percent of women did not take maternity leave in the time frame for which data was collected, similarly that percentage was ninety-two percent for country D, and 100 percent for country E. Among those women who took maternity leave, an average time of sixty-five days for country program A and forty-four days for country program D were taken. Paternity leave was not taken by deminers in country program A and E. In country program D, five percent of deminers took paternity leave for an average time of two days.

Overall, the number of deminers who take parental leave is small. The results indicate that maternity leave is taken by a very small proportion of women deminers in a year.

Average time taken off. Sub-question three looks at the average time taken off when excluding parental and compulsory leave. Country program B shows women taking on average one leave day less than men, while in country program A the opposite is true, women take on average one day more. In country programs E and D, the difference is measured in hours rather than days. Overall, in all four country programs the results indicate that there is no meaningful difference between men and women in time taken off.

Conclusion

The analysis indicates that there is no meaningful difference in availability to work between men and women employed in field-based roles. In particular, the findings suggest that women and men take roughly equal sick leave and general leave from work. These findings also suggest that maternity leave is taken by only a small proportion of women deminers and paternal leave by a very small number of deminers and only for short periods.

Country	Average per women per year	Average per men per year	Difference (in days)
A	9.2	6.7	2.5
B	2.9	3.1	-0.2
C	0.4	0.5	-0.2
D	3.9	3.6	0.3
E	4.4	4.5	-0.1

Table 2. Average time taken off for sick leave.

	Staff who took parental leave per gender (%)		Average days taken for staff who took parental leave	
Country	Women	Men	Women	Men
A	4%	0%	64.7	0
D	8%	5%	44	2.1
E	0%	0%	0	0

Table 3. Deminers (percentage) who took parental leave including average time taken off.

Country	Average per women	Average per men	Difference (in days)
A	3.5	2.6	0.9
B	9	10.4	-1.4
D	5.6	5.4	0.2
E	7.7	7.8	-0.1

Table 4. Average time taken off excluding parental and compulsory leave.

Recommendations for Future Research

Gender inequality in the country programs analyzed are ranked from low to very high, but this difference in contextual reality is not reflected in the findings. Considering the difference in gender index scores, it is likely that across the country programs analyzed, the degree to which women will have additional burdens—such as unpaid care and housekeeping chores—may differ from men. This observation raises several questions related to women's experience in the mine action sector which may merit investigation in further research.

Final Remarks

This study explored the relationship between operational efficiency and gender. It did so by looking at the rate at which product is produced (U) and working time (T). For there to be a difference in operational efficiency, there would have to be a difference in either operational productivity or available time to work, or both.

The findings indicate:

- *no meaningful difference in operational productivity (U) based on gender;*
- *no meaningful difference in availability to work (T) based on gender.*

This suggests that there is no meaningful difference in the operational efficiency of field-based staff on the basis of gender, at least within the data available to this study.

Annex – Methodology

This annex details the methodology adopted throughout the study. It outlines how the data was collected and analyzed for each research question.

Data Collection & Generalizability

A purposive sampling method was used to collect data for the two research questions, meaning that operators and country programs were deliberately approached.[13] This method reflects the realities of collecting data in the mine action sector whereby it is necessary to first build a rapport with relevant operators and second to determine what data they collect and what they can share. Although the findings cannot, in strict statistical terms, be generalized to the whole population of deminers working around the world, it is reasonable to conclude that on the basis of the wide breadth of data collected from fourteen country programs and four distinct operators, the findings are indicative for the entire mine action sector.

Research Question 1: Data selection *Comparing 'like-for-like'*

Like most human endeavors, mine action, especially survey and clearance, is complicated and often complex.[14] Easily defined activities, such as searching ground for EO hazards, take place within a wider context of interacting physical, economic, social, and professional influences. Defining those influences can often be difficult and developing mechanisms to describe their interactions is even more challenging. The mine action sector continues to devote time and effort to developing common methods for documenting and analyzing factors such as ground, topography, vegetation, weather, and security, but effective systems are not yet fully agreed upon or implemented. Other factors, such as management decision-making, including the influences of prejudices, assumptions, misconceptions, and other perceptions, may also influence the conduct of survey and clearance by deminers.

The breadth and uncertainty of contextual aspects meant that any analysis seeking to compare performance between individuals in different survey and clearance teams, working at different locations, would have suffered from distortion by too many external factors that could not be normalized. These factors are considered external variables which, if not controlled for, could affect the measurement of the independent variable, gender. Due to the nature of clearance, it is difficult to fully control these external variables, but it is possible to mitigate against them.

In the absence of either enough contextual data, or any agreed method to normalize performance within such data, the study team ensured that performance comparisons satisfied "like-for-like" requirements as much as possible. Comparison between men and women was conducted for deminers within the same team working on the same task on the same days over an extended period. Doing so minimized the influences of decision-making managers and the physical environment by ensuring that any comparisons were made within a team context that would be subject to the same group of influences at the site, and on the day, when working data was recorded. It is recognized that, even on one work site, different clearance lanes can be subject to very different physical factors, including slope, vegetation, contamination, etc., but by imposing a minimum number of days of data for each team, the effects of such factors on individual performance are more likely to even out.

While collecting data, special attention was given to what type of clearance methodology was used by a deminer on a particular day. In the rare instances where deminers from the same team were working according to different methods of clearance, only those values that were from the same clearance methodology were compared. This ensured that values were compared on a "like-for-like" basis.

Inclusion Criteria for Data Selection

When analyzing issues relating to gender, it is important to take into consideration societal factors. For instance, a team leader may treat women and men differently, which could in turn influence their outputs. By selecting teams where women and men are evenly split (or close to), the study mitigated against some of those societal factors.

An inclusion range was developed to ensure that the averages calculated were as representative as possible. Ensuring that there was a balanced number of women and men in the team analyzed increased the chances that the results were not explainable by chance alone. This inclusion range was a minimum of thirty percent women or men deminers per team. Any mixed teams with fewer than thirty percent men or women deminers were excluded from the analysis. This percentage did not include the team leader as they did not have square meters cleared associated to their name.

Teams with fewer than twenty values (person-days) on average per deminer were also excluded. A value represents the total m^2 cleared in one day by one deminer. This inclusion criterion was developed to ensure that the values collected per deminer were as representative as possible of their "normal" performance. A low number of values are more likely to be susceptible to the effects of external factors such as differences in terrain between deminers or how the deminer was feeling on that specific day. By including teams with a minimum average of twenty days per deminer, the likelihood of strong fluctuation decreases.

Operational data from six country programs satisfied the inclusion criteria. Clearance methodologies included ODOL with detector, sub-surface BAC and other mixed excavation and detection approaches. All clearance methods were included in the analysis if it was possible to determine which square meters were cleared by which deminer. Within the data, twenty-three teams from six country programs each from different geographical regions yielded a total of 7,575 'person-day' values that met the inclusion criteria. On average, within the data collected, teams were composed of forty-five percent women and data were extracted over an average period of thirty-six days per team.

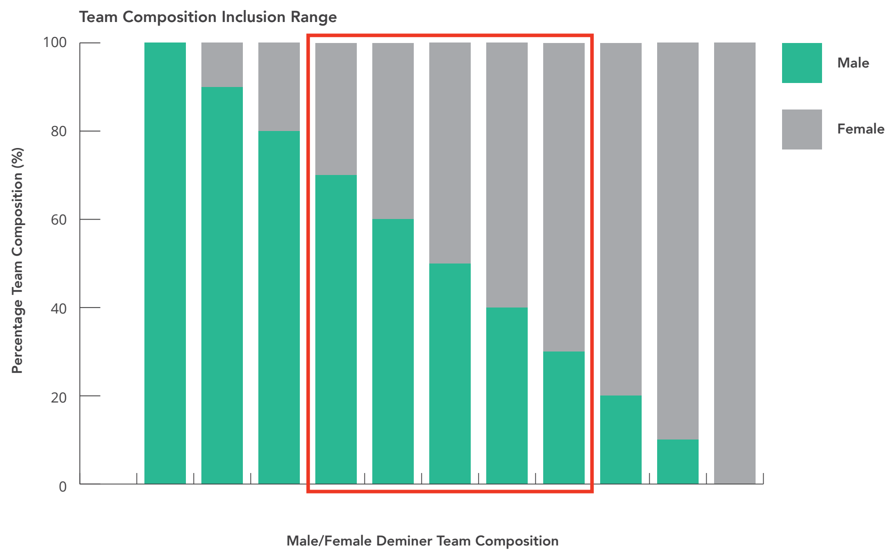

Figure 3. Inclusion range for composition of mixed teams.

Data Analysis

The data was normalized per team to combine the data from all twenty-three teams. Normalization means adjusting the values measured on different scales to a common proportional scale to be able to compare their distribution. Each daily value for individuals within a specific team was ratioed to the average value for that team across all data for that team, with the team average equaling one. To do so the following equation was used:

normalised data=data/(average m² cleared).

The average output per deminer for each team equates to one. The output values associated with each deminer on that day at that site were ratioed against the average output per day to yield a spread of productivity disaggregated by gender. In this way all values within the dataset become a ratio of the average performance per deminer per day for their team. The results are displayed in the form of a histogram. The x axis corresponds to the proportional area cleared (normalized by team). The y axis represents the frequency of this value as a percentage of the overall dataset (i.e., the percentage of the overall dataset of 7,575 person-days).

Figure 2 shows how the distribution would look if one group were performing at thirty percent less than the average deminer and the other at thirty percent above the average. The data for Group A follows a normal distribution with (μ= 0,7, σ = 0.2) and for Group B the parameters are (μ= 1,3, σ = 0.2).

The performance results for men and women approximate to a normal distribution curve in both cases (women: μ= 0.970, σ = 0.367; men: μ= 1.028, σ = 0.401). The difference between means (μ) is negligible, indicating that there is no meaningful difference in operational productivity by deminer based on gender.

The analysis draws from 7,575 data points of which 4,135 are days worked by men and 3,440 by women. The histogram is separated into forty bins of a width of 0.05 and range from zero to two. Although outliers with values above two are included in the analysis, these are not displayed in the figure as they do not affect the results and are not helpful in visualizing the general pattern which emerges.

Research Question 2: Data Selection

HR data relating to leave days was collected for all operational/technical staff within a country program across a total of five countries and spanning over three continents.[15] Operational/technical staff included those who were engaged in community liaison (CL), explosive ordnance risk education (EORE), and survey and clearance. As opposed to RQ1, HR data was not only collected for deminers but for all field staff, as they are likely to experience similar influences relating to leave including management practices, program policies, and societal factors. An added benefit of expanding the inclusion criteria to all field-based staff was that larger datasets could be included in the analysis. Senior management and office-based support staff were not included in this analysis, as different leave policies and practices apply to field-based and office-based staff. It was not necessary to look at HR data on a team basis as the study did not need to mitigate for differences relating to the type of minefield or task.

The datasets were collected in a way which minimized the impact of the COVID-19 pandemic on the data. The pandemic, which started in 2019 and is still ongoing at the time of writing, may have affected leave days taken by operational staff as they were forced to quarantine if they either contracted the virus, displayed symptoms, or were in contact with someone who tested positive. Two approaches were used to minimize the effects of the pandemic on the datasets: (1) talking to country programs to understand in what way the pandemic had affected their operations and collect data from those years where they had been least affected, and (2) excluding leave days relating to COVID-19 when this was possible to do so, i.e., the country program differentiated leave days taken because of COVID-19 from other types of leave (including sick leave for other reasons).

Data Analysis

The dataset sample grouped five country programs and included a total of 1,105 individuals, 361 of which were women. Availability was measured by calculating the average "unavailable" time for men and women within operational/technical staff per country program.

availability to work=(total time off)/(number of deminers).

Categories of leave across operators and country programs were not necessarily equivalent or measured in the same way. Some datasets were more detailed, with eight categories of leave specified including COVID-19 and accident leave, while others only included sick leave. Although categories may have a similar heading, it is not guaranteed that the definition of that category is identical in all country programs. For instance, several operators record compassionate leave, but this may be measured differently in various country programs.

To conduct cross-comparison between country programs, leave types were grouped into larger categories: compulsory, sick, and parental leave, while other types were grouped into one remaining category ("other"). This ensured that only those leave types that were common across all datasets such as sick leave and parental leave were compared against each other.

Compulsory leave encompasses annual and compensatory leave as it is time taken off that is required by operators. Sick leave data was available in all five datasets. Parental leave data, which includes maternity and paternity leave, were available in four datasets (A, B, D, and E). Finally, all other types of leave, which did not necessarily have an equivalent across country programs, were grouped into the remaining "other" category.

The analysis therefore focused on sick, parental, and "other" categories of leave.

See endnotes page 108

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THE DEADLY LEGACY OF WORLD WAR II IN ALASKA

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Japanese Occupation of the Aleutian Islands

In the middle of the Bering Sea—closer to Japan than the continental United States and more than 1,000 miles from Alaska's largest city, Anchorage—sit the Alaskan islands of Attu and Kiska. It was the summer of 1942, nearly six months after Japan's surprise attack on Pearl Harbor, that Japanese forces invaded these islands in what was some of World War II's most brutal fighting and use of explosives.

The Japanese military high command had decided to occupy Attu and Kiska to fulfill several goals:

- To prevent American use of the Alaskan archipelago for mounting offensive operations (Attu is only 720 miles from Japan's Northern Territories islands)[1]
- To drive a wedge between US and Soviet insular possessions
- To establish bases for air operations against Alaska and the west coasts of Canada and the United States.

When Japanese forces occupied Attu and Kiska, it was the first time since the War of 1812 that American soil had been held by foreign forces. The islands are in the far western part of the Aleutian Islands chain. Most Americans were not aware of the Aleutians until the Japanese invasion, but the chain of islands was considered a valuable strategic piece of real estate by both Japanese and American leaders. One year later, Allied forces retook the islands in bloody fighting that resulted in a deadly legacy of thousands of explosive remnants of war (ERW), unexploded ordnance (UXO), landmines, and booby traps, some of which may still infest the soil.

The major obstacle for both armies was the Aleutians' isolated geography, characterized by difficult weather. Among all World War II battlefields, the Aleutian Islands were some of the wildest and most inhospitable. Terrific winds blow at more than 100 miles per hour, perpetual fog hinders vision and orientation, and there are almost no trees on the islands. The temperature drops below freezing in winter and seldom exceeds sixty degrees in summer, and the islands have as many as 250 rainy days a year.

Over the fourteen-month occupation, an estimated 8,600 Japanese troops were deployed to Attu and Kiska, which they heavily fortified in anticipation of inevitable American offensive operations to recapture the islands. The Japanese prediction was correct: in responding to the invasion, the US military underwent the first mass airlift in its history. Within thirty-six hours of the islands' occupation, 2,300 American troops and tons of supplies and weapons were flown to Nome, on the western edge of the Alaska mainland.

Buildup of the US Army's forces in Alaska continued until 94,000 troops were stationed across thirteen newly-constructed bases, including Cold Bay at the western end of the Alaska Peninsula. Due to US testing and stockpiling of weapons on Cold Bay, humanitarian threats from UXO became an issue.[2] One former Cold Bay inhabitant remembers that "[p]eople were always whizzing around on three-wheelers, and kids could test their luck screwing around with the buried World War II munitions that still dot the landscape." Additionally, children were remembered as "playing on actual World War II-era torpedoes abandoned on the beach."[3]

North of Cold Bay and the Aleutian Islands sits the Pribilof Islands group, which is where the US Army built a long-range aid to navigation (LORAN) station, controlling the Bering Sea approaches to the Alaskan coast. Stationed on the island of Saint Paul, US soldiers placed landmines around the village buildings on the chance that the Japanese would invade.[4]

The impact of WWII in the Aleutian Islands remains one of the most visible features that dot this remote landscape today. WWII concrete bunker, Dutch Harbor, Alaska.
Image courtesy of the author.

A six-inch projectile in the emplacement of a six-inch coastal defense battery on Little Kiska (Gun C).
Image courtesy of the author/Museum of the Aleutians.

Possibly unexploded shell largely buried in the sift soil. Seen northwest of Gun A, six-inch gun battery, North Head.
Image courtesy of the author/ Museum of the Aleutians.

ATTU: Operation Landgrab

Attu is about forty miles long and twenty miles wide, and its highest peak rises more than 3,000 feet above the sea. On 11 May 1943, Attu would be the US Army's first island amphibious landing of the war.[5] The soldiers landed in dense fog and were unopposed. Sergeant Hamlin of the 7th Scout Company recalled how "It was easy to get completely lost in the fog. It was easy to get completely turned around in the thick moving mist that made everything vague … the freezing cold and fog had been a harder enemy to fight than the Jap[anese]. Ninety percent of the Scout Company and three-fourths of the 7th Reconnaissance Troop suffered from severe exposure."[6]

From the beginning, Japanese troops were on the defensive and made the most of the terrain for that purpose. Rather than organizing beach defenses, they chose to defend the high ground at the northern end of Massacre Bay at 3,000 to 4,000 yards inland, and in the valleys leading to Chichagof Harbor, where the Japanese had established a strong defensive position.[7] In general, the Japanese forces employed the same tactics they had used in the South Pacific. While Attu and Kiska lacked the foliage and tropical growth provided by the islands in the South Pacific, the Japanese prepared excellent camouflaged positions and dotted the terrain with foxholes and two-man caves protected by light machine guns, mortar positions, and emplaced landmines.

On the morning of 29 May 1943, nineteen days after American troops landed, the Japanese staged a massive "Banzai" charge with around 800 Japanese soldiers attacking the American lines. Before the charge, nearly 500 Japanese wounded soldiers committed suicide or were killed by their own troops rather than being allowed to surrender.[8] The Japanese inflicted heavy casualties as they overran the frontline American positions, but most were quickly killed by the American troops.[9] By the following morning, the battle for Attu was over. The American victory in Attu was bloody and costly: "549 Americans were killed, and more than 3,200 were wounded or suffered from exposure or other battle injuries. Of the approximate 2,600 Japanese troops on the island, only 28 were taken prisoner. All others had honored the Samurai code of death."[10]

The Battle of Attu ranks as the second deadliest battle in the Pacific Theater (in proportion to the number of troops engaged), closely falling behind Iwo Jima. The casualties incurred during the invasion of Attu were appalling, with Americans suffering 3,248 casualties, roughly 25 percent of the invading force. Of these, 541 men were killed. Of the Japanese forces, 2,350 men were counted by American burial parties, and hundreds more were presumed already buried. The Japanese fought to virtually the last man.[11]

Image courtesy of Alaska Veterans Museum.

KISKA: Operation Cottage

After the bloody repatriation of Attu, the US Army turned its sights 205 miles east to the island of Kiska. Approximately thirty miles long and seven miles wide, the island has a shoreline that includes few beaches suitable for landing, and the better of the available beaches were controlled by entrenched Japanese defensive positions. The Japanese defenders augmented the island's favorable defensive geographical features—steep, hilly terrain and a profusion of valleys and caves—with machine gun positions, newly constructed tunnels and roads, and landmines.

In retaking the island, US forces subjected Kiska to a heavy pre-invasion bombardment. The first bombing attacks were carried out 11 June 1943 by four B-24s out of Cold Bay.[12] A total of 424 tons of bombs were dropped on Kiska in July. During the same month, a strong naval task force lobbed 330 tons of shells onto the island.[13]

"The surrounded Japanese garrison found a small window of opportunity in the Allies' seamless ring of ships to quickly and quietly evacuate the island in a dense fog. On 28 July, the Japanese garrison evacuated 5,200 Japanese soldiers on nineteen boats that formed the rescue armada. The evacuation was completed in just fifty-five minutes. Nothing much was left behind except a few dogs, a corpse of a soldier who had died recently of natural causes, a litter of landmines and booby traps, and some bombs preset to blow at the rate of one a day.[14] An after action report by US Army Intelligence noted that the south end of Kiska was found to be sprinkled liberally with mines and booby-traps. One of the favorite methods was to wire an M-93 mine upside down to about thirty blocks of TNT, thus increasing the concussion area."[15]

Canadian artillery officer Captain William Kirby, who was part of the Kiska recapture, shared how the enemy's ability to slip away "through the 'impenetrable' Allied naval blockade, which was really a triple blockade of seaplanes, submarines and coastal torpedo boats escorted by destroyers, had been a daring and brilliant feat."

Additionally, the Kiska evacuation had been carried out almost three weeks before the planned Allied landing. Since the Japanese departure went undetected, US forces continued to bomb and shell the abandoned island. In the ensuing month, more than 2,700 tons


Former classified Kiska Map - Pre-Allied invasion of Japanese occupied Kiska Island. "War Department, Corps of Engineers, US Army," July 1943. One of the few if not only map of landmines emplaced on US soil by a foreign Army. The US Army suffered landmine casualties on the island.

Image courtesy of the author/Museum of the Aleutians archives.

of bombs were dropped on the deserted island, including "two of the navy's bombardments that were the heaviest in Pacific naval warfare."[17] More than 300 tons of explosives were dropped in a single day alone: 4 August 1943.

Kiska D-Day, 15 August, was a typical Aleutian day. Dense fog covered the island, accompanied by high winds and a cold, heavy rain. Despite the weather conditions, almost 35,000 US and Canadian soldiers poured ashore. One Allied leader predicted that recapturing Kiska would be "bitter fighting with a Japanese force of from six to ten thousand" and that their goal was "to take as many prisoners as possible and … put a wedge into their Samurai code."[19]

Heavy casualties were also expected based on American soldiers' recent experience at Attu. For every 100 Japanese killed on Attu, seventy-one American soldiers were killed or injured. The estimated casualty rate expected for Allied soldiers at Kiska was 90 percent.[20] Information gathered by the Alaska Defense Command and the Advanced Intelligence Center, North Pacific Area, showed that "the Japanese development of Kiska was much more extensive than the development of Attu. Almost all beaches possessed some defenses, including barbed wire and mines."[21]

Allied commanders refuzed to believe that the Japanese could have completely evacuated Kiska.[22] For days, American and Canadian troops searched the island that they thought was still under the control of Japanese forces. The only living creatures the American and Canadian soldiers found were a few stray Japanese dogs. "We dropped 100,000 propaganda leaflets on Kiska, one airman said, "but those dogs couldn't read."[23]

Eventually more than 300 casualties would be recorded on Kiska. Some men were killed by friendly fire when confused and scared soldiers accidentally shot their comrades in fog-laden gunfights.[24] Others were killed or injured by landmines and the timed bombs the Japanese left behind.[25] Warnings were sent out not to pick up any Japanese candles as they were booby traps left behind.[26] On 24 August 1943, *The New York Times* asserted, "2 KILLED AT KISKA; Land Mines and Booby Traps Encountered in Landing."[27]

Deadly Legacy

While Attu is the only battle fought on American soil in World War II, its deadly legacy of conventional weapons contamination continues. In the three-week battle, more than 3,000 tons of ordnance were deployed. Currently, the most dangerous ordnance on Attu are the buster shells, which is a type of munition designed to penetrate Japanese targets buried deep underground, such as military bunkers. Live shells were found in the ammunition dump, and the island is off-limits to personnel without proper clearance.[28]

In 2013, the US Fish and Wildlife Service concluded that the threat of UXO and ERW

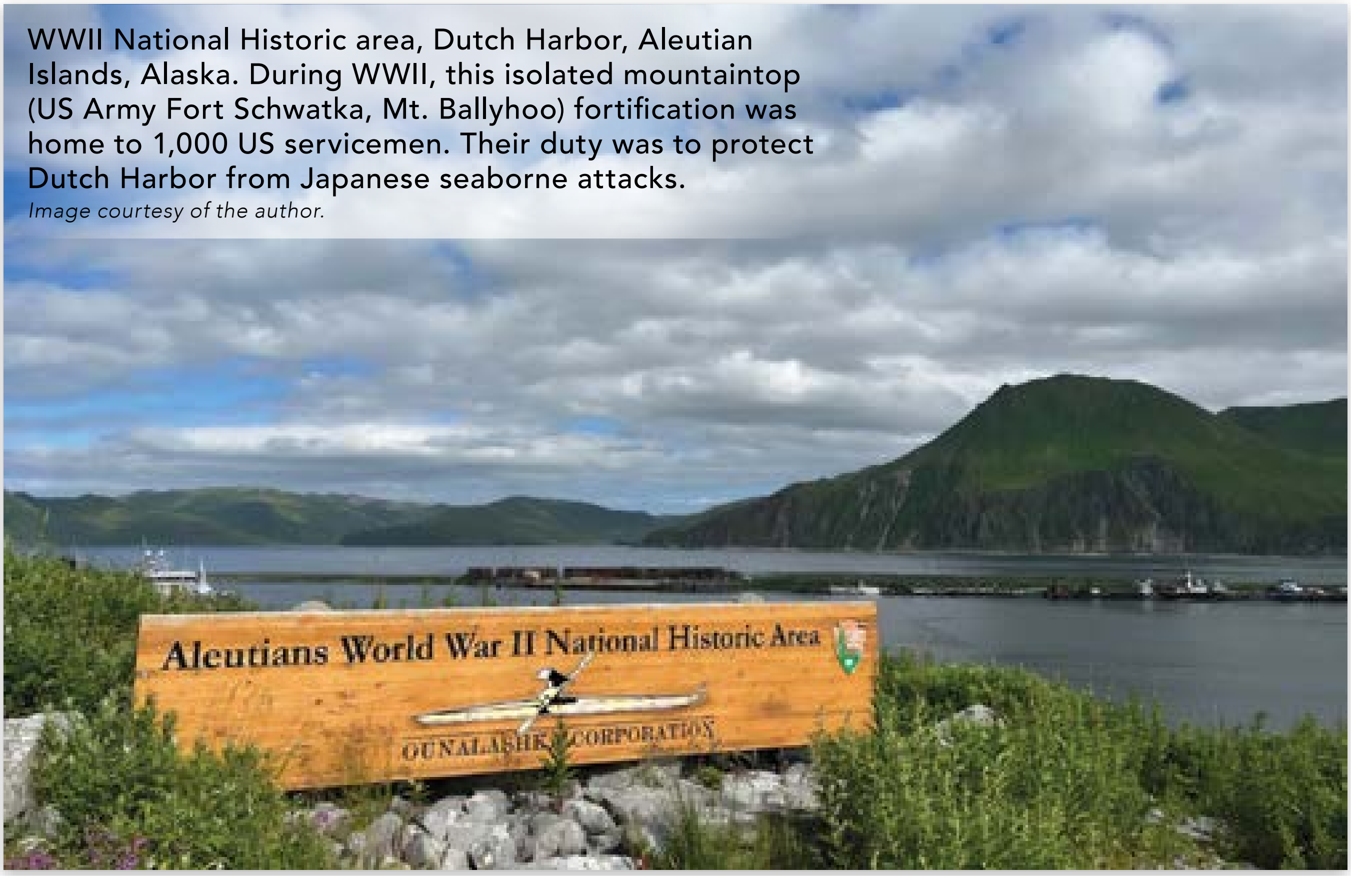
Warning sign at Kiska.
Image courtesy of the author.

from the fighting and occupation by both Japanese and Allied forces during World War II remains an issue on both Attu and Kiska. Despite the islands being designated as national wildlife refuges reserved for the conservation of wildlife and fish, UXO and ERW remain safety hazards. In particular, "[a]s the years progress, erosion exposes new sites while others are overgrown by vegetation."[29]

As of 2016, "there are fears of unexploded munitions that haven't either been discovered and removed, or otherwise disabled that perhaps in part drives these cautionary measures."[30] Few individuals visit Attu because the National Park Service has placed the island under restrictions.[31] Previous US government-funded UXO and ERW investigations for Attu have found a 100-pound Army practice bombs; smoke pots; smoke generators; smoke grenades; flares; fuzes; barrage rockets; 250- and 500-pound projectiles; incendiary bombs and bomblets; 6-, 10-, 12-, and 14-inch projectiles; small arms ammunition up to .50-caliber; high-explosive anti-tank and high-explosive incendiary rounds; fragmentation bombs; 20-mm (high-explosive) and 40-mm warheads; and anti-personnel mines. An Army Corps of Engineers report concluded that "[o]rdnance and explosive waste was estimated in tons, with some concentrated and with significant amounts scattered throughout the island hidden by the dense vegetation."[32] At last count, twenty-five warning signs were posted around known UXO and ERW areas on Attu.[33]

Kiska is now recognized as a National Historic Landmark and is part of the World War II Valor in the Pacific National Monument.

An American landmine detector used in the Aleutian Islands.
Image courtesy of the author/Museum of the Aleutians.



WWII National Historic area, Dutch Harbor, Aleutian Islands, Alaska. During WWII, this isolated mountaintop (US Army Fort Schwatka, Mt. Ballyhoo) fortification was home to 1,000 US servicemen. Their duty was to protect Dutch Harbor from Japanese seaborne attacks.
Image courtesy of the author.

Kiska is the only battlefield in the United States, and is only one of three battlefields worldwide, where there was no substantial human presence before the battle and where no subsequent alterations to the landscape have occurred.[34]

During the fourteen-month Aleutian Islands campaign to recapture Kiska, 3,000 tons of bombs rained down on the island, while the Japanese defenders mined and booby trapped their positions.[35] Because of the intensive bombing efforts and the large quantities of abandoned ordnance left behind by the Japanese, large quantities of UXO and ERW remain on Kiska,[36] where the traces of the battle are preserved in place and unchanged.

Because the full extent of UXO and ERW contamination is unknown and not all areas of Attu and Kiska have been investigated, the potential exists for such contamination to be present anywhere on these islands. Posted signs read "Warning! Kiska is a World War II battlefield. Unexploded ammunition is scattered throughout the landscape!"[37]

See endnotes page 108

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HOW CAN MINE ACTION IMPROVE THE MANAGEMENT OF FREE FROM EXPLOSIVE (FFE) ITEMS?

By Roly Evans [Geneva International Centre for Humanitarian Demining]

Assessing and making items free from explosive (FFE) are among the most dangerous things we do in mine action and are perhaps the least regulated. Mine action operators use items that have been made FFE or INERT for training and demonstration purposes. However, the sector does not really have sufficient procedures or qualifications to assess items as certified free from explosive (CFFE), or to make items FFE/INERT. Assessing or making items FFE are explosive processes and should be treated as such more consistently within the mine action sector. This article will outline the current state of play concerning FFE items in mine action, some of the problems involved, and suggest some potential options for consideration.

The Requirement for FFE Items

The humanitarian mine action (HMA) sector uses items of explosive ordnance (EO) that are CFFE, or INERT[1] for a range of reasons (INERT and FFE are interchangeable terms with the same essential meaning). Foremost among these is the need to provide items for training, not only to show students what different categories, sub-categories, and models of EO[2] look like, but also to provide items for realistic field exercises.[3] For example, training deminers to find a specific type of mine will typically involve some form of INERT substitute target. An anti-personnel (AP) or anti-vehicle mine is made FFE, but as many metal components as practicable are retained.[4] In this way, the item keeps the electromagnetic signature of the mine for detection purposes but does not pose an explosive hazard to the trainee. Substitute targets are also used throughout the day on demining sites by trained deminers in order to calibrate and re-calibrate their detectors as required.[5] Given that manual demining requires thousands of staff to be trained and re-trained without immediate risk, and that each demining site needs a substitute target for its test pit,[6] the need for inert targets for demining operations is arguably substantial. While inerting items involves an "inherent risk,"[7] it could be claimed that not inerting items and therefore not having targets with a high degree of fidelity also poses a risk to deminers. Without such high-fidelity substitute targets, deminers might be at greater risk of missing mines. Sometimes deminers will neutralize, disarm, and then inert the first landmines found on a survey or clearance task and use these as test targets for calibrating detectors. The logic behind this is that the mine will have weathered in a way consistent with other mines on that particular site and therefore provides a more faithful representation of what deminers need to detect with their Electro-Magnetic Induction equipment.[8] (Specific test pieces are manufactured but they don't have the ageing characteristics of items found on site.) FFE items may also be required for research, such as the evaluation of new sensors for mine detection.[9,10] While there have been efforts to develop surrogates for use in lieu of FFE items for research purposes,[11-13] testing in field locations still invariably uses items immediately available, such as FFE mines, rather than surrogates that might need to be imported at significant expense.

FFE items are also needed to train HMA explosive ordnance disposal (EOD) staff, not just for recognition purposes, but also for simulated task scenarios. Such needs mirror those of military EOD units. In the United States, the Department of Defense requires Secretaries of Military Departments to "provide sufficient quantities of inert and live EO items for EOD procedures joint validation and test verification and EOD training."[14] While surrogates made by means of 3D printing are available,[15] they can be expensive and may be deliberately made to be

Figure 1. An INERT LU 211 BB 155mm projectile. Note the clear INERT marking on the ogive. Rigorous marking of FFE items is essential. Some items in the sector are simply inadequately marked with an indelible permanent marker pen.
Image courtesy of Danish EOD and Search Center.

visually distinguishable from real versions that have been made FFE. Other uses of FFE items are perhaps less essential and include displays of items made FFE at various mine action organizations. Such displays may have many purposes, including as a form of exhibit to brief visitors while doubling as a training resource. FFE items are also used for museum displays.[16]

Current Risk Management of FFE in Mine Action

There are a range of documents detailing how FFE items should be made and certified. The documents reflect the different contexts of mine action and ammunition storage and are therefore not necessarily consistent. The current mine action guidelines on making and assessing items as FFE in mine action are detailed in International Mine Action Standard (IMAS) 10.50, "Storage, Transportation and Handling of Explosives."[17] While not a normative reference of IMAS 10.50, International Ammunition Technical Guideline (IATG) 06.50, "Specific Safety Precautions (Storage and Operations)," also has pertinent detail.[18] Notably, Annex F of IMAS 10.50 details some requirements concerning the "breakdown or modification of live mines and ammunition into inert, drill, instructional or replica items," whilst IATGs only give guidance on certifying those items as FFE.[19] Breakdown of ammunition is detailed in IATG 07.30, "Ammunition Processing Operations," but not really in the context of inerting items in order to certify them as FFE.[20] This is consistent with the old UK Joint Service Publication 482 on which much IATG content is based.[21] It might also be said that this reflects the different needs of each respective sector. Some may argue that mine action needs to conduct inerting procedures in a way that is not necessary for routine ammunition storage. What is clear is that a sector that conducts inerting is carrying significant levels of risk and accordingly should have a high level of risk management practice as a norm.

Does mine action have sufficiently developed risk management procedures for making items FFE, let alone certifying items? It is not clear that it does. One significant omission from IMAS 10.50 Annex F is the lack of any form of risk assessment requirement prior to making an item FFE. Perhaps remarkably, the whole of the current IMAS 10.50 does not include the term "risk assessment" at all. IATGs do require a risk assessment prior to any explosive process, including CFFE.

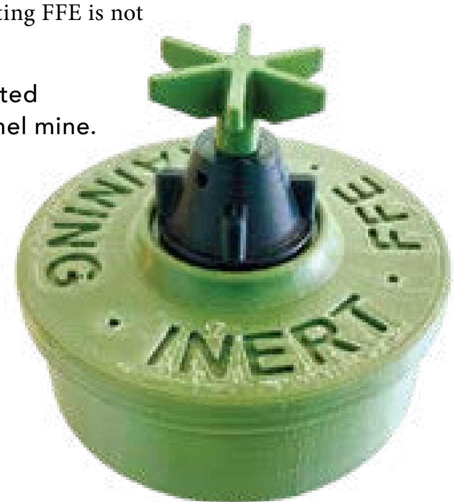
While IMAS 10.50 emphasizes the need for authorization procedures, Annex F often uses the word "must" rather than "shall" when detailing requirements, which in the IMAS entails a degree of ambiguity. These requirements include the need for full technical documentation and the need for authority from the National Mine Action Centre to conduct a procedure. IMAS also states that "all authorised breakdown or modification of live mines and ammunition into inert, drill, instructional or replica items shall only be carried out by appropriately qualified and authorised personnel."[22] Which personnel in mine action are "appropriately qualified and authorized" to make items FFE, let alone certify items? It is not clear whether there is actually a specific qualification to inert items. The US Marines are often seen as leading on inerting undamaged and unfired EO. While they have an exploitation course, it is not a requirement for inerting. It tends to be done by those with the highest levels of skill and experience.[23–25] IMAS 10.50 does add that only EOD Level 3+ personnel conduct demilitarization. However, at the time when the third edition of IMAS 10.50 was written in 2013, the EOD competencies did not mention demilitarization or FFE at all.

The new Test and Evaluation Protocol (T&EP) 09.30, "Conventional EOD Competency Standards,"[26] tried to provide more detail on the knowledge and skills required to at least assess items as FFE. A new EOD 3+ module, Advanced Explosive Theory, listed thirty-one competencies for assessing items. Emphasis was placed on understanding in detail all energetic elements within an item of EO. Other skills listed included use of X-ray, development and maintenance of FFE register, and drafting of specific risk assessments for assessment and certification of FFE items. Unlike IMAS 10.50, the competencies covered FFE assessment only, not any form of inerting or making items FFE. At present there are no competencies that cover inerting or demilitarization even though these are activities that do occur in the sector. During the development of revised 2022 T&EP 09.30, the possibility of a specific EOD 3+ module covering demilitarization competencies was raised but was ultimately rejected. If such a module had been developed it would have been suitable only for the most advanced EOD technicians and would have involved technical training well beyond any other 3+ module. A 3+ demilitarization module would last many months, rather than just a few weeks, require strict pre-requisites for candidates, and necessitate specialized ammunition processing facilities.

Certain commercial organizations do have detailed risk management processes for demilitarization. Fenix Insight conduct demilitarization of a range of ordnance, notably cluster munitions and explosive submunitions, in order to assist countries to meet their Article 3 obligations under the *Convention on Cluster Munitions*.[27] The nongovernmental organization (NGO) Golden West Humanitarian Foundation (GWHF) runs a demilitarization site in Cambodia where EO, once disarmed, is harvested for explosives that are then used for donor charges for demining activities.[28–31] The risk management systems for explosive processing for both organizations are stringent. Each process, clearly documented, is subject to formal internal approval. Managers actively identify, manage, and own risk.

FFE in the British Military

In the United Kingdom, military "CFFE is to be treated as an explosives process,"[32] which implicitly requires a number of safety and risk management precautions to be observed. "Any task involving the manufacture, assembly, repair, testing, modification, or disassembly of explosives carries with it an increased risk of accidental initiation. It is therefore to be regarded as explosives processing and is to be carried out in a facility suitable for explosives processing."[33] In accordance with Army Command Standing Order 1200,[34] the "implementation of Safe Systems of Work (SSOW)" is an overall framework that describes the main elements of a safety implementation when conducting an explosive process, including FFE. The key elements are competent staff, adequate supervision, suitable written work instructions, appropriate work equipment, and adequate work facilities.[35] The form an SSOW takes is guided by a risk assessment that considers training needs.[36] This is sometimes referred to in shorthand as "safe place, safe people and safe procedures." Notably "staff must have appropriate written authorization indicating their competency to carry out particular tasks."[37] The process would need to be detailed by work instructions[38] authorized by someone not below the rank of Major or equivalent, with an intimate knowledge of the process, who is themselves authorized by someone not below the rank of Lieutenant Colonel or equivalent.[39] Personnel authorized to certify FFE are published on Unit Standing Orders, adding to transparency.[40] Another means of controlling the process is the implementation of a Permit to Work system.[41] Mine action does not have an equivalent.[42,43] Above all these requirements, the key document on the subject, Defence Safety Agency 03. Ordnance Munitions and Explosives only details certifying items FFE. It does not describe the requirements for actually inerting items. This is because typically the process of inerting would not be done by military personal at all, but by specialists at the Defence Science and Technology Laboratory who possess the remote equipment required for this form of explosive processing. It is notable that an equivalent overarching framework for conducting FFE is not replicated in HMA.[44]



Figures 2 and 3. A 3D printed replica PMA-2 anti-personnel mine. The INERT item has been developed for training deminers by the Swiss EOD Center. The training aid has been designed to assist detection training, with with ability to change the metal content in the small red container. While not necessarily a perfect match for items that have weathered over time, and not an option for test pieces, such items are an option for training deminers.
Figures courtesy of the author.

Should Mine Action Even Be Making Items FFE?

It could be argued that making items FFE should largely stop within the mine action sector. There are already many items that are claimed as FFE by many organizations, and these can be supplemented by inert training aids that can be produced relatively easily by means of 3D printing. If making items FFE entails a "high degree of inherent risk," does the risk-reward calculation make sense anymore? After all, military organizations such as the British Army only inert items if it is strictly necessary. The question is at least worth asking within HMA.

Some will argue that it is justifiable to continue to inert items, not least since in certain circumstances we will continue to neutralize and disarm items of EO regardless. For some simple AP mines, the process of neutralization and disarming is a significant part of the inerting process anyway. At least for minefield clearance, no longer inerting items could mean not having high fidelity test pieces that reduce the risk of missed mines and also more destruction of mines in situ, potentially leading to more metal contamination and false positive signals during clearance, as well as more risk in a different sense.

In some ways inerting items of EO poses a dilemma for the mine action sector. On the one hand, the ammunition management sector sees making items FFE as a last resort, and when it is done, it must be justified by managers, and extensive levels of risk management are required. The mine action sector, used to removing explosives from items such as simple AP mines in order to make test pieces over many years, has not treated this as an explosive process but sometimes as a relatively routine field practice. Whether mine action should strictly mirror ammunition management and apply the same level of rigor is up to those who lead the sector. However, it is clear that when both certifying and inerting items, the mine action sector should review its norms and consider whether its procedures reduce risk to a level "as low as reasonably practicable" (ALARP).

Figure 4. Mechanical Remote Fuze Disassembly Kit used for removing small energetic components such as primers in fuze rotors, GWHF Cambodia 2014. If mine action organizations wish to make items of explosive ordnance INERT, and to train suitable staff to do so, specialist explosive processing facilities are required.
Image courtesy of Roger Hess.

Possible FFE Risk Management Options to Consider

Designing a detailed and heavy risk management system for inerting and certifying FFE is an option, but any proposed system needs acceptance by the sector. The answer could be to revise the risk management system so that it is rigorous but does not overburden HMA field operators and recognizes the context of HMA demining operations. Calibrating such a system appropriately will be an important part in its success or failure. Some options to consider could include:

- *All organizations maintaining a central record of all items they have certified FFE globally, respectively*
- *An approved, model-specific, energetic component check list for certifying each item of FFE held*
- *FFE certificates listing the exact energetic components removed with date, time, and individual who conducted the procedure recorded, along with detail of the permanent FFE marking*
- *A surveillance regime for all accidents related to FFE*
- *Development by each mine action organization of an overall standard operating procedure (SOP) for assessing items as FFE*
- *If the organization wishes to make items INERT, a list of approved technical procedures needs to be developed for each model to be made FFE. Each procedure could have two technical approvals, one of which could be independent of the organization*
- *If the organization wishes to make items INERT, an FFE training record that details each specific model an individual is authorized to make or certify as FFE that is time limited*
- *A risk assessment specific to the model of EO, primarily applicable to making items FFE but also relevant to certification*
- *For making an item FFE, a Permission to Work form to be completed by an authorized senior technician that confirms that a SSOW is in place for an explosive process to take place*
- *If an organization wishes to make items INERT, development of advanced demilitarization training.*

While these options might seem basic, if just CFFE options were implemented in mine action, the risk of FFE-related incidents could be reduced. Even something as simple as the widespread development of SOPs for assessing items as FFE would be a significant step forward. For organizations that wish to make items FFE, a full review of how this can be achieved while managing risk responsibly could be advisable.

Figure 5 (left). An INERT MRV-U fuze complete. Note that the fuze appearance has been altered in order to make the item FFE. A full cut has been made above the shutter in order to gain access to the primers, stemming, and other energetic components. For some models, cuts on fuze bodies can be good initial indicators as to whether energetics have been removed and the item really is FFE. A window to view the setback sleeve has also been added during the inerting process. Making such an item FFE is an explosive process that should be conducted with a high level of risk management.
Figure courtesy of Dutch EOD Center.

Figure 6 (right). A cutaway of an FFE MRV-U fuze. The pink and yellow elements visible in the booster section are not explosive but an inert substitute intended to indicate the position of some energetic elements within the fuze.
Figure courtesy of Dutch EOD Center.

FFE Risk Assessments

If organizations wish to make items INERT, pertinent written risk assessments are an essential element of any risk management system. The key principle for an FFE risk assessment is that it must be specific, not generic, in that it must refer to each exact energetic component contained within an item of EO. The risk assessment will also detail a control measure or risk treatment for that component. That control measure will often be the same as the specific part of the authorized process to remove that component, but the documents are not necessarily the same. The risk assessment would complement the inerting process but would not be a substitute for it.

It is notable that even for a relatively simple AP mine, the risk assessment is fairly detailed. More complex items of EO will invariably require a more detailed risk assessment, consistent with the number of energetic components they contain, and formally approved procedures required to access and remove those components.

FFE Procedure

The development of a technical procedure is an indispensable element of any FFE process, both for making and certifying an item as FFE. The procedure must not only identify each energetic component, but how it will be removed safely. NGOs such as GWHF have developed such procedure documents.[45,46] It should also be sufficiently illustrated with technical photographs so that there is no ambiguity as to the information it is trying to convey. The procedure complements a risk assessment for a specific item, but it is not a substitute for one. HMA organizations should be careful that the procedure is only ever carried out by those proven competent to do so. A reasonable test for such competency, even for those with advanced EOD qualifications, would be for the EOD technician to rehearse how the procedure will be conducted without reference to the procedure document, in order to confirm understanding, prior to a Permission to Work being granted.

Environmental Considerations

Removal of energetics, particularly main charges, can lead to chemical waste such as wastewater contaminated by TNT through the process of wash out and steam out,[47] or by means of hydro-abrasive cutting.[48,49] Mine action has only recently started to appreciate the specific pollution risks associated with EO.[50,51] Especially if large items with significant volumes of explosive fill are to be made FFE, the risk assessment should include how any specific environmental impact will be controlled. Various energetics have differing levels of toxicity. For example, Tetryl has been phased out since the 1970s due to health effects experienced by exposed munitions workers since the 1940s.[52–54] It is still commonly found in legacy munitions. Chronic exposure to both RDX and TNT is known to present a degree of risk.[55–57] Any inerting risk assessment should consider the potential health effects that repeated exposure to a given energetic could entail and identify the standard controls, such as use of basic personal protective equipment.

FFE Records

HMA organizations should maintain a detailed record of all FFE items they have globally. Keeping records solely at a given location is insufficient. Such a detailed register must be more than a list of FFE certificates with accompanying FFE codes. It should detail when the item was originally made FFE, when it was certified, when it was last checked, when it must be checked again, and who has conducted all these procedures. Individual FFE certificates should also list the energetic components removed from an item. If an X-ray image was used to confirm the absence of energetics within an enclosed item (e.g., a fuze), the X-ray image should be included on the certificate, annotated to show where components are confirmed as absent. In this way instances of "assumed FFE," such as fuzes that have been burnt, can be avoided. The record must identify where the marking of the item is positioned and whether the marking is engraved (recommended) or just indelibly marked. The security of the item should also be detailed (i.e., is the item locked away so that it cannot be mixed inadvertently with live ordnance).

Figure 7. An X-ray of an ADSID sensor. X-rays were taken of the ADSID using a SAIC RTR-4 with the XRS-3 X-ray source; 10 pulses at 25cm for all X-rays. No detonation cord, booster, or main charge was detected in the body. X-rays are an important means of discovering whether items still contain energetic components, prior to certifying them FFE.
Figure courtesy of GWHF.

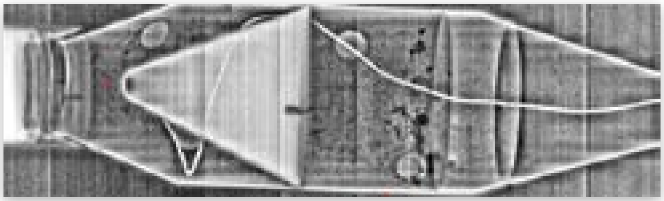


Figure 8. An X-ray of a heat warhead. X-rays are an important means of discovering whether items still contain energetic components, prior to certifying them FFE.
Figure courtesy of private individual.

Conclusion

Making and certifying items FFE are relatively unregulated activities in HMA. It might well prove that a more stringent system than the one briefly sketched here will be required at some point in the future. In any case, what is outlined in this article would be a significant increase in the current level of risk management process for FFE in mine action and can at least serve as a starting point for a long overdue discussion within the sector. Regardless of whether a new way of making and certifying items as FFE is adopted, the approach outlined in various documents concerning FFE, including IMAS 10.50, IATG 06.10, and T&EP 09.30, requires rationalization, so that at least a consistent approach can be adopted. In addition to this, each mine action operator may wish to review their FFE SOPs to ensure they are content with the levels of risk management detailed. Ultimately, each mine action organization should not only be able to identify and manage risk but actively own the risks they choose to take.

See endnotes page 109

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MAPPING UNEXPLODED ORDNANCE IN SYRIA:

Harnessing the Power of Open-Source Information

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For over a decade, the widespread use of explosive weapons by all sides in the Syrian conflict has been well documented by a litany of public sources. Many of these explosive munitions fail to detonate as intended, thereby becoming unexploded ordnance (UXO) that threaten post-conflict recovery. To begin the process of clearing these explosive remnants of war (ERW), desk studies/non-technical studies can be utilized to initially assess the concentration and distribution of explosive weapons across a conflict zone, which in turn suggest the risk of UXO in an area. Traditional methods in non-technical surveys (NTS) focus on unweighted conflict intensity scores (counting the number of events) or after-the-fact munition detonations to determine current contamination.[1] The authors propose a novel, nuanced approach to counting the number of munitions per event, not just the number of events. This new open-source weighted estimate (OSWE) method contains higher-fidelity data for analysis with more specific coverage across a larger geographic area than prior models. Using crucial and corroborated open-source investigation workflows, the authors created a nationwide assessment paradigm. In comparison with older models, we anticipate that the OSWE method of estimating UXO concentration is more useful across a greater range of geographic scopes through its leverage of big data, weighted nature, and data selection for events likely to generate UXO. The OSWE method also produces an estimate for UXO in Syria (a minimum of 100,000 nationwide). These are important findings, as more accurate estimates can be replicated across contexts, including in Ukraine.

Destroyed buildings in Homs, Syria.
Photo courtesy of Adobe Stockphotos.

Introduction

Although media attention has waned, the Syrian conflict continues, albeit on a smaller scale.[2] A nationwide cease-fire announced in March 2020 has largely held, leading to minimal exchange of territory among the major warring factions. Despite relatively constant areas of control, the use of explosive weapons and the detonation of UXO is a weekly occurrence. These detonations happen across the country regardless of which faction controls territories and often at the cost of civilian life and limb.

In Syria, clearance of explosive contaminants is disrupted by a slew of variables, namely instabilities in project funding, a volatile security environment, a prohibitive sanctions regime, uncooperative local partners, and security access challenges of remote contamination assessment. Despite these complicating variables, this paper will specifically focus on the initial stages of the explosive ordnance (EO) clearance process by using open-source data on the conflict in Syria to enhance an NTS. This approach is intended to assist in the prioritization of key areas.

In 2011, many Syrian civilians took to the streets, calling for reform as part of a popular national protest inspired by other mass mobilizations collectively described as the Arab Uprisings. An ensuing security crackdown on peaceful protesters prompted the protest movement to call for the overthrow of the Syrian government led by President Bashar al-Assad.[3] Further crackdowns led to defections from the armed forces of Syria, and armed demonstrators shooting back at military forces sent to quell riots. This cycle escalated into open conflict, occurring for over a decade with four major territory-holding factions vying for control. Two dozen more international armed forces have also engaged in Syria, mostly through airstrikes and artillery strikes.

Syria has had stable frontlines since the spring of 2020, when a cease-fire was brokered between the government of Syria and the Turkish-backed opposition in Syria's northwest. While no new major offensive has occurred since then—itself a mark of the cease-fire's conflict resolution success—the term "cease-fire" is a misnomer, as indirect conflict and occasional clashes are still reported daily in Syria. Syria's northwest region, where frontlines between the opposition and the government meet, averages at least 350 conflict events per month as recorded by the Armed Conflict and Location Event Database (ACLED).

Literature Review

Since World War II, UXO have traditionally been detected on the ground by clearance teams who detect potential hazards, excavate, and determine if the object is a UXO.[4] The prevailing approaches used in humanitarian mine action (HMA) employ either magnetometers or terrestrial electromagnetic induction (EMI) systems.[5] Although these have been validated as one of the most dependable geophysical methods for HMA, they have several weaknesses, including high false-positive rates in areas with metallic clutter,[6] time and labor intensiveness,[7] and operator vulnerability.[8] These factors, along with operator experience and the technological capability of mine-detection technology, impact the rate of mine clearance.[9]

Newer approaches conduct automated surveying by remote sensing via magnetometers deployed on unmanned aerial vehicles (UAVs) to scan wider areas more rapidly and safely.[10] This reduces both financial costs in terms of information-gathering and risks to personnel and equipment related to accidental detonation during on-site detection.[11] Although this is a useful preliminary tool for reducing the geographical expanse and cost of ground-based surveys employed in HMA, UAVs are generally limited by weather and environmental conditions,[12] though novel approaches such as using multi-sensor configurations attempt to overcome this.[13] UAV surveying also requires analyzing large, complex datasets, relying heavily upon advances in machine learning (ML) to help interpret the data.[14] Background noise in the data is another obstacle.[15] Recent work using ML to detect and classify ordnance shows promise,[16] but it is still in early phases of testing and implementation.

Given these challenges, many HMA organizations have shifted efforts toward desk-based, data-driven approaches such as NTS.[17] Such approaches offer preliminary assessments to detect areas of interest to prioritize technical on-the-ground surveying.[18] The inherent difficulty in UXO detection and clearance in active conflict zones[19] can be augmented using these methods, given the risk of surveying areas that are traditionally considered too dangerous for intervention (i.e., along the frontlines).[20] Recent efforts demonstrate the value of using open-source investigation (OSINV) for such preassessments. An innovative approach developed by The Carter Center in 2019 optimizes existing open-source data on conflict events in Syria (ACLED and The Carter Center data collections) to produce heat maps for high levels of explosive weapons use and therefore potential UXO contamination.[21] The HALO Trust, one of the world's preeminent demining organizations, recently joined forces with Esri (the organization that develops ArcGIS) to map in real time the presence of UXO and damage to residential areas or infrastructure as the Russian invasion of Ukraine unfolds.[22] This includes efforts to automate mapping processes, where experts can filter through a stream of evidence instead of manually searching the internet for news articles and social media.[23] Although this offers the potential to document UXO presence in current and future conflicts, munitions exist from as far back as World War I.[24] The utility of The Carter Center's approach is evident in the potential to make use of decades of existing data,[25] in combination with current OSINV methods to address ERW.

Methodology and Models

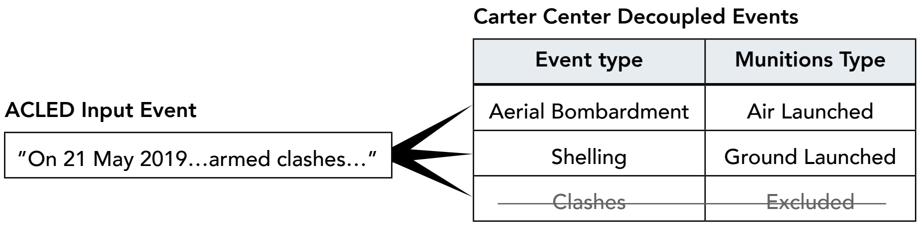

Figure 1. Visual description of The Carter Center's process for decoupling data from ACLED. *All graphics courtesy of the authors.*

Explosive contaminants are a large set of deadly munitions or devices that include landmines and improvised explosives devices (IEDs) as well as ERW. ERW as a classification includes both UXO and abandoned explosive ordnance (AXO); the former fail to detonate as intended and the latter are left behind or forgotten about.

Two core databases of conflict events inform this study. The first is ACLED, which has coverage dating back to early 2017 for the whole of Syria. The second is a unique dataset collected by The Carter Center dating to 2012. Both datasets use a similar sourcing methodology based on open-source collection and multi-user verification. Key sources for both sets include the Syrian Observatory for Human Rights (SOHR)—a research network of on-the-ground journalists and activists led by Rami Abdulrahman,[26] conflict event information posted by trusted accounts on Twitter, local newspapers, and video content shared on YouTube or Telegram, with The Carter Center more often leveraging the latter. These conflict events in both datasets are classified by location, date, event type, and a qualitative description of the event in plain writing.

The first and primary model we present is the OSWE model. To create this model, raw data from ACLED and The Carter Center are amended to be more optimally useful for desk study of UXO concentration.[27] ACLED combines multiple explosive events (including multiple event types) in one location on one day into a single event, labeled as only the event type considered to be the most extreme. For example, an event that had artillery shelling, aerial bombardment, and armed clashes would be treated as one event marked as aerial bombardment. The additional event types are then described in the qualitative description column. See Figure 1 for a visual explaining this decoupling.

The parsing of events helps to more accurately detect potential areas and density of UXO contamination. In partnership with Microsoft, we deploy a natural language processing technique based on the BERT model[28] to efficiently and broadly separate ACLED-reported events into constituent conflict events.[29] We then begin by filtering data from both ACLED and The Carter Center for conflict events that deploy explosive munitions, namely aerial bombardment, shelling, IEDs, landmines, and reports of other UXO.

After selecting these event types, the question of how to weigh different event types persists. A key benefit of The Carter Center's 2012–2017 data is that it contains occasional mention of munition count estimates from on-the-ground reports[30] or in some cases, explicit counting of munitions from video footage used as sourcing material.[31] After cleaning the data further to specify munition counts across the data in which numbers are included, we then use each munition category (air-launched, ground-launched, IED/UXO/landmine, and miscellaneous other) to create an estimate for each. The number of events that inform each of these estimates, as well as the mean of each sample used for each category are included in Table 1.

Munitions Category	Sample Set Event Count	Sample Set Average (Estimate)
Air-Launched Munitions	6,718	7.78 (8)
Ground-Launched Munitions	6,250	9.96 (10)
Landmines/UXO/IED	5,549	1.10 (1)
Miscellaneous Other	214	4.05 (4)

Table 1. Open-Source Weighted Estimate Model Sample Set Detail.

Next, for comparison, we create two other models derived from the same underlying dataset at the same scale. The first of these models is the conflict intensity model, traditionally the default approach for United Nations agencies and others alike.[33] This model takes underlying conflict event data of all types (inclusive of clashes, sniper fire, etc.), and uses these unweighted values to assess the intensity of fighting over the course of a war in a geospatially specific manner. The final model, the UXO detonation model, pulls from conflict event data of recorded UXO detonation, excluding all other events. This is done through qualitative filtering of events based on the notes/description column of the data, selecting for events explicitly mentioning unexploded munitions, munitions exploding from previous fighting, and explosives of unknown origin.

We then run all three models at localized point-of-interest areas in Syria, which are based on an intentionally and conflict-relevant amended version of the United Nations Office for the Coordination of Humanitarian Affairs' (UNOCHA) geolocated populated places data.[34] The amendments are minor but incorporate several key areas such as critical infrastructure or military locations in addition to the civilian points of the UNOCHA dataset. We then geoprocessed latitude and longitude coordinates for territorial control points using ArcGIS's Thiessen projection's function,[35] thereby creating polygons around each unique spatial point to estimate each location's geographic area.[36] Using a 1:1 spatial join, the results from each of the three distinct models are added to the Thiessen shapefile, providing a sum of munitions estimates for the OSWE model and a count of events for the other models.

The results for each of the three UXO data results for potential areas of contamination are normalized by the estimated polygon shape area for each location and then selected for high and low concentration estimates. These estimates are then assessed for comparative analysis of differences between the three models at a local (i.e., populated places) scale. Findings based on these comparisons are presented and discussed next.

Data Findings

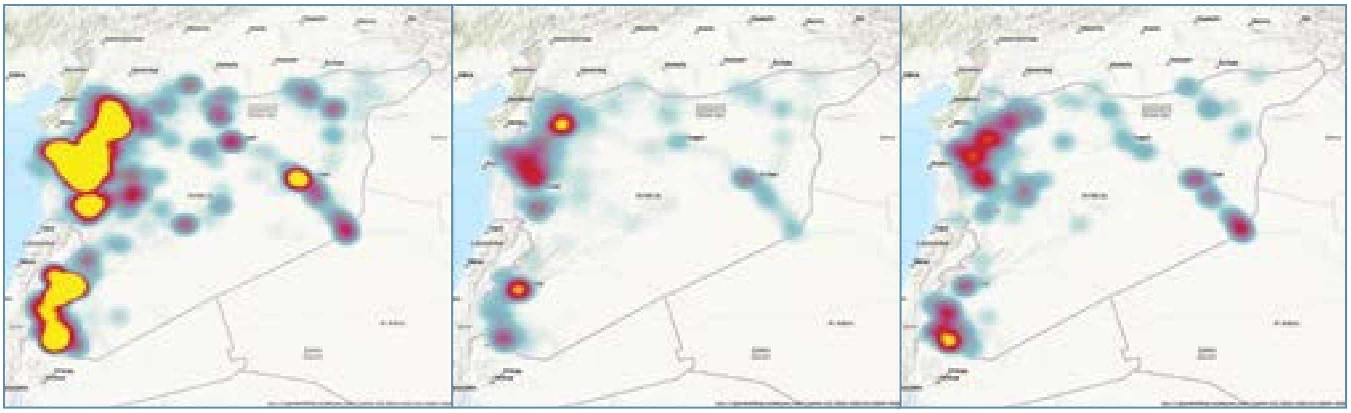

Figure 2. Nationwide heatmaps of the OSWE model (left), conflict intensity model (center), and UXO detonation model (right).

Utilizing the OSWE model permits interpolating estimates for missing data of munitions counts, thus enabling us to extrapolate closer estimates of likely explosives munitions use across Syria.[37] Notably, this nets an estimate of well over one million explosive munitions deployed in Syria by mid-2021. At a ten percent munitions detonation failure rate,[38] over 100,000 munitions need clearance nationwide, though this number is likely much higher.

Each model results in different spatial distribution of likely UXO concentration; they are compared in Figure 2, indicating OSWE, conflict intensity, and UXO detonation models from left to right.

The OSWE model (left) has much higher concentration in western Syria. The conflict intensity model (center) has a bit more of a dispersed geospatial concentration. Finally, the UXO detonation model (right) is heavily skewed toward southern Syria. Viewing these models at a national scale is not as meaningful as getting into a location-based specificity, so the authors developed an analytical framework based on high levels of local concentration of explosive munitions use, conflict events, and UXO detonations, respectively.

Using these three models to assess local contamination, we then select for what we refer to as high-UXO-density locations (HUDLs)—locations that score one standard deviation above the model's mean point value. These communities are those in which each model presents a location of imperative UXO cleaning operations.

The three models identified different numbers of HUDLs based on levels of variance inherent within the models. The OSWE method pinpointed the broadest number of HUDLs (126), given the disproportionate level of explosives munitions use within a broad swath of key locations. Many of these locations endured long-term active frontlines or were under heavy siege for many months. The UXO detonation model determined the lowest number of HUDLs (eighteen), in large part due to the comparatively low level of data inputs.

While these three models bear some overlap in HUDL selection (see Figure 3), the findings suggest that each approach has a distinct usefulness or aim, with substantial overlap between the OSWE method and a contemporary conflict intensity method.

All three models are derived from data with significant correlation (and indeed perhaps some codeterminance if not compared and analyzed more intimately). The breakdown of locations identified by these models is shown in Table 2 (next page).

Notably, Model A (OSWE) and B (conflict intensity) had the most overlap with each other, sharing the majority of their identified HUDLs. The conflict intensity model has the most unique locations identified, a factor that we attribute to the broadness of this model's approach as we describe earlier in this paper.

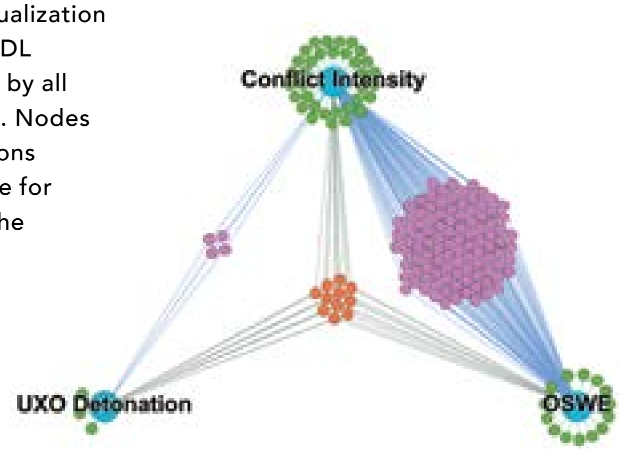

Figure 3. Visualization of shared HUDL identification by all three models. Nodes are for locations and edges are for selection in the associated model.

Model	Shared with Model A (percentage)	Shared with Model B (percentage)	Shared with Model C (percentage)	Unique Locations Idenfied (percentage)
Model A - OSWE	-	112 (75%)	11 (61%)	14 (11%)
Model B - Conflict Intensity	112 (89%)	-	15 (83%)	34 (23%)
Model D - UXO Detonation	11 (9%)	15 (10%)	-	3 (17%)

Table 2. UXO estimate model HUDL overlap.

Analysis and Implications

We conclude that the OSWE method has more optimal, precise, and expansive coverage of potential UXO contamination for current, future, and past conflicts. This is in large part due to the leverage of weighted big data approaches that underlie the desk study method. This gives our approach considerable leverage for assessing needs and directing resources in any high-level armed conflict where explosive munitions are and have been used at scale.

It is also crucial to note that this is only the tip of the OSWE iceberg, as other sources for estimate weights can be applied across contexts. In the model deployed for this desk survey, we base estimates around munitions category (air-launched, ground-launched, etc.), whereas munitions type (mortar, rocket artillery, barrel bomb, airplane-launched, etc.) will provide a more granulate weighted estimate. Other methods of interpolation, such as frontline density, era of conflict, or initiating actor could allow for a compounding weighted estimate that may provide a more rigorous insight in future models.

UXO contamination is an issue that crosses frontlines and political divides, affecting large portions of Syria. Of the communities at high risk identified through the OSWE method, Table 3 identifies the breakdown of which actors control the most likely HUDLs in Syria.

Perhaps unsurprising to those watching Syria closely, the government of Syria controls the lion's share of HUDLs in all models, in no small part due to its control over most of the territory of Syria. However, this still accounts for a disproportionate share of explosives munitions use, given that the government holds territorial claim over about fifty-five percent of all point locations tracked by The Carter Center and about sixty-four percent of the total territory. Part of this high concentration of likely UXO contamination in government-held territory has to do with the protracted conflict and heavy besiegement of many territories retaken by the government, especially between 2017 and 2018.

Another crucial component of the OSWE method is that in addition to providing a count and percentage of HUDLs held by each territory-holding actor in Syria, it allows for an estimated count of munitions within each actor's held territory. Table 4 identifies this breakdown by each of the three major actors.

Using the results from the OSWE model helps assess contamination for areas controlled by different actors in Syria, allowing HMA organizations with access to only one actor to assess needs across their accessible territory. Table 3 indicates that the government of Syria controls many HUDLs through all three model approaches; the OSWE can give useful insights about the density

Model	Count of HUDLs Government-Held (percentage)	Count of HUDLs Opposition-Held (percentage)	Cound of HUDLs SDF-Held (percentage)	Count of HUDLs Joint Government & SDF-Held (percentage)
Model A - OSWE	117 (92%)	6 (5%)	2 (2%)	1 (1%)
Model B - Conflict Intensity	129 (86%)	9 (6%)	6 (4%)	4 (4%)
Model D - UXO Detonation	10 (56%)	5 (28%)	0 (0%)	3 (16%)

Table 3. HUDL count by faction control.

	Count of HUDLs (percentage)	Total Territory Held in SQKM (percentage)	Estimated Count of UXO (percentage)	UXO Density in UXO per SQKM
Government-Held	117 (92%)	118,869 (64%)	757,689 (79%)	6.4
Opposition-Held	6 (5%)	11,174 (6%)	145,369 (15%)	13.0
SDF-Held	2 (2%)	46,087 (25%)	33,146 (3%)	0.7
Joint Government & SDF-Held	1 (<1%)	2,939 (2%)	24,643 (3%)	8.4
US-Held	0 (0%)	6,759 (3%)	14 (<1%)	0.0

Table 4. OSWE model detection of UXO by faction.

Model	Count of HUDLs (percentage)	Primary HUDL Holder, by Count (percentage)	Primary Governorate, by Count (percentage)
Model A - OSWE	100 (79%)	Government, 117 (93%)	Aleppo, 57 (45%)
Model B - Conflict Intensity	92 (61%)	Government, 129 (86%)	Aleppo, 70 (47%)
Model D - UXO Detonation	18 (100%)	Government, 10 (56%)	Aleppo, 5 (28%)

Table 5. Model comparison, filtered by location 2+ degrees from a frontline.

of explosive weapons use and likely UXO contamination that follows. Using this approach, we find that the territory holder with the highest likely UXO density is the armed opposition, who have almost twice the likely level of contamination as the government of Syria on the aggregate. Notably, the opposition only controls about six percent of all territory by area and about sixteen percent of all settled locations.

One final example assessing HUDLs and areas of control by the major factions in Syria's war has to do with the frontlines in Syria. A major hurdle identified both in the literature and in conversations we had with HMA personnel pertains to the aforementioned security risks associated with frontlines. Filtering these three models for locations that are at least fifteen km from a frontline allows for selection of both high-density areas for clearance and those that are more accessible to technical survey and clearance teams. This can be accomplished by using The Carter Center's previously discussed geolocated dataset on territorial control in Syria. The previously described Thiessen polygons are created by estimated midpoints between neighboring locations. Dissolving these point-centered polygons based on an aggregated feature, in this case "armed group in control," allows for creating larger polygons that denote areas of control for each month in the conflict, resulting in a highly accurate and dynamic estimate of frontline locations. Using the proximity function, the distance from each location point to the boundary of neighboring polygons controlled by opposing armed factions allows for estimating distance from the frontline, or more than one in cases where multiple fronts are colliding. In turn, it is possible to assess how geographically concentrated locations are within conflict zones.

See Table 5 for information about how each of these three models interacts with this filter for HUDLs at least fifteen km away from a frontline.[39] As of June 2022, 5,127 locations (points of control) are at least fifteen km from a frontline (or sixty-three percent of Syria).

Combining such analysis with the OSWE method illustrates how impactful such a method could be for those directing the difficult work of technical surveys and eventual UXO and mine clearance projects while safeguarding the safety of their staff.

Conclusion

It is crucial to note that this methodology is still in development. This paper builds upon a few years of data collection and analysis, but The Carter Center is continuing to hone this methodology. We aim to ensure that the method is easily replicable in other contexts, and indeed a similar approach is now being used by others in the field today. As noted, HALO is partnering with Esri to utilize open-source data to anticipate UXO clearance needs in Ukraine as the war there unfolds. Development of this theoretical desk study method, as with any method for determining likely UXO density and clearance need, is directly connected to saving the lives of civilians who have already endured a brutal conflict.

The Carter Center is expressly interested in working with HMA organizations to continue developing methods to improve and make the explosives clearance process more feasible and efficient. Relatedly, this method could be tested in the future against UXO clearance data—checking the newer OSWE method against legacy desk study approaches. With access to that responding data, analysts will be able to run tests measuring direct applicability of this method to continue to assess biases in the data and its methods.

See endnotes page 111

The views expressed in this article do not represent the authors' current or previous employers.

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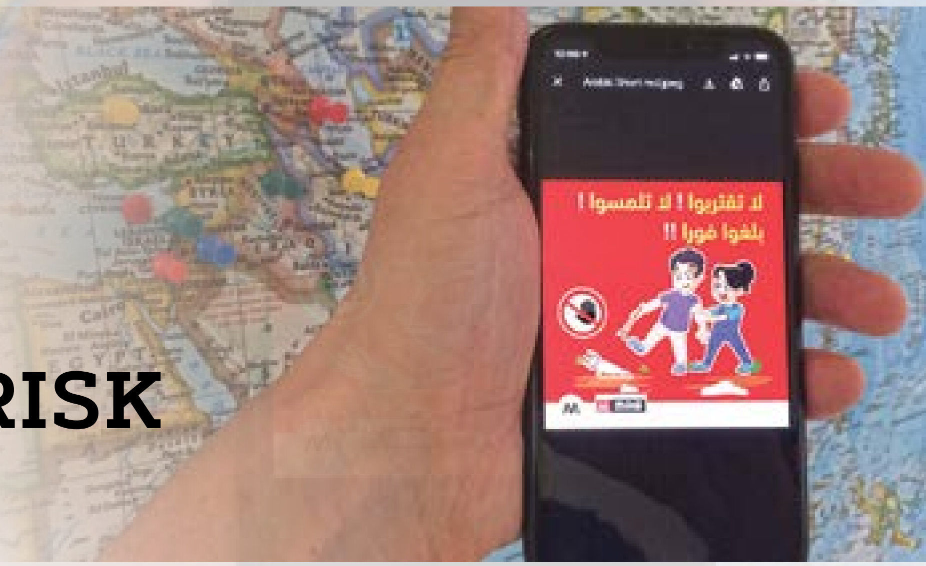
THE TIME HAS COME FOR DIGITAL EXPLOSIVE ORDNANCE RISK EDUCATION



Simple graphics from the pilot project in Ninewa, Iraq.
All images courtesy of the author/MAG.

By Robin Toal [MAG, Mines Advisory Group]

The increase in the number of civilian casualties from landmines and other explosive ordnance (EO) in recent years has driven the demand for new and innovative ways to provide communities with risk education. Additionally, with access limited by the COVID-19 pandemic, humanitarian organizations like MAG (Mines Adivsory Group) have had to adapt their approach, focusing on digital explosive ordnance risk education (EORE) to reach individuals and communities affected by EO.

MAG's digital risk education project uses targeted social media ads to encourage safe behavior and teach communities how to identify and report EO to local authorities. The latest data on EO accident trends via the Information Management System for Mine Action (IMSMA) or national databases, plus real-time user engagement data via digital platforms, are used to inform agile strategies that can respond to changes and developments on the ground, ensuring messages reach high-risk regions and demographics.

Since 2019, MAG has piloted online risk education to encourage safe behaviors. In Ninewa, Iraq, the pilot—the first phase of the project—was the first time that risk education messaging was delivered on a large scale using Facebook ads. The results were promising, with ads shown twenty-nine million times to 983,447 people in Ninewa Governorate. Community liaison surveys showed that 94 percent of people surveyed in the community confirmed they saw the ads on Facebook and that the ads helped them understand the risks posed by EO.

Following the successful pilot in Iraq, MAG formed a partnership with the Office of Weapons Removal and Abatement in the US Department of State's Bureau of Political-Military Affairs (PM/WRA) and Facebook to launch the second phase of the project. While the pilot project focused solely on areas of northern Iraq liberated from ISIS, phase two reached more than eleven million at-risk civilians in Iraq, Lebanon, Somalia, and Vietnam in 2021. The partnership expanded in 2022 to include Palestine (via the United Nations Mine Action Service) and Syria, while digital risk education was also delivered in Ukraine. These countries remain heavily contaminated by landmines, improvised explosive devices (IEDs), unexploded ordnance (UXO), and other EO that kill and maim civilians while also blocking economic development and the return of displaced communities.

MAG's senior community liaison advisor Sebastian Kasack notes that "new approaches are crucial to try to reach as many people as we can, especially in challenging environments. Using social media, for example, provides the opportunity to reach high numbers of people, including younger audiences, which can be difficult to reach through 'traditional' means."

Abdulsalam Muhammed of Northeast Ninewa sharing risk education messages on Facebook with his grandchildren.

Digital EORE

As digital EORE is a realitively new initiative, there is little data available on the efficacy and efficiency of using social media to impact change. MAG's monitoring and evaluation (M&E) approach aims to provide context to the development and distribution of digital risk education materials, identify and provide recommendations to address barriers to access, measure communities' knowledge of safe behaviors (pre-campaign), and determine the extent to which changes are seen by measuring understanding of safe behaviors (post-campaign). MAG gathered feedback on these activities through focus group discussions and a quantitative survey among community members before and after the project. Our team also circulated digital surveys with users who were shown ads online to capture comprehensive insights on the effectiveness of the initiative.

Social media is a competitive and congested environment where it is easy to scroll away from content that is not of interest or relevant to the user. Particularly in highly developed social media markets like Vietnam and Lebanon, content must be competitive among other ads. To maximize effectiveness in an advertising-based social media space, digital risk education must present the issues realistically, engage users within the first few seconds, and deliver key messages promptly. By breaking up longer videos into shorter individual key messages, risk education practitioners can significantly increase the consumption of EORE materials, enhance awareness of the threat, deliver practical steps on how to stay safe, and provide guidance on how to report EO to relevant authorities. Alternatively, EORE image ads are effective at engaging with communities who have limited or expensive internet data and thus may be more suitable for communities living in remote and rural areas.

In all country contexts, EORE video ads produced by the NGO Clowns Without Borders[1] and videos of higher production value performed better. Animated ads worked best with young people, while live action videos were popular in all contexts where they were published. In most countries, users appeared to clearly understand the message of the ads, and 68 percent of beneficiaries surveyed recalled recently seeing one of the ads published by the project. Of respondents who recalled seeing an ad, 98 percent said that they had read the ad and/or clicked on the link, and 91 percent reported learning something from the ad. Beneficiaries' level of confidence to report dangerous items to MAG or the national mine action authority rose after viewing the ads.

Gender and Local Environment. Additionally, to deliver effective digital EORE, it is recommended to invest in high-quality content that effectively engages users of both genders. MAG advocates for the integrated and systematic use of gender analysis at all stages of the project cycle. Digital risk education is designed with gender-sensitivity, inclusion, and participation as a core principle. Data from the first year of MAG's digital risk education project revealed that girls and women tend to engage more with human faces and stories. As a result, and in order to boost interaction, MAG developed people-centric and beneficiary-based risk education content that reflects situations, landscapes, and people from their communities.

Traditional in-person risk education approaches can be limited or restricted entirely due to environmental and logistical barriers. Security considerations can prevent community liaison teams from accessing areas to deliver risk education, leaving EO-affected communities without support when they need it most. Weather, such as during monsoon seasons, can also restrict access and may become a greater problem as climate change triggers more extreme weather events.

Local community guidance and buy-in is needed to inform relevant and responsible choices about project and material design. In some contexts, community liaison staff that closely identify with the communities they serve enjoy increased access and higher engagement; however, digital approaches can reach communities regardless of liaison staff.

An 8th grade student at Hai Lam Primary and Secondary School, views risk education materials on her mobile phone.

Benefits of Digital EORE. To engage groups unable to attend or for which in-person sessions are inaccessible, digital EORE content can reach platforms where they are already active. Digital EORE can also provide a lower-cost method of engaging target communities as it requires fewer human resources and has lower logistical costs. Social media advertising in particular can be a cost-effective method of engaging both large and niche communities.

Changes in technology have also served to better enable risk education practitioners to take control of the content development and distribution processes that increases speed and reduces costs. Graphic design, including video development, is now accessible to more people using simple and affordable software while tools to create and deliver messages and ads on social media is intuitive and easy to learn.

Developing a digital component to established EORE activities increases opportunities to engage with mine-affected communities. Additionally, digital content is more universally accessible to people with limited mobility as it can deliver messages to their home via their personal devices. Our materials tend to include subtitles and spoken word audio to enable people with sight or hearing impairments to engage with the materials. This approach complements in-person activities by providing accessible, lifesaving information and prioritizing key messages with traditional sessions. Digital EORE works best when there is human capacity and knowledge to integrate and complement existing activities and bridge the gap between the online and offline worlds.

A short risk education video developed by Clowns Without Borders in the Maxa language for Somalia delivered using Facebook ads.

In Bata, Equatorial Guinea, MAG used digital technology to deliver emergency risk education.

Case Study: Equatorial Guinea

While digital EORE works best when supported by an active clearance capacity to remove the threat, it can also function as a stand-alone activity, and in some circumstances, may be the only way to engage with mine-affected communities. In March 2021, Bata, the largest city in Equatorial Guinea, was rocked by an explosion that killed 107 people and injured another 600. The explosion scattered EO across the city and up to 7 km from the blast site, causing significant damage to infrastructure.

The population of Bata were unfamiliar with the threat of EO and engaged in risk-taking activities such as taking selfies with items of scattered ordnance. Assessment teams observed civilians collecting and selling scrap metal and children playing in dangerous areas. The situation required an urgent response.

In coordination with UNICEF, the UN, and UNESCO, MAG rapidly developed Spanish language digital EORE materials and distributed them via Facebook ads to all users within 40 km of the blast site. Within six days of the explosion, digital EORE materials reached more than 18,000 individuals online, providing them with potentially lifesaving information.

"This new approach of delivering lifesaving lessons via Facebook ads in response to emergency scenarios ensures that we reach people affected by EO when they need it most, helping to reduce the risk of harm and keeping families safe. Digital channels enable us to get urgent warnings to affected communities when physical access is challenging."

~ Sebastian Kasack, MAG Senior Community Liaison Advisor

Case Study: Sy Vietnam

Truong Van Sy, a twenty-three year-old computer technician, lives in Hoành Viễn village, Quàng Binh Province, with his parents, brother, his wife, and their daughter. Sy's neighbor, at only thirty-five years-old, was a victim of an EO accident, killed in 2011 after stepping on a cluster bomblet.

Sy saw MAG's EORE messages on his mobile phone in August and September 2021 and through these ads, found the EO reporting hotline number for Quảng Bình Province. He called the hotline number to report a BLU-26 submunition, which he discovered on the edge of his fish farm during cultivation some time ago but had not known how or who to call for help.

> *A year ago, I encountered a cluster bomblet while working in my family farm. At that time, I was very scared and nervous and didn't know what to do. I left the area with the bomb untouched. Recently, many local people went into my land for picking mushrooms (and shooting birds) so I was really afraid that they might unfortunately step on the bomb that could endanger them. I always told everyone about the location of the bomb so people knew to avoid it.*

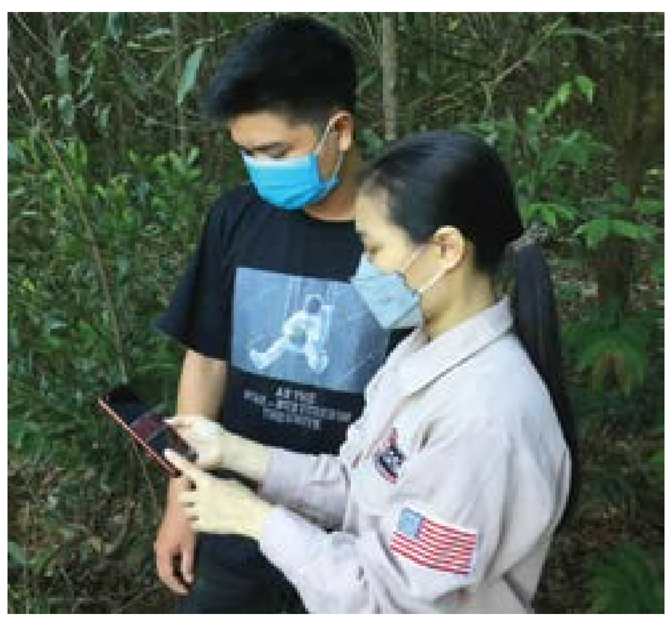
Sy and his family are all regular Facebook users. Sy has liked and followed MAG Vietnam's Facebook page for updates.

> *I feel lucky to be able to know about MAG's work and the EO reporting hotline number via MAG's Facebook page so I can report the item. I hope that there will be more meaningful ads like these in the future so everyone knows how to call for help when an EO is found and knows how to avoid EO-related accidents as well.*

Sy reported the cluster bomblet on 27 September 2021. MAG received the request from QB Mine Action Database and Coordination Unit and sent a community liaison team there to collect information the next day. MAG's Multi-Task Team destroyed the bomb in situ on 30 September.

Sy said after the bomb was destroyed, "We feel safe now to work on the land."

Sy and a MAG community liaison officer view the Facebook post that gave Sy the information on how to report the explosive ordnance he found on his land.



What's Next?

"The digital EORE project is an exciting project taking advantage of the opportunities new technologies offer. Our lifesaving messages delivered through social media networks can reach men, women, and teenagers living in remote areas and still living on land contaminated with explosive remnants of war. The project allows us to tremendously increase our reach and increase the impact of our lifesaving work."

~ Hélène Kuperman, Former MAG Country Director for Vietnam

MAG has established and integrated digital EORE into a number of programs, country strategies, and proposals to provide a sustainable platform for further development. In 2023, MAG will continue to develop digital EORE, including in Iraq, Lebanon, Palestine, Syria, Vietnam, and Ukraine, as well as developing digital provision to support small arms and light weapons (SALW) risk education. Similar to MAG's approach with EORE, the purpose of SALW risk education will be to raise awareness of the threat of SALW and provide practical advice on how to reduce risks. Examples of practical SALW advice may include communicating the risks of firing your weapon into the air and safety reasons for securing weapons.

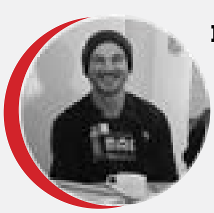
Emerging in the sector before the COVID-19 pandemic began in 2020, digital approaches became more important than ever as teams around the world were severely limited in performing in-person EORE. The Geneva International Centre for Humanitarian Demining's (GICHD) *Review of New Technologies and Methodologies for EORE in Challenging Contexts* captured the growing number of activities across the humanitarian mine action (HMA) sector, which led to the creation of the Digital Task Team as an official offshoot of the EORE Advisory Group.[2] Representatives from HMA organizations around the world regularly meet to develop strategies and best practices, and to formalize the initiative through a consistent monitoring and evaulation framework.

In May 2022, the first ever digital EORE workshop was hosted by UNICEF and GICHD in Switzerland. The workshop gathered around twenty EORE practitioners from across regions and organizations to take stock of tools, trends, successes, and gaps in digital programming both in EORE and other humanitarian aid sectors in order to strategically promote effective and ethical digital EORE in mine action. Participants drafted an action plan with short-, medium-, and long-term actions—many of which could fall under the scope of the Digital Task Team either through its existing subgroups or through the setup of new subgroups. Many HMA organizations are now active in delivering some form of digital EORE in countries on every continent.

Social media provides a new way to engage with communities in a dynamic and cost-effective manner. It enables us to reach large numbers of people in a specific area, overcoming obstacles posed by security, geography, and complex operating environments that limit the delivery of face-to-face risk education. The ability to target people based on specific criteria will ensure that we reach the most at-risk communities as well as groups that are harder to attract through "traditional" face-to-face sessions such as youth and young adults who are often the most difficult to reach.

See endnotes page 112

MAG's digital EORE work is generously supported by the US Department of State and Facebook.



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THE EVOLUTION OF PHYSICAL SECURITY AND STOCKPILE MANAGEMENT:

A Successful Implementing Partnership Perspective

By Lee Moroney [Golden West Humanitarian Foundation]
and Mark Veneris [US European Command HMA Program]

To avoid unplanned explosion of munitions (UEM) and to lower the risk of illicit diversion, the humanitarian requirements ensuring strong ammunition management structures, systems, and processes by states have been well documented in past issues of this *Journal* and other publications. These needs have led to the evolution of multilateral and bilateral support from donor nations that see the humanitarian value of supporting physical security and stockpile management (PSSM).

Over the past two decades, the Office of Weapons Removal and Abatement in the US State Department's Bureau of Political-Military Affairs (PM/WRA) and the US Department of Defense (DoD) have shown significant support for PSSM through the geographic combatant command (COCOM) programs. This article analyzes how methods have changed from just planting the flag with "first-aid fixes" to a holistic, capacity-building approach.

Even though early engagements in PSSM operations proved that something is better than nothing, these actions had limited impact. These varied from assessment missions with recommendations but "no teeth" to short-term training with no continuation training or mentorship programs, while others involved building storehouses without looking at procedural development support or one-off disposal projects that ignored wider surveillance and disposal planning. Presently, only one COCOM[1] currently engages in a comprehensive capacity development approach working to develop national capability.

With Golden West implemented project management, EUCOM provided financial support to renovate this explosive storehouse (ESH).
All images courtesy of Golden West Humanitarian Foundation.

Georgian Defence Forces conduct explosive limit license exercises during EUCOM-Golden West mentorship.

Georgian Defence Force graduates of the EUCOM PSSM foundation course.

The US Approach

The US European Command (EUCOM) is the US DoD's COCOM that has embraced this deliberate approach to its theater security cooperation (TSC) programs and has been leading the way with ongoing successful projects in Moldova, Georgia, and Albania since 2018, with more countries to be supported in the future. Since 2018, the EUCOM PSSM program has provided over US$10,000,000 to support PSSM activities within its three main focus areas: infrastructure support, equipment support, and training and mentorship support.

First steps. Like any successful TSC program, the core element to success begins with the host nation officially requesting support rather than having support forced on them. This is the first challenge, as it can be suggested that decision makers generally don't know what they don't know. An approach implemented by Golden West Humanitarian Foundation (GWHF) in 2018, with donor support from PM/WRA, brought together senior officers directly involved in PSSM in their host countries to share their experiences in conversations chaired and guided by qualified practitioners. Also invited as participants were the EUCOM HMA program manager and subject-matter experts (SMEs).

Having the right people involved from the start and enabling open dialogue rather than a one-way training approach enabled various structural and capability gaps to be identified so a baseline needs assessment could be produced. This process ultimately led to support projects starting in three countries within twelve months of these meetings.

Maintaining momentum. Following the initial meetings, participants briefed their chain of command, and follow-up meetings with high-level leaders and decision-makers occured to maintain momentum and guarantee support for the host nation. Due to multiple layers of bureaucracy to work through in recipient countries, momentum is critical for multi-year PSSM activities that also depend on the movement of other inter-dependent activities. By maintaining momentum, projects can move forward successfully and in unison with other relevant PSSM work. This level of host nation support was possible through the combined efforts of the EUCOM team (and combined US military) as well as the implementing international nongovernmental organizations' (INGO) SMEs. We believe this contributed to the overall success of the programs since previously lead PSSM initiatives had held numerous assessments with limited authorities involved or budgets to work with, and failed to conduct follow-up assessments.

Mentored by Golden West, Moldovan Armed Forces conduct quantity distance on-the-job training.

EUCOM provided infrastructure and equipment for this ammunition depot in Moldova. The program does not just focus on explosive storehouses but all facilities that support best practices in ammunition management for safety and security.

Evolution of PSSM

One of the major evolutions over the past few years has been an increase in communication and collaboration between countries, donor governments, and international organizations. Beginning with the introduction of the International Ammunition Technical Guidelines (IATG) in 2011, the community now coordinates and works together well, while the establishment of the Ammunition Management Advisory Team (AMAT) at the Geneva International Centre for Humanitarian Demining (GICHD) is a good example of how to bring international organizations together. Together with organizations like the United Nations Office for Disarmament Affairs (UNODA) and donors such as the United States, practitioners and implementing partners similar to GWHF and other INGOs coordinate with and support countries who request PSSM assistance. This multi-faceted working group in both official and unofficial forms has engaged collaboratively throughout the development of Version 3 of the IATG. On behalf of EUCOM, GWHF ensures that the execution of the new Version is implemented at all levels—where support includes manageing infrastructure, procuring equipment, developing training, and providing SMEs and (embedded) mentorship for host nations.

An additional evolution for PSSM was the modification of United States Code Title 10 Section 407 in 2017 that placed the authority to conduct PSSM activities squarely in the DOD HMA TSC program.

Measuring Success

Success in PSSM can only be measured by lasting impact. As the HMA community has learned through its demining efforts, ensuring a sustainable impact is immensely challenging. Compared to demining, measuring PSSM success is even more difficult. Success in demining can be determined by numbers, such as square meters cleared, land released through survey, unexploded ordnance (UXO) destroyed, abandoned explosive ordnance destroyed, countries declared mine-free, etc. Less obvious are the metrics for PSSM, which must be viewed through a different lens than mine action.

The EUCOM program views this success as supporting the development of a national capacity where countries have national regulations, procedures, political structures (within the responsible ministries), tradesmanship, infrastructure, training, equipment, supplies, and national budget allocations in place for PSSM programs. Through GWHF, EUCOM contracts experienced qualified retired military personnel with HMA experience to work directly with the host nation. They also engage closely with the US Office of Defense Cooperation (ODC), who are generally working with other elements of support to MOD structures in all of these levels in a top-down and bottom-up approach.

The EUCOM program understands trust takes time to build and works through partnerships with the host nation, ODCs, and implementing partners such as GWHF, to develop a quantifiable plan of action directed towards eventual fade out.

Over the past two decades, the Office of Weapons Removal and Abatement in the US State Department's Bureau of Political-Military Affairs (PM/WRA) and The US Department of Defense (DoD) have shown significant support for PSSM through the geographic combatant command (COCOM) programs.

Utilizing the results of EUCOM infrastructure upgrades, with equipment provided to the Albanian Armed Forces.

Albanian personnel inspect, audit, palletize, and store ammunition in accordance with international best practices.

Tailoring the Approach

As detailed at the start of this article, the level of long-term partnerships and multi-year assistance provided to countries are measures of success. Similarly, the updated UNSaferguard Quantity Distance maps of depots represent an achievement of the program that would reduce the risk and impact of a potential UEM. While countries will rarely have exactly the same needs at the same levels of support, supporting synergies such as standardized training curriculums, training trackers, and national regulators are required for most (but not all) countries. Qualified SMEs that can advise, mentor, support training, manage programs in refurbishment/construction projects of old storage areas to IATG-compliant standards, and procure equipment throughout the plan of action are investments that donors employ to build a sustainable ammunition management program.

EUCOM continues to refurbish ammunition depots and compounds, and provides equipment ranging from the basic materials such as pallets and banding equipment to mechanical handling equipment (MHE). The program is concurrently developing and executing a comprehensive phased train-the-trainer program from basic ammunition management through to an upper management level based on the IATGs. By creating various levels of regulatory and procedural review for each country, EUCOM identifies relevant, implementable, and sustainable focus areas for the partner country through the US military and GWHF SMEs.

While the EUCOM example may not be appropriate for every country, geopolitics and funding may dictate that support to one country requires multiple-lateral engagement. However, even with the best of intentions, this approach can be more difficult. Aspects of financial and operational support may need to synchronize, stretching the capacity of an already over-extended host nation.

As PSSM challenges arise, EUCOM will proudly continue to support countries that have requested assistance. Accepting these challenges, GWHF, as a US-founded and US-based INGO, will continue to leverage the technical expertise and project management it has provided the US Government. However, the partner nations deserve recognition for taking the first step, choosing to open up their structures, facilities, and regulations to strengthening their capacity and capabilities for a safer and more secure ammunition management structure.

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Lee Moroney is a retired British Army Ammunition Technician with global operational experience in CIED, EOD, and Ammunition Management. He has managed humanitarian mine action programmes in South Sudan, Lao PDR, Vietnam, Thailand, and North Macedonia. Currently, Moroney is the Director for the Golden West PSSM programs in Albania, Georgia, Moldova, and previously Ukraine. He is the Golden West coordinator for support to US EUCOM and POC for all PSSM-related global partnerships with other IO's and INGOs. Additionally, Moroney holds a Master of Arts in International Policy and Diplomacy and is a member of the Institute of Explosives Engineers.

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ENDNOTES

Open-Source Research and Mapping of Explosive Ordnance Contamination in Ukraine by Mathewson [from page 34]

1. Tett, Gillian, "Inside Ukraine's open-source war, *Financial Times*, July 22, 2022, Accessed July 28, 2022. https://on.ft.com/3bjIaXl.
2. IMAS 08.10, "Non-technical Survey," First edition, 10 June 2009, Amendment 4, 2019, chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.mineactionstandards.org/fileadmin/MAS/documents/standards/IMAS-08.10-Ed1-Am4-Non-Technical_Survey.pdf.
3. Calcea, Nicu, Mengying Du, and Giacomo Boscaini-Gilroy. "How big is occupied Ukraine?" *The New Statesman*, July 28, 2022, Accessed July 20, 2022. https://bit.ly/3bevuRN.
4. Berehulak, Daniel, "Death in Ukraine: A Special Report," *The New York Times*, June 18, 2022, Accessed July 22, 2022. https://nyti.ms/3vqm0cY.
5. "The Promise of Open-Source Intelligence," *The Economist*, August 7, 2201, Accessed July 20, 2022. https://econ.st/3vp8Lci.
6. Schwartz, Leo, "Amateur open-source researchers went viral unpacking the war in Ukraine," March 7, 2022, Accessed July 20, 2022, https://bit.ly/3JuV3Lb.
7. For an event to be added to HALO's map, the location must be specified or ascertained to at least the settlement level. The only exception are civilian accidents, that are added regardless, to assist in tracking the number of casualties of ERW in Ukraine.
8. The only exception to this rule is imagery depicting explosive ordnance remnant of World War II. While not from the current conflict, locating such ERW remains beneficial and allows for its safe and proper disposal.
9. It is important to note that these most likely represent only a fraction of all civilian accidents due to the presence of ERW due to the fog of war and underreporting of accidents by the populace.
10. Yushchenko, Irina, "Beware of mines: A tractor driver was blown up in the field of Gogol, and rescuers were in the exclusion zone," *Brovary Tribune*, April 5, 2022, Accessed July 22, 2022, https://bit.ly/3OJFK22.

Explosive Weapons Use and the Environmental Consequences—Mapping Environmental Incidents in Ukraine by Cottrell, Darbyshire, and Obrestad [from page 44]

1. CEOBS, 2022. Sustainable recovery? First sustain interest in Ukraine's environment. https://bit.ly/3y52wMj
2. "In historic move, UN declares healthy environment a human right," UN Environment Programme, https://bit.ly/3Ec0i1H.
3. UN Environment, 2017. Conflict pollution and the toxic remnants of war: a global problem that received too little attention. https://tinyurl.com/ayyamz9j
4. CEOBS, 2020. Eyes in the sky – earth observations to monitor conflict and environment. https://tinyurl.com/yfxrnn9c
5. Such as the Sentinel Hub EO Browser, which allows one to view open- source imagery from the Sentinel, Landsat, and MODIS instruments, https://bit.ly/3rlwV5q
6. Via NASA's Fire Information for Resource Management Systems (FIRMS) website, https://go.nasa.gov/3CkShWO
7. CEOBS, 2019. The weaponisation of environmental information in the era of fake news. https://bit.ly/3E3iz13
8. Hodgkin & Nielsen, 2022. Rebuilding Ukraine: The imminent risks from asbestos. https://bit.ly/3SpzOOg
9. PCBs are a group of man-made organize chemicals consisting of carbon, hydrogen, and chlorine atoms. They have a range of toxicity. https://bit.ly/3SuW6OI
10. CEOBS & Zoï Environment Network, 2022. Ukraine conflict environmental briefing: nuclear sites and radiation risks. https://bit.ly/3RrJS8n
11. IMAS, 2015. Technical Note 09.30/02 Clearance of depleted uranium (DU) hazards. https://tinyurl.com/5n7e3bej
12. International Mine Action Standard (IMAS) 07.13 Environmental management. https://www.mineactionstandards.org/fileadmin/user_upload/IMAS_07.13_Ed.1.pdf
13. Ecoaction – https://en.ecoaction.org.ua/, and Environment People Law - http://epl.org.ua/en/pronas/
14. Green Reconstruction of Ukraine: Position of Civil Society, May 2022. https://bit.ly/3dSv0Cf
15. "Pollution mitigation and control in areas affected by armed conflict or terrorism," United Nations Environment Assembly of the United Nations Environment Programme, https://bit.ly/3RqaJS7

A Brief History of Mine Detection Dogs by Evans [from page 50]

1. F. Boutineau. The Mine Clearing Dog. Bulletin Technique du Genie Militaire. Troisième Quarter. 1961. pp. 179-190.
2. Notes on a Discussion on Mine detectors at Berkeley Court on 26/3/43. p.2. The National Archives. AVIA 22/861.
3. Letter on behalf of Assistant Director of Scientific Research. 17 March 1943. "We have an urgent Service requirement for a detector capable of detecting non-metallic anti-tank mines. The type of mine we visualise having to deal with comprises a wooden or plastic case, embodying only a small amount of metal in the fuze, trip wire mechanism, etc." The National Archives. AVIA 22/861,
4. Report on Trials. 16 December 1943. The National Archives. WO 203/3126.
5. TRADESMEN: General (Code 87(A)): Trade Test for Dog Handlers. Minutes of Meeting Held on 24 April 1944 to Consider the Provision of Dog Units for 21st Army Group. 25 April 1944. The National Archives. WO 32/11100.
6. Chief Engineer, 1 Corps, to Chief Engineer, Second Army. 17 July 1944. . The National Archives. WO 203/3126.
7. Report on the Employment of No.1 Dog Platoon, Royal Engineers at Carpiquet Airfield. 31 July 1944. The National Archives. WO 205/1173.
8. Military Operational Research Unit Report No.7 Battle Study. Minefield Clearance and Casualties. p.8. The National Archives. CAB 106/1023.
9. Military Operational Research Unit Report No.7 Battle Study. Minefield Clearance and Casualties. p.8. The National Archives. CAB 106/1023.
10. Report on Mineclearance in the Netherlands, 01 November 1945. Recording Methods and Organisation. p.5. The National Archives. WO 205/1186.
11. Report on Mine Dogs from 21 Army Group. The National Archives. WO 205/1173.
12. Chief Engineer, Second Army, to Chief Engineer, 21st Army Group. 16 December 1944. The National Archives. WO 205/1173.
13. Summary of Comparisons Made during 26, 27, 28 Febru-

ary 1945 of Sappers Working with No.2 Dogs Platoon. 28 February 1945. The National Archives. WO 205/1173.
14. OC NO.2 Dog Platoon RE. Report on Mine Detection by Dogs. p.2. The National Archives. WO 205/1173.
15. M. Lemish. War Dogs. A History of Loyalty and Heroism. Washington 1996. p.95.
16. J. Pettit and R. Hughes. Engineer Mine Detection Dogs. Engineer. U.S. Army Engineer School. Fort Leonard Wood. July-September 2004. p.18
17. Headquarters, Department of the Army. Field Manual 7-41. Mine and Tunnel Dog Training and Employment. March 1973. p.3.
18. M. Lemish. War Dogs. A History of Loyalty and Heroism. Washington 1996. pp.94-95.
19. J. Romba. A Study in Training Methodology of Mine Dogs. Army Land Warfare Laboratory. Army Mobility Equipment Research and Development Command. June 1974. p. 3.
20. U.S. Army Engineers. Note on Visit to British Was Dog Training Centre on 13th March 1945. p.1. The National Archives. WO 205/1173.
21. Maclean. Perspectives on Animal Learning Theory. Comparing Concepts and Styles. in GICHD. Mine Detection Dogs. Training, Operations and Odour Detection. Geneva. 2005. pp.7-10.
22. Makor R. Crawthorne. Military Operational Research Report. Interim Report No.2. On the Detection of Mines by Dogs. April 1947. The National Archives. WO 291/1048. p.2.
23. Use of Dogs for Mine Detection. 03 June 1944. The National Archives. AVIA 24/271.
24. Training Instructions on the Handling of Dogs for Mine detection. June 1944. p.2. The National Archives. WO 205/1173.
25. Ministry of Supply. Department of Chief Scientific Officer. Report of Meeting. 18th February 1946. p.1. The National Archives. AVIA 22/862.
26. Ministry of Supply. Department of Chief Scientific Officer. Report of Meeting. 18th February 1946. p.2. The National Archives. AVIA 22/862.
27. R. Kirk. In Dogs We Trust? Intersubjectivity, Response-Able Relations and the Making of Mine Detector Dogs. *Journal of the History of the Behavioral Sciences*. Volume 50. Winter 2014. p.24.
28. https://www.bridgemanimages.com/en/noartistknown/australian-troops-move-through-dusty-conditions-in-korea-and-train-mine-dogs-to-detect-buried-mines/footage/asset/1631884
29. "Booby Traps Take High Vietnam Toll." *New York Times*. 30 March 1967. p.1.
30. LTC P.W. Carroll III. "Mine and Boobytrap Warfare: Lessons Forgotten." U.S. Army War College. 29 February 1988. p.8.
31. Headquarters, Department of the Army. Field Manual 7-41. Mine and Tunnel Dog Training and Employment. March 1973. p.3.
32. G. Magner. Detection and Avoidance of Mines and Boobytraps in South Vietnam. Interview with Commander of C Company, 1/52nd Infantry Battalion. March 1968. p.71. Available at: https://apps.dtic.mil/sti/pdfs/ADB951773.pdf
33. U.S. Army Engineers. Note on Visit to British Was Dog Training Centre on 13th March 1945. pp.1-2. The National Archives. WO 205/1173.
34. Fleet Marine Force Publication (FMFRP) 12-43. Professional Knowledge Gained from Operational Experience in Vietnam, 1969, Special Issue, *Mines and Boobytraps*. May-June 1969. p.14.
35. Major J. Sewell. Booby Trap Trends and Countermeasures. Headquarters. 9th Infantry Division. 16 February 1969. p. 13.
36. Lieutenant General Gribble, Chief of Research and Development, Department of the Army and Assistant Secretary of the Army Robert L. Johnson. Written Statement. Hearings, Reports and Prints of the House Committee on Armed Services. 01 April 1971. p.4009.
37. Headquarters, Department of the Army. Field Manual 7-41. Mine and Tunnel Dog Training and Employment. March 1973. p.4.
38. Department of the Army. Senior Officer Debriefing Report: Colonel W.F. Williams. CO, 3rd Brigade. 9th Infantry division. Period 27 March 1970 to 2 October 1970. 16 February 1971. p. I-10.
39. Army Concept Team in Vietnam. Final Report – 60th Infantry Platoon. (Scout Dog) (Mine/Tunnel Detector Dog). 02 January 1970. pp. III-1 – III-2.
40. Headquarters, United States Army Vietnam. Combat Intelligence Lessons. Issue Number 11. 01 October 1971. p.2.
41. Captain R. Johnston. Mine Dog Successes and Failures. Dog Training Detachment. USARV. 11 June 1971. p.2.
42. Hearings Before a Subcommittee of the Committee on Appropriations of the House of Representatives. Subcommittee on Department of Defense. Department of Defense Appropriations for Fiscal Year 1972. Tuesday 01 June 1971. p.80.
43. G. Cosmas and Lieutenant Colonel T. Murray (USMC). U.S. Marines In Vietnam. Vietnamization and Redeployment. 1970-1971. History and Museums Division. Headquarters, U.S. Marine Corps. Washington D.C. 1986. p.262.
44. J.L. Maxey. "Identification of Potential Characteristics, Aptitudes, and Acquired skills Involved in Human Detection of Mines." Human Resources Research Organization. Office of Chief of Research and Development. National Technical Information Service. U.S. Department of Commerce. AD-769780. August 1973. p.5.
45. Headquarters, Department of the Army. Field Manual 7-41. Mine and Tunnel Dog Training and Employment. March 1973.
46. Headquarters, Department of the Army. Field Manual 7-41. Mine and Tunnel Dog Training and Employment. March 1973. pp.31-34.
47. Afghanistan Mine Action Standards. 06.06. *Mine Detection Dogs Operations*. Fourth Edition. Version 4. May 2013. p.6.
48. D. Hayter. Training Dogs to Detect Trip Wires. in GICHD. Mine Detection Dogs: Training, Operations and Odour Detection. 2003. pp.109-138. Note that since this publication little if any advocacy for training dogs to detect trip wires has been made. The 2005 IMAS 09.40 Guide for the use of mine detection dogs, makes minimal mention of using dogs to attempt to detect trip wires. No mention at all is made in the 2008 amended version.
49. Headquarters, Department of the Army. Field Manual 7-41. Mine and Tunnel Dog Training and Employment.

March 1973. p.66.
50. J. Romba. A Study in Training Methodology of Mine Dogs. Army Land Warfare Laboratory. Army Mobility Equipment Research and Development Command. June 1974. p. 5.
51. D. Mitchell. *User's Guide: Land Mine and Booby Trap Detector Dogs. Final Technical Report. Volume III*. September 1976. p.vii. United States Army Mobility Equipment Research and Development Command.
52. D. Mitchell. User's guide: *Land Mine and Booby Trap Detector Dogs. Final Technical Report. Volume III*. September 1976. p.19. United States Army Mobility Equipment Research and Development Command.
53. J. Pettit and R. Hughes. Engineer Mine Detection Dogs. Engineer. U.S. Army Engineer School. Fort Leonard Wood. July-September 2004. p.18
54. Mansfield. Stepping Into a Minefield. Newport. NSW. 2015. p.108.
55. Mansfield. Stepping Into a Minefield. Newport. NSW. 2015. p.109.
56. M. Bolton. Goldmine? A Critical Look at the Commercialization of Afghan Demining. London School of Economics. 2008. p.13.
57. GICHD. Mine Detection Dogs: Operations. Case Studies of Operational Systems. Geneva. September 2005. pp. 46-65.
58. H.E. Hem Sophoan. Mine Detection Dog Program: The Cambodian Experience. *The Journal of Mine Action*. Volume 7. Issue 01. April 2003. pp.87-89.
59. GICHD. Mine Detection Dogs: Operations. Case Studies of Operational Systems. Geneva. September 2005. pp. 26-45.
60. H. Bach, I. McLean, C. Akerblom and R. Sargisson. Improving mine detection dogs: an overview of the GICHD dog program. Proceedings of EUDEM2-SCOT- Volume 1. 2003. p.149.
61. GICHD. Detection of Landmines by Dogs. Environmental and Behavioural determinants. Geneva 2005. p.7.
62. H. Bach, I. McLean, C. Akerblom and R. Sargisson. Improving mine detection dogs: an overview of the GICHD dog program. Proceedings of EUDEM2-SCOT- Volume 1. 2003. p.154.
63. GICHD. Mine Detection Dogs. Training, Operations and Odour Detection. Geneva. 2003. p.10.
64. Major R. Storck. Improvised Explosive Device Detector Dogs (IDDs): Is the USMC barking up the wrong tree? Marine Corps University. 29 February 2021.p.18.
65. GICHD. Mine Detection Dogs. Training, Operations and Odour Detection. Geneva. 2003. p.1.
66. IMAS 09.43. Remote Explosive Scent Tracing (REST). Second Edition. 01 August 2005.
67. GICHD. Detection of Landmines by Dogs. Environmental and Behavioural determinants. Geneva 2005. p.62.
68. GICHD. Detection of Landmines by Dogs. Environmental and Behavioural determinants. Geneva 2005. p.iv.
69. GICHD. Detection of Landmines by Dogs. Environmental and Behavioural determinants. Geneva 2005. p.iv. and p.41.
70. Major R. Storck. Improvised Explosive Device Detector Dogs (IDDs): Is the USMC barking up the wrong tree? Marine Corps University. 29 February 2021.p.18.
71. The HALO Trust. Technical Challenges in Humanitarian Clearance of Anti-Vehicle Mines: A Field Perspective. Geneva. 09 April 2015. p.3. and p.6.
72. R.Roberts. Anti-Vehicle Mine Contamination in Afghanistan. Impact and MAPA Response. 09 November 2018. p.13.
73. GICHD. Field Trials of Smart System and Technical Survey Dogs in Cambodia. Final Report. November 2021.
74. International Mine Action Standard. 09.40. Animal Detection Systems- Principles, Requirements and Guidelines. Third Edition. July 2018. p.3.
75. IMAS 09.40. Animal Detection Systems – Principles, Requirements and Guidelines. Edition 3. Amendment 1. 31 March 2020.
76. GICHD. Animal Detection Systems For Post-Conflict Recovery. Geneva. 2013. pp.19-24
77. https://dtr.digger.ch/dtr/products-and-services/smart-mdd/
78. The National Archives. AVIA 74/15. Detection of Non-Metallic Mines. 01 July 1946.
79. Goth, I. Mclean and J. Trevelyan. How Do Dos Detect Landmines? A Summary of Research Results. in GICHD. Mine Detection Dogs. Training, Operations and Odour Detection. Geneva. 2003. pp.195-208.
80. U.S. Army Engineers. Note on Visit to British Was Dog Training Centre on 13th March 1945. p.1. The National Archives. WO 205/1173.
81. J. Pettit and R. Hughes. Engineer Mine Detection Dogs. Engineer. U.S. Army Engineer School. Fort Leonard Wood. July-September 2004. p.19.

Clear then Grow: Integrating Mine Action with Food Security in Northeast Syria by Balić [from page 58]

1. According to Caparini and Reagan, the Triple Nexus is a concept used to capture the interlinkages between the humanitarian, development, and peace sectors. Specifically, it refers to attempts in these fields to work together more coherently in order to more effectively meet peoples' needs, mitigate vulnerabilities, and move towards sustainable peace.M. Caparini & A. Reagan, "Connecting the Dots on the Triple Nexus," Stockholm International Peace Research Institute (SIPRI), 2019, https://bit.ly/3dX1rPx.
2. NES is located between the banks of the Tigris and Euphrates rivers, known in history also as Mesopothamia, and is home to vast fertile areas.
3. See, for example, the Geneva International Center for Humanitarian Demining (GICHD) and United Nations Development Programe (UNDP)'s 2017 study: "Leaving No One Behind: Mine Action and the Sustainable Development Goals."
4. See, for example, the previously mentioned GICHD and UNDP 2017 study. A number of important discussions on this topic were also held at the 25th International Meeting of Mine Action National Directors and United Nations Advisers.
5. International Trust Fund for Demining and Mine Victims Assistance was established in Slovenia in 1998 to provide assistance in Bosnia and Herzegovina. By 2012, the Trust Fund has been transformed into an organization following a broader mission of enhancing human security as a way of bridging the divide between the seemingly "hard"

mine action topics and "soft" people-centered approaches. The Trust Fund was then rebranded into ITF Enhancing Human Security (ITF). ITF's 2021-2025 strategy states that the organization's mission is, "Strengthening human security and building resilient communities by reducing risks to peace and security through compassion, innovation, transparency and partnerships."
6. The military action was code-named "Operation Peace Spring," which is also the name used to refer to the area along the border between Turkey and Syria that continues to be controlled by Turkey and is experiencing regular shelling.
7. The project ends August 31, 2022, but ITF may continue with phase III in 2022–2023.
8. This is referring to areas along the Turkish-Syrian border that are controlled by Turkey and where considerable new contamination is expected.
9. The Autonomous Administration of Northeast Syria has since taken the step of establishing a Mine Action Office of NES with the aim of improving coordination, overseeing and supporting the work of international partners, and making mine action in NES more systematic and structured. Discussions on the exact same shape of this cooperation are still ongoing during the writing of this article.
10. The NES Mine Action Sub Working Group (MASWG) active under the NES Protection Group (PWG) is hosted by iMMAP and brings together all mine action organizations operating in NES through regular coordination meetings. Participation in MASWG is voluntary.
11. Komin (or commune) is an organisational unit in a territorial community. Sometimes it is also organized on the basis of ethnic group belonging or for women only. The komin takes into considerations the needs of the community and makes decisions (including electing representatives) to higher organizational units in NES, such as the city councils.
12. Humanity & Inclusion,"Explosive Ordnance in Syria: Impact and Required Action," ReliefWeb, 2022, https://bit.ly/3TfKSye.
13. The Humanitarian Needs Overview 2022 states that one third of populated communities throughout Syria are estimated to be contaminated with explosive ordnance. This information relates to the Whole of Syria, and is not specific to NES. The Humanitarian Needs Overview is published by UN OCHA at.
14. IMMAP,"Northeast Syria: Progress, Challenges and Forecast of Humanitarian Mine Action," 2022, https://bit.ly/3R544wI.
15. World Food Program, "Syria mVAM Bulletin #55: May 2021," ReliefWeb, 2021, https://bit.ly/3QLTjzM.
16. Mukhtar is the head of a town, village, or neighborhood.

Gender and Operational Efficiency by Lark, Hewitson, and Wolsey [from page 68]

1. Mines Action Canada, "Gender and Employment in Mine Action by the Numbers," Mines Action Canada, 2019.
2. United Nations, 'Social Development Goal 5,' 2022, https://sdgs.un.org/goals/goal5.
3. Mines Action Canada, "Gender and Employment in Mine Action by the Numbers," Mines Action Canada, 2019.
4. Nilsson, Marie and Virginie Rozes, "Gendered Structures of Mine Action," *The Journal of ERW and Mine Action*, Vol.12: Iss.2, 2008; https://bit.ly/3nYlbnG; Laura Biscaglia et al., "Gender Mainstreaming in Mine Action: Powerful Linkages for Progress Across the SDGs, " Global CWD Repository, 1249, 2018; https://bit.ly/3c4bKAi; Rachel Canfield and Chad McCoull, "Gender in the Mine Action Community," *The Journal of EWR and Mine Action*, Vol.12, Iss. 2, 2008, https://bit.ly/3bWZjWQ.
5. A binary use of gender (men and women) is used in this report; however, this does not reflect a belief that gender is a binary concept. On the contrary, gender and gender identity are recognized as more pluralistic and complex than this binary use may suggest.
6. For instance, in IMAS 04.10 efficiency is defined as "a measure of how economically resources/inputs (funds, expertise, time, etc.) are converted to results (outputs and outcomes)" and in ISO 9000:2015 as "relationship between result achieved and the resources used".
7. Other inputs can include resources such as equipment and funds, however the study focuses specifically on time spent by deminers, in order to address the research questions at hand.
8. See Annex A: Methodology for further information.
9. OECD, SIGI: Social Institutions & Gender Index, 2021, https://www.genderindex.org.
10. Higher values indicate higher inequality.
11. Noting that working days per week, leave patterns and other factors influence the actual number of days in a working year in different countries.
12. Kultar, Singh, "Quantitative Social Research Methods," Sage Publications Pvt. Ltd., 2007.
13. Using the meanings of complicated and complex from the Cynefin framework. In the 'complicated' domain cause and effect can be established, but it requires expertise to do so; in the 'complex' domain, cause and effect can only be determined in retrospect.
14. 'In country operational staff' consisted of Community Liaison (CL) teams only. In the other countries a mix of survey and clearance as well as CL teams were included.

World War II's Deadly Legacy in Alaska by Ken Rutherford, Ph.D. [from page 76]

1. The status of the Northern Territories remains in dispute between Japan and Russia. https://www.jstor.org/stable/41394411
2. UXO on the mainland is from US UXO testing, stockpiling, and ammunition that did not go off.
3. Michelle Theriault Boots, "The Last Kid in Cold Bay," *Anchorage Daily News*, August 8, 2015.
4. Stan Cohen, *The Forgotten War: A Pictorial History of World War II in Alaska and Northwestern Canada*, Vol. 1 (Missoula, MT: Pictorial Histories Publishing, 1992).
5. Cohen, *The Forgotten War*, Vol. 1, 189.
6. 1st Sgt. Fenton Hamlin, 7th Scout Company, as quoted in *The Capture of Attu: Tales of World War II in Alaska—As Told by the Men Who Fought There* (Anchorage: Alaska Northwest Publishing Company, 1984), 40.
7. Massacre Bay was named after Russians had massacred the Aleut natives in the late 18th century.
8. Cohen, *The Forgotten War*, Vol. 1, 193.
9. The day before the attack (on May 28), the Japanese killed

more than 600 of their own wounded rather than surrender to the Americans.
10. Cohen, *The Forgotten War*, Vol. 1, 193.
11. John Cloe, "It All Started at Dutch Harbor and Ended at Kiska," *VFW Journal*. May 1993. p. 25.
12. D. Colt Denfield, US Army Corps of Engineers, Alaska District, May 1988, "History of Cold Bay," in Cohen, *The Forgotten War*, Vol. 3, 40–42.
13. "The Invasion of Kiska: The Aleutian Campaign," National Park Service, https://www.nps.gov/articles/the-invasion-of-kiska.htm.
14. "The Battle for Kiska," Pvt. Henri Richard, August 3, 2020. Story by Rhonda Roy, Originally Published in Esprit de Corp Magazine, Vol. 9, Issue 4, and Vol. 9, Issue 5, https://bit.ly/3BVtU0h
15. S-2 Periodic Report, "Enemy Situation at the End of the Period." Headquarters US Troops, Office of the Intelligence Officer From 19 August 1943 to 1 September 1943.
16. "Canadian artillery officer Captain William Kirby as quoted in "The Battle for Kiska," Story by Rhonda Roy, Originally Published in *Esprit de Corp* Magazine, Vol. 9, Issue 4, and Vol. 9, Issue 5, https://bit.ly/3BVtU0h
17. "Raids Made Island Too Hot to Hold: Kincaid Believes Some Rescue Ships Were Sunk," *New York Times*, August 22, 1943, p. 3; George L. MacGriggle, Aleutian Islands: The US Army Campaigns of World War II (United States Army Center of Military History, CMH Pub 72-6), 24.
18. Cohen, *The Forgotten War*, Vol. 1, 208.
19. "Message to British Chiefs of Staff re Operation Against Kiska," June 8, 1943, The National Archives, Kew, London, Cabinet Office Paper 122/659, as quoted in Saul David, *The Force: The Legendary Special Ops Unit and WWII's Mission Impossible* (New York: Hachette, 2019), 28.
20. "The Battle for Kiska."
21. Cohen, *The Forgotten War*, Vol. 4, 116–117.
22. It was the Battle of Kiska that would lead *Time* magazine to create the acronym JANFU (joint army-navy foul-up) to complement the earlier SNAFU (situation normal, all fouled-up). Never before had such a colossal amount of weapons, ammunition, manpower, and equipment been thrown into a battle without an enemy.
23. The Capture of Attu, 6.
24. "The Invasion of Kiska."
25. Dirk H.R. Spennemann, Janet Clemens, and Janis Kozlowski, "Scars on the Tundra: The Cultural Landscape of the Kiska Battlefield, Aleutians," National Park Service, https://bit.ly/3fwYLcf.
26. Russell Annabel, "Japs Threat on Kiska Wall Gives Americans a Laugh: Trucks Half Buried and Shattered Huts Tell Force of Bomb Attacks; Scanty Supplies Hint Garrison was Getting Hungry," *Denver Post*, August 23, 1943.
27. "2 KILLED AT KISKA; Land Mines and Booby Traps Encountered in Landing," *New York Times*, August 24, 1943, p. 3.
28. Cohen, *The Forgotten War*, Vol. 4, 92.
29. Deborah D. Rudis, Alaska Maritime National Wildlife Refuge – Attu and Kiska Islands Contaminant Assessment, US Fish and Wildlife Service, Juneau Field Office, Alaska, 2013, https://bit.ly/3LZmuxW.
30. "Attu, Post-WWII," https://bit.ly/3y5Whrr
31. Today, Attu is under the protection of the National Park Trust.
32. As quoted in Rudis, Alaska Maritime National Wildlife Refuge – Attu and Kiska Islands Contaminant Assessment, p. 17.
33. Rudis, Alaska Maritime National Wildlife Refuge – Attu and Kiska Islands Contaminant Assessment, pp. 25 and 29.
34. National Park Service, "Silent Sentinels of Kiska," https://www.nps.gov/articles/silent-sentinels.htm; *Adak Historical Guide*, https://adak-ak.us/www/historical.html.
35. Rudis, Alaska Maritime National Wildlife Refuge – Attu and Kiska Islands Contaminant Assessment, p. 10.
36. US Fish & Wildlife Service, "Contaminant Cleanup," July 2, 2020, https://bit.ly/3LY3TlD.
37. There are also some ordnance hazards issues on the island of Adak, between 200 and 400 miles westward from Kiska and Attu, respectively. The 193 potential ordnance sites identified on Adak include practice ranges, defensive positions, minefields, and storage and disposal areas. Ordnance items found to date include napalm, mortars, artillery, grenades, practice mines, and small munitions. Poster presentation by Jordan H. Stout, US Fish & Wildlife Service Environmental Contaminants Program, Anchorage Field Office, "Contaminated Military Sites on National Wildlife Refuges in Alaska," as quoted in Alaska Maritime, National Wildlife Refuge, Alaska, US Fish & Wildlife Service, https://www.fws.gov/refuge/alaska_maritime/what_we_do/adak_island.html. In 1994, the Adak base was placed on the National Priorities (Superfund) List.

How Can Mine Action Improve the Management of Free from Explosive (FFE) Items? by Evans [from page 82]

1. Glossary of mine action terms, definitions, and abbreviations. International Mine Action Standard 04.10. Edition 02. Amendment 10. February 2019. p.25, https://bit.ly/3pX872O.
2. Information Management for Mine Action. International Mine Action Standard 05.10. Second Edition. Amendment 01. February 2020. Pp, 17-18, https://bit.ly/3y9E5xd
3. Free From Explosives Regulations. Chapter 27. DSA 03. OME Part 2. November 2019. p.8, https://bit.ly/3dXnh5O
4. C. King. Janes Mines and EOD Operational Guide. 2020-2021. p.343.
5. Mines Advisory Group. Standard Operating Procedures. Number 04. Third Edition. November 2018. P.4.
6. The HALO Trust. Manual Clearance and Technical Survey. Standard Operating Procedures. 04 January 2019. p.8, https://bit.ly/3CmYLEo
7. International Mine Action Standard 10.50. Storage, Transportation and Handling of Explosives. Annex F. Edition 03. Amendment 05. Annex F. 01 May 2013. p.22, https://bit.ly/3RE4Xgn.
8. A. Smith. Comment: FFE/FFI – or blow in situ? https://bit.ly/3B8whhn.
9. Project Mimeva. Study of Generic Mine-like Objects for R&D in Systems for Humanitarian Demining. DG Joint Research Centre. European Commission. 2001, https://bit.ly/3Eo8agH
10. F. Lombardi, M. Lualdi, F. Picetti, P. Bestagini, G. Janszen and L. Di Landro. Ballistic Ground Penetrating Radar Equipment for Blast Exposed Security Applications. *Remote Sensing*. Volume 12. Issue 4. 21 February 2020,

https://doi.org/10.3390/rs12040717
11. A. Lewis. Test and Evaluation of Dual Sensor Mine detectors based on a Combination of Metal Detector and Ground Penetrating Radar. (TEDS). Institute for the Protection and Security of the Citizen. 2006, https://bit.ly/3CmuzcA
12. F. Lombardi, H. Griffiths, A. Balleri. Landmine Internal Structure Detection from Ground Penetrating Radar Images. IEEE Radar Conference April 2018, DOI: 10.1109/RADAR.2018.8378733
13. I. Chant, D. Lee, and D. Ireland. DSTO Landmine Detection Test Targets. Weapons Systems Division. Department of Defence. Australian Government. 01 June 2005, https://bit.ly/3EaQFQC
14. Department of Defence Directive Number 5160.62. Single Manager Responsibility for Military Explosive Ordnance Disposal Technology and Training (EODT&T). 24 September 2018, https://bit.ly/3SBU8Ma
15. A. Tan. Advanced Ordnance Teaching Materials. *Journal of Conventional Weapons Destruction*. Volume 18. Issue 2. July 2014. pp. 39-43, https://bit.ly/3KAQ7Vl.
16. Director Ammunition and Explosive Regulation Annual Report. Fifth Report to the Deputy Minister and the Chiefs of the Defence Staff. 01 january-31 December 2012. p.12, https://bit.ly/3B0mdqg.
17. International Mine Action Standard 10.50. Storage, Transportation and Handling of Explosives. Annex F. Edition 03. Amendment 05. Annex F. 01 May 2013. p.22. Available at: https://bit.ly/3rqpA4c
18. International Ammunitions Technical Guidelines 06.50. Special safety precautions (storage and operations). Third Edition. March 2021. pp.4-7. Available at: https://bit.ly/3URyEwJ
19. International Ammunitions Technical Guidelines 06.50. Special safety precautions (storage and operations). Third Edition. March 2021. pp. 4-6. Available at: https://bit.ly/3URyEwJ
20. International Ammunitions Technical Guidelines 07.30. Ammunition processing operations – Safety, risk reduction and mitigation. March 2021. Available at: https://bit.ly/3dTDoBs
21. Free From Explosives Regulations. Chapter 27. JSP 482. Edition 4. Available at: https://bit.ly/3E6xnMh
22. International Mine Action Standard 10.50. Storage, Transportation and Handling of Explosives. Annex F. Edition 03. Amendment 05. Annex F. 01 May 2013. p.22. Available at: https://bit.ly/3rqpA4c
23. Department of the Navy. Marine Corps Order 8011.5. Ammunition Policies, Procedures and Information for Training, Programmed Testing and Security. 06 August 2012. p. 1-12. Available at: https://bit.ly/3LUgEO6
24. Department of the Navy. Marine Corps Order 3571.2H. Explosive Ordnance Disposal (EOD) Program. 08 August 2015. Available at: https://bit.ly/3rnm5eU
25. US Marine Corps. MAGTF Explosive Ordnance Disposal. MCTP 10-10D. November 2012. pp. 4-11 - 4-14. Available at: https://bit.ly/3y2M92Y.
26. Test and Evaluation Protocol 09.30/01/2022. Conventional Explosive Ordnance Disposal (EOD) Competency Standards. Second Edition. February 2022. Available at: TEP_09.30.01.2022_Ed.2_02.pdf. (mineactionstandards.org).
27. L. Maroney and K. Gamst. Self-help Ammunition Destruction Options Worldwide (SHADOW). *Journal of Conventional Weapons Destruction*. volume 17. Issue 3. October 2014. pp. 40-43. Available at: https://bit.ly/3SvzqOu
28. Golden West Humanitarian Foundation, https://bit.ly/3rkXrM1.
29. R. Hess. Explosive Harvesting Program. *Journal of Mine Action*. Volume 10. Issue 2. Article 44. November 2006. Available at: https://bit.ly/3E4vLTl
30. R. Hess. Golden West Humanitarian Foundation. Information Briefing. Explosive Harvesting System (EHS). 2007 Global Demilitarization Symposium. May 2007. Available at: https://bit.ly/3BXFAQf.
31. Golden West Humanitarian Foundation and the Cambodian Mine Action Centre. Information Briefing. Explosive Harvesting System. From Initial Concept to Operational Reality. Regional Approach to Stockpile Reduction Workshop. May 2011. Available at: https://bit.ly/3BZSey1
32. Free From Explosives Regulations. Chapter 27. DSA 03. OME Part 2. November 2019. p.8, https://bit.ly/3dXnh5O
33. Explosives Processing. Chapter 19. DSA 03. OME Part 2. November 2019. p.8, https://bit.ly/3RrOdlk
34. Army Command standing Order No 1200. The Army's Safety and Environmental Management System. January 2021. pp.60-67, https://bit.ly/3KwOcRD.
35. *Explosives Processing*. Chapter 19. DSA 03. OME Part 2. November 2019. p.10, https://bit.ly/3RrOdlk
36. *Explosives Processing*. Chapter 19. DSA 03. OME Part 2. November 2019. p.12, https://bit.ly/3RrOdlk
37. *Explosives Processing*. Chapter 19. DSA 03. OME Part 2. November 2019. p.12, https://bit.ly/3RrOdlk
38. *Free From Explosives Regulations*. Chapter 27. DSA 03. OME Part 2. November 2019. p.8, https://bit.ly/3dXnh5O
39. *Explosives Processing*. Chapter 19. DSA 03. OME Part 2. November 2019. p.13, https://bit.ly/3RrOdlk
40. *Free From Explosives Regulations*. Chapter 27. DSA 03. OME Part 2. November 2019. p.10, https://bit.ly/3dXnh5O
41. *Explosives Processing*. Chapter 19. DSA 03. OME Part 2. November 2019. p.18, https://bit.ly/3RrOdlk
42. Glossary of mine action terms, definitions, and abbreviations. International Mine Action Standard 04.10. Edition 02. Amendment 10. February 2019, https://bit.ly/3E283ai
43. International Mine Action Standard 07.14. Risk Management in Mine Action. First Edition. February 2019, https://bit.ly/3pX872O
44. International Mine Action Standard 10.50. Storage, Transportation and Handling of Explosives. Edition 03. Amendment 05. 01 May 2013. pp.22-25, https://bit.ly/3RE4Xgn
45. GWHF. Inerting Outline. M35 HE APERS GRENADE w/ integral IMPACT Initiated Fuze. 15 July 2008.
46. GWHF. Inerting Procedure German 81mm and DM111A2 PD Fuze. 30 November 2010.
47. Committee on Alternatives for the Demilitarization of Conventional Munitions. Board on Army Science and Technology Division on Engineering and Physical Sciences. Alternatives for the Demilitarization of Conventional Munitions. Washington 2019. p.81, https://bit.ly/3SGGrLQ
48. P. Miller. A Retrospective Study on the Safety of Waterjet and Abrasive Waterjet Processing of High Explosive Ordnance. National Defence Industrial Association, https://

bit.ly/3y15xNJ
49. Golden West Humanitarian Foundation and the Cambodian Mine Action Centre. Information Briefing. Explosive Harvesting System. From Initial Concept to Operational Reality. Regional Approach to Stockpile Reduction Workshop. May 2011, https://bit.ly/3BZSey1
50. R.Evans and A. Duncan. Disposal of Explosive Ordnance and Environmental Risk Mitigation. *The Journal of Conventional Weapons Destruction*. Volume 24. Issue 1. Available at: https://bit.ly/3fraDfD
51. GICHD. Guide to Explosive Ordnance Pollution of the Environment. December 2021, https://bit.ly/3Tqn1Mt.
52. W. Alfaraj, B. Mcmillan, A. Ducatman and C.Werntz. Tetryl Exposure: Forgotten Hazards of Antique Munitions. *Annals of Occupational and Environmental Medicine*. Volume 28. Issue 01. 08 April 2016, https://bit.ly/3URBge1
53. D. Bodeau. Military Energetic Materials: Explosives and Propellants. pp.305-357 in. D. Deeter and J. Gaydos (Eds). Occupational Health. The Soldier and the Industrial Base. Maryland 1993, chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://ke.army.mil/bordeninstitute/published_volumes/occ_health/ohfm.pdf
54. J. Daniels and J. KInezovich, "Human Health Risks from TNT, RDX, and HMX in Environmental Media and Consideration of the US Regulatory Environment," Proceedings Demil '94. Luxembourg. November 14-16, 1994, https://bit.ly/3y7uVBg
55. Environmental Protection Agency. Technical Fact Sheet. RDX. November 2017, https://bit.ly/3RuHJIO
56. Environmental Protection Agency. Technical Fact Sheet. TNT. November 2017, https://bit.ly/3fmwCUY
57. M. Shorati, B. Najafian, A. Saburi, E. Vahedi and M. Ghamei. Spirometric findings in TNT factory Workers Compared with Unexposed Controls. *Asia Pacific Journal of Medical Toxicology*. Volume 3. Issue 3. 2014, https://bit.ly/3ftw13Y

Mapping Unexploded Ordnance in Syria: Harnessing the Power of Open-Source Information by Stall, Hudson, Leendertse, Prasad,McNaboe, Shabb, and Robinson
[from page 88]
1. As a data abstraction of UXO detonation data as detection model, some UXO clearing organizations also use models based on injuries or fatalities rated to UXO detonation events. This report will not cover this method, but Carter Center staff did run the model for testing.
2. The Carter Center continues to release quarterly conflict summaries on the war in Syria, which can be read on the Conflict Resolution Program's departmental webpage here: https://bit.ly/3amZjiq.
3. Mona Yacoubian, "Syria Timeline: Since the Uprising Against Assad", United States Institute of Peace, January 1, 2021, accessed June 16, 2022, https://bit.ly/3atsAZ2.
4. MacDonald 2004.
5. Baur et al. 2021; MacDonald 2004.
6. For example, shrapnel, soup cans, bottle tops, etc. (MacDonald 2004). See also, Beran 2013 and Bauer et al. 2021.
7. This is particularly the case in challenging terrain.
8. Baur et al. 2021. The challenge in distinguishing actual hazardous ordnance from harmless metallic clutter means that operators then must balance between two competing objectives: tuning detectors so precisely that they result in very high levels of false positives, or not fine-tuned enough and missing real UXOs (Beran 2013).; MacDonald 2004. Traditional metal detectors also cannot capture an object's size, shape, or material properties, though innovation is ongoing in the field to overcome this limitation. For example, Wilson and Ledger (2021) explore the use of magnetic polarizability tensor (MPT). The balancing results in a "receiving operating characteristics" (ROC) curve, which estimates the probability of false alarms (MacDonald 2004). Previous estimates have shown that the rate of false alarms to true UXO detection is 99 to 1. Alternate methods include sifting layer by layer of an entire area, which has several weaknesses such as the high cost, endangerment to wildlife, and environmental destruction.
9. Baur et al. 2021; Nikulin et al. spring/summer 2020.
10. Remote sensing using UAVs allows for quick and efficient low-altitude scans of expansive areas.
11. Kolster et al. 2022.
12. Myers and Lathrop 2021.
13. Myers and Lathrop 2021; Kolster et al. 2022. Multi-sensor systems have traditionally been land-based, and they are very costly to manufacture and burdensome to transport to remote locations.
14. Baur et al. 2021.For instance, multi-sensor configurations use ML to assess weather and terrain conditions to inform which on-board geophysical instrument(s) would produce the most precise landmine detection (Myers and Lanthrop 2021).
15. Nikulin et al. spring/summer 2020. Available at: https://commons.lib.jmu.edu/cisr-journal/vol24/iss1/13/
16. See for instance: Baur et al. 2021; Henkel et al. 2020; Myers and Lanthrop 2021.
17. Robinson and Baade 2021.
18. Robinson and Baade 2021.
19. The challenge of humanitarian efforts in conflict zones exemplifies this. For instance, in 2020, 475 aid workers were attacked, with 108 of them killed, across 41 countries. The majority were working on the frontlines https://bit.ly/3OW0hRN. Halo Trust has called for increased funding to accurately map areas for future clearance efforts, noting there is a shortage in funding to conduct such surveys (Halo Trust 2020). Available at: https://bit.ly/3c0Wbtd
20. Halo Trust 2020. Available at: https://bit.ly/3c0Wbtd
21. The Carter Center 2022. Available at: https://bit.ly/3bOCbty
22. Lanclos and Cottray 2022. Available at: https://bit.ly/3IqSrgB
23. https://bit.ly/3IqSrgB
24. Defense Science Board (DSB) 2003. Available at: https://bit.ly/3yul9sf
25. See ACLED database for available years of data collection by country. Available at: https://bit.ly/3In6Iee
26. Keefer 2021. Available at: https://bit.ly/3yReXMB
27. Peacebuilding Initiative 2009. Available at: https://bit.ly/3OVNGhs
28. International Crisis Group March 2015. Available at: https://bit.ly/3yO2x8a
29. Neil MacFarquhar, "A Very Busy Man Behind the Syrian Civil War's Casualty Count", New York Times, April 9, 2013, accessed June 16, 2022, https://nyti.ms/3RvJ1om.

30. This data cleaning was done in large part through a partnership with the Georgia Tech-based DataWorks, through which our team and theirs manually cleaned conflict data to prepare it for analysis.
31. [Devlin et al., 2018] Jacob Devlin, Ming-Wei Chang, Kenton Lee, and Kristina Toutanova. BERT: Pre-training of Deep Bidirectional Transformers for Language Understanding. arXiv e-prints, page arXiv:1810.04805, Oct 2018.
32. Trivedi, Anusua; Keator, Kate; Scholtens, Michael; Haigood, Brandon; Dodhia, Rahul; Lavista Ferres, Juan; Sankar, Ria; and Verma, Avirishu. (2021). How to Handle Armed Conflict Data in a Real-World Scenario? Philosophy & Technology. 34. 1-13. 10.1007/s13347-020-00424-5. https://bit.ly/3In7tE6
33. For example, see "112 Russian Air Strikes in Syrian Desert; about 20 ISIS mercenaries killed", Hawar News Agency, February 25, 2021, accessed June 16, 2022, https://bit.ly/3yrrk0n.
34. Examples include from Twitter. See QalaatM, "Low Flying Helicopters Are Perfect Targets for #ATGM", Twitter, April 5, 2022, accessed June 16, 2022, https://bit.ly/3nO1Bu9. QalaatM, "E. Syria: US Airstrikes vs Ammo depots & positions", Twitter, January 5, 2022, accessed June 16, 2022, https://bit.ly/3PhdLaO. YouTube also contains multiple videos uploaded by the various belligerents in the Syrian conflict, see Thawir Al-Yasamin, "الفرقة الوسطى صد الهجوم الايراني النصيري على مدينة الشنابرة بقذائف الهاون 82", YouTube, December 16, 2015, accessed June 16, 2022, https://bit.ly/3P0AvMw.
35. Note: "Miscellaneous other munitions" includes specifically only those cluster munitions that we have not yet been able to confirm as from air-launched or ground-launched deployment systems.
36. See, for example, Figure 1 on page 2 of the May 2022 report put out by the United Nations' Syria Response Mine Action Area of Responsibility, available at the following link: https://bit.ly/3nTNNy4
37. https://bit.ly/3astC7t
38. Hayhoe, H. N., and G. D. V. Williams. "Computing and Mapping Thiessen Weighting Factors from Digitized District Boundaries and Climatological Station Latitudes and Longitudes." *Journal of Applied Meteorology* (1962-1982) 21, no. 10 (1982): 1563–66. http://www.jstor.org/stable/26180774.
39. There is not a dataset of agreed-upon location border are not polygons for all locations at the local level, so the size/geographic expanse of locations must be estimated. For example, Syria LiveUAMap has more local level polygons but village boundaries are not always available.
40. When using this method in real time, munition counts can be tracked to better inform the weighted estimate through both ACLED weekly outputs and open-source investigation of combat footage.
41. Note: there is no universally accepted "failure rate" calculation agreed upon by HMAs and others. A 10-30% failure rate is expected for cluster munitions, but the same cannot be said for all other explosive munitions given the complex matrix of variables that lead to munition failure such as ground type, firing conditions, ammunition age, and more. We instead advocate for using a munitions counting approach, as it makes any possible failure rate applicable to a dataset. 10% is a conservative estimate for a method that is assumed to still be a major undercount of full munitions count. The US military also uses an 11% failure rate as a standard for decommissioning firing ranges, giving further credence to acceptance of a 10% failure rate as a minimum. See, for example: Brannon et al. 2000, pg 5
42. 15 km range is used based on the top-end range of an early modern 155mm howitzer.

The Time Has Come for Digital Explosive Ordnance Risk Education by Robin Toal [from page 95]

1. MAG has worked with Clowns without Borders in Lebanon and Myanmar prior to engaging in digital EORE. CWB was founded in 1993 and exists in 15 countries. Its vision is: to create a world where all people can experience laughter, play, and feel hope, especially in humanitarian crises. https://clownswithoutborders.org
2. "Review of New Technologies and Methodologies for EORE in Challenging Contexts," Geneva International Centre for Humanitarian Demining, EORE.org, accessed 13 September, 2022, https://www.eore.org/.

The Evolution of Physical Security and Stockpile Management:A Successful Implementing Partnership Perspective by Moroney and Veneris [from page 101]

1. Geographic combatant commands operate in clearly delineated areas of operation and have a distinctive regional military focus
2. https://bit.ly/3y2PwqE

THE JOURNAL
of Conventional Weapons Destruction

Upcoming Topics

Featuring: Ukraine

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

Images courtesy of Sean Sutton/MAG (Mines Advisory Group).

Anti-Handling Devices and Booby Traps

EOD technicians must remain vigilant of anti-handling, anti-lift, and anti-tamper techniques used by malicious actors. How are mine action operators relying on their training and active information sharing channels to be aware of known threats to safely clear landmines and improvised explosive devices?

Cluster Munitions

The decline in casualties from CM since 2020 has recently been eclipsed by Russian attacks using CM with a reported six types of CM used by Russia as reported by the *Landmine & Cluster Munition Monitor*. How are organizations preparing for survey and destruction of stockpiles in Ukraine? How is mine action tailoring risk education to reach those most vulnerable to munitions, including children, refugees, and pastoral communities?

Explosive Hazards Clearance and Debris Disposal

Urban settings and destroyed buildings present mine action actors with incredible challenges. With the need for battle area clearance and debris disposal in Ukraine, how are organizations using best practices in urban settings where explosives and other hazardous materials present unique problems for detection, clearance, and disposal activities?

Survivor Assistance

During conflict, persons with disabilities face barriers to evacuation, being left behind in dangerous situations, inaccessible shelters, and an inability to access humanitarian aid. Before the war, Ukraine had the highest number of children in institutions in Europe; nearly half of them were children with disabilities. As the sector mobilizes to assist Ukraine, how can we ensure survivor assistance is not overlooked? How can we ensure digital EORE is accessible to disabled persons, survivors have access to the care they need, and survivors are included in the planning and mobilization of services?

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

From Beneficiaries to Partners

Marginalized communities continue to be represented within mine action as beneficiaries of services and mine/UXO survivors as inspirational. How is mine action countering bias in its operations and services?

Mine Action and the Triple Nexus

How is MA positively contributing to sustainable landscapes, capacity-building, economic empowerment, and national security?

Innovations in Environmental Considerations

How are organizations ensuring environmental considerations are being implemented in every stage of operations—from survey and clearance to stockpile destruction?

Underwater UXO Survey and Remediation

Offshore, sustainable energy projects need to identify and remove underwater unexploded ordnance (UXO) in order to build necessary infrastructure. How are organizations using recent advances in underwater survey techniques?

Image courtesy of Charles Brown, Platinum East.

Innovative Training Aids for Mine Action and Risk Education

Advances in 3D printing and augmented/virtual reality help EOD instructors and risk education providers communicate abstract concepts by creating content that conveys empathy and communicates risk to promote awareness and to educate.

Image courtesy of Catholic Relief Services.

Flooding and Mine Action: Yemen, Vietnam, and the Balkans

With increased flooding events occurring or having occurred in Yemen, Vietnam, and the Balkans, how are organizations coping with the potential shifting of landmines due to flooding caused by landslides and mudflows?

South Caucuses

Due to fighting between Armenian and Azerbaijani forces in the South Caucuses, the conflict zone of Nagorno Karabakh is contaminated with landmines and UXO that kill and maim civilians, impede the return of displaced populations, and hinder economic development.

Linking Explosive Hazards Clearance and Industry

In situations where large-scale contamination impacts critical industries such as agriculture and energy, how should mine action organizations allocate their resources?

Equitable Social Media and Marketing

Social media is a powerful tool through which HMA organizations tell their stories, highlighting their operations in countries, beneficiaries, and money well spent. When highlighting recipients of our programs and operations, are we doing so with the input, opinions, knowledge, and experiences of those individuals and communities we're aiding? Are we cognizant of not using an individual's disability, socioeconomic status, and/or trauma to highlight our needs and successes?

Photo courtesy of ITF Enchancing Human Security.

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?

For full descriptions, visit our website

UPCOMING TOPICS

FEB 2023 — 27.1

Accessible Technology for MA

How can the MA sector create technology that is more accessible for disabled persons and inclusive for the general population? From cutting-edge to low-cost, what has already been incorporated and what does the future hold to make technology more accessible for more people?

Image courtesy of Humanity & Inclusion.

Ukraine

Colombia

IED Clearance: Revising Practices and Lessons Learned

Improving PSSM

Mobile SAA (and SALW) Disposal

JUN 2023 — 27.2

Machine Learning for Open-Source Intelligence in MA

Events in Ukraine demonstrate the value of open source intelligence. With ubiquitous access to social networks and mobile phones with high-quality cameras, an overabundance of images and videos need careful, technical scrutiny. How is mine action using advances in computer vision to make object detection and identification integral tools for organizations looking to gather and analyze data from public sources?

Environmental Management and Sustainable Development

How are organizations mitigating the environmental impacts of operations on vegetation, wildlife, soil, and air? How is MA positively contributing to the protection of natural resources, to local socioeconomic development, and to environments post clearance?

Interoperability in Mine Action and PSSM

Frequently, humanitarian demining and CWD programs rely on the capacity, expertise, knowledge, and resources of multiple entities. How are programs making connections, building relationships, growing capacity, and strengthening regional security?

Ukraine

Anti-Handling Devices and Booby Traps

Cluster Munitions

Survivor Assistance and Ukraine

Reporting and Terminology

OCT 2023 — 27.3

Image courtesy of Sean Sutton/MAG (Mines Advisory Group).

The Blurred Line of Humanitarian Aid in Conflict Settings

Mine action is grounded in humanitarian principles and maintains strict policies of neutrality. When 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?

Ukraine

Explosive Hazards Clearance & Debris Disposal

Legal Considerations for Remote Sensing and AI in HMA

History of SALW & PSSM: Lessons Learned and the Way Forward

Quick Reaction Force

Gender and Age in CWD

THE JOURNAL of Conventional Weapons Destruction CALLS FOR PAPERS

27.1 PUBLISHING FEBRUARY 2023

Ukraine
- Accessible Technology for MA
- Colombia
- Mine Action and the Triple Nexus
- IED Clearance: Revising Practices and Lessons Learned
- Innovations in Environmental Considerations
- Improving PSSM
- Mobile SAA (and SALW) Disposal
- From Beneficiaries to Partners
- Underwater UXO Survey and Remediation

27.2 PUBLISHING JUNE 2023

Ukraine
- Anti-Handling Devices and Booby Traps
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- South Caucuses

27.3 PUBLISHING OCTOBER 2023

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- Explosive Hazards Clearance and Debris Disposal
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- History of SA/LW & PSSM: Lessons Learned and the Way Forward
- Quick Reaction Force
- Gender and Age in CWD
- The Blurred Line of Humanitarian Aid in Conflict Settings
- Linking Explosive Hazards Clearance and Industry
- Equitable Social Media and Marketing
- Munitions Destruction: Techniques and Equipment

UPCOMING TOPICS
MORE DETAILS INSIDE

Image courtesy of Sean Sutton/MAG (Mines Advisory Group).

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