Welcome to our twenty-fifth edition of *The Journal*. Sometimes it's a good idea to know where you've been to know where you're going. With this in mind, our team spent considerable time reviewing all sixty-four issues of *The Journal* and what an informative, humbling, and rewarding exercise it's been. With over 1,700 articles published over the course of twenty-five years, *The Journal* is a historical narrative and timeline of the evolution of mine action within the context of the global world in which it operates, reflecting the growth and decline of key trends and topics, highlighting successes and challenges, and bringing attention to ever-evolving programs and technology. Familiar personalities in mine action as well as new contributors working outside of the field have all shared their unique perspectives, insights, and experiences, expanding the breadth of knowledge of our community as we prepare for the future.

We're proud of the pertinent, timely, and valuable information the community of action has contributed in this edition, with articles highlighting the history of mine action; successful completion of clearance in the Falkland Islands; continuing evolution of explosive ordnance risk education; the use of virtual reality to aid survivors and demining programs; mine action in Ukraine and the Middle East; and innovative programs in data analysis, machine learning, and small arms and weapons destruction. Additionally, reflecting broader global trends and their effects on mine action, we feature articles on mental health and mine action; the ongoing effects of the global COVID-19 pandemic on operations; environmental concerns of clearance; and how we can reframe stereotypical gender narratives in the realm of mine action reporting.

One of the benefits of this pandemic has been our ability to virtually communicate with one another: from attending meetings, symposia, workshops, and seminars, to chatting virtually with our authors, the mine action community has been able to meet despite isolation and separation from one another. With this in mind, we hope that *Journal* contributors will join us in a new initiative we're calling the "CISR Exchange", as we engage with authors in ways that both highlight their work and discuss its broader implications within the field of practice. By talking with experts and sharing these conversations online, we hope the Exchange can help contextualize the challenges that mine action practitioners face today while showcasing how the free exchange of information can spark new ideas and potential solutions, something which we believe is the very crux of *The Journal*.

*The Journal* is only possible through the generous support of the U.S. Department of State and the contributions made by the community. We are continuously impressed by and grateful for the field's commitment to collaboration to achieve a world free from the dangers of explosive weapons and other legacies of war. As the sector now faces the effects of an ongoing pandemic and increasingly unstable operating environments, we encourage readers to look back over Journal articles published throughout the years, finding encouragement in how far the mine action sector has come and the many voices, individuals, and organizations that have brought us thus far. And finally, I commend *The Journal* publications staff for its success in providing a consistent quality space for sharing the stories and lessons of this remarkable community.

Stay safe,

Suzanne
Note from the Interim Director, Suzanne Fiederlein, Ph.D.

Letter from the Editor: The Journal of Conventional Weapons Destruction Celebrates 25 Years!
Steven Costner [ Deputy Director, Office of Weapons Removal and Abatement, Bureau of Political-Military Affairs, U.S. Department of State ]

Past, Present, Future: Mine Action in Motion
By Ambassador Stefano Toscano, Ph.D.
[ Geneva International Centre for Humanitarian Demining ]

Mine Action: The Early Years
By Ian Mansfield [ Mine Action Consultant ]

Applying “All Reasonable Effort” in the Falkland Islands Mine Clearance Programme: Encouraging Efficient, Confident, and Timely Evidence-Based Land Release Decision Making
By David Hewitson and Guy Marot [ Fenix Insight Ltd. ]

The Exploitation of Landmines in the Falkland Islands
By Colin King [ Fenix Insight Ltd. ]

Linking Mine Action and Development: The Case of Komyshevakh

Developing National Landmine Clearance Capacity in Ukraine

Saving Lives in Eastern Ukraine: Alternative EORE Approaches

Explosive Ordnance Risk Education in Ukraine During the COVID-19 Pandemic

Landmine Clearance and Socioeconomic Development: A Study in Colombia
By Oliver Ford, Amasia Zargarian [ The HALO Trust ], and Eric Keefer [ Office of Weapons Removal and Abatement, Bureau of Political-Military Affairs, U.S. Department of State ]

Impact Caused by the COVID-19 Pandemic on Humanitarian Demining in Colombia
By Salomé Valencia Aguierre, Angela De Santis, Ph.D., and Sebastián Tovar Jaramillo [ Swiss Foundation for Mine Action ]

Moving the Story Forward: Utilizing Deminer Narratives to Increase Women’s Empowerment in Mine Action and Beyond
By Brenna Matlock [ Center for International Stabilization and Recovery ]

Digital Rehabilitation Technologies Deliver Hope for Survivors
By Abder Banoune [ Humanity & Inclusion ]

Mental Health: Taking a Proactive Approach to Support Staff in Mine Action
By Laura Biscaglia, Abigail Jones, and Robert White [ Geneva International Centre for Humanitarian Demining ]
An Innovative Approach to the Mental Health Needs of Humanitarian Mine Action Personnel
By Ken Falke, Bret A. Moore, Psy.D., ABPP, and Richard Tedeschi, Ph.D.
[Boulder Crest Institute for Posttraumatic Growth]

Data-Driven Decision-Making in Southeast Asia
By Mikael Bold and David Avenell [MAG, Mines Advisory Group]

Key Performance Indicators (KPIs) for Land Release and Stockpile Destruction Operations – Notes on a New Technical Note for Mine Action
By Roly Evans [Geneva International Centre for Humanitarian Demining] and David Hewitson [Fenix Insight Ltd.]

A Virtual Reality Application for the Training of Deminers
By Lynn Al Khansa, Elias Bou Saada, Rachid Maalouf, Ali El-Hajj, Ph.D.
[Electrical and Computer Engineering Department, American University of Beirut], Mohammed Al-Husseini, Ph.D., Mohammed Baydoun, Ph.D., and Hassan Ghaziri, Ph.D. [Beirut Research and Innovation Center, Lebanese Center for Studies and Research]

Recognizing and Reducing Risks From Ammunition and Explosives
By Martina Salini and Samuel Paunila
[Geneva International Centre for Humanitarian Demining]

Alternatives to Open Burning and Open Detonation: The Disparity Between HMA and Commercial Best Practices
By Linsey Cottrell [Conflict and Environment Observatory] and Kendra Dupuy [Norwegian People’s Aid]

First Steps to Limiting Conflict Pollution in Central Vietnam
By Allan Vosburgh [Golden West Humanitarian Foundation]

Measuring Explosive Munitions Use with Open-Source Data: A New Tool for Enhancing Humanitarian Mine Action
By Jonathan Robinson [Humanitarian Researcher] and Christoph Baade [United Nations Office for the Coordination of Humanitarian Affairs]

The Elusive “Just Enough”: Re-inventing Explosive Hazard Clearance Management in Iraq
By Mark Wilkinson, Ph.D. [United Nations Mine Action Service]

Managing Risk Through Transparency and Cooperation: Improving Lebanon’s PSSM Capacity
By Jamie McGhee [MAG, Mines Advisory Group]

Assisting Landmine Survivors in Yemen
By Elise Becker and Tamara Klingsheim [Marshall Legacy Institute]

Remote Sensing and Artificial Intelligence in the Mine Action Sector
By Martin Jebsen [International Committee of the Red Cross] and Rob White [Geneva International Centre for Humanitarian Demining]

How to Implement Drones and Machine Learning to Reduce Time, Costs, and Dangers Associated with Landmine Detection
By Jasper Baur [Binghamton University and Columbia University], Gabriel Steinberg, Alex Nikulin, Ph.D., Kenneth Chiu, Ph.D., and Timothy S. de Smet, Ph.D. [Binghamton University]

See endnotes page 146
Letter from the Editor:

THE JOURNAL OF CONVENTIONAL WEAPONS DESTRUCTION Celebrates 25 Years!

By Steven Costner [Deputy Director, Office of Weapons Removal and Abatement, Bureau of Political-Military Affairs, U.S. Department of State]

The Journal of Conventional Weapons Destruction is the leading publication in the fields of humanitarian mine action (HMA) and munitions destruction and security. Since 1997, experts in these fields have shared their critical thinking and innovative ideas on how to make their practical work safer and more efficient at the same time. For this 25th edition of The Journal, I invite you to join me in celebrating all the present and past authors who have shared their ideas, inventions, and perspectives to improve the lives of countless communities around the world.

When I joined the Department of State over thirty years ago, humanitarian demining was a radical occupation not given much international attention. Then Princess Diana thrust the dangerous work of deminers into the spotlight in 1997 when visiting minefields in Angola and Bosnia and Herzegovina. The United States first funded a humanitarian demining program in Afghanistan in 1988, planting the seed for what has been the most robust conventional weapons destruction (CWD) program globally. Since establishing a dedicated HMA program in 1993 (and then expanding it in 2001 to include small arms and light weapons [SALW] and ammunition destruction and security), the United States has provided more than US$4 billion to support HMA, weapons and ammunition destruction, physical security and stockpile management (PSSM), and associated activities in more than 100 countries. But funding totals don't reveal how much has been accomplished, so let me give you a few examples: From 2016 to 2020 alone, these programs have resulted in the destruction of more than 139,316 SALW and over 67,000 tons of ammunition, making it harder for terrorists and drug traffickers to get weapons. We have cleared more than 1.4 million landmines and explosive hazards, and returned 225.87 sq mi to post-conflict communities for safe and productive use, promoting stability, security, and prosperity in the process.

My personal visits to the fields of Cambodia, Chile, and Zimbabwe impressed on me the dangerous work deminers undertake in sometimes very harsh conditions. Heat, rocky terrain, thick brush, and steep hills are just a few examples. I quickly appreciated the vast backgrounds these deminers come from, all joined by the common desire to provide safety and economic growth for their communities and their children. As the horrendous attack on a HALO Trust camp on 8 June 2021 in Afghanistan demonstrated, the work of deminers in countries still experiencing conflict sometimes brings with it the ultimate sacrifice. The use of improvised explosive devices (IEDs) by adversaries has added an additional layer of risk for many organizations and has required additional training to detect and render safe such items. Of course, the threat is not limited only to deminers. All too often a civilian stepping on a decades-long hidden landmine or a child picking up a brightly colored piece of unexploded ordnance results in life-altering injuries or death.
The Journal has managed over the years to illustrate how the work of demining has evolved and the skills required to render communities safe can be honed through up-to-date training. The articles published in The Journal have introduced or explained bright ideas to reduce this suffering. Authors have demonstrated that dogs, rats, drones, LiDAR technology, excavation, and simple tedious inch-by-inch manual landmine discovery and extraction are all viable methods to render land safe for travel, agriculture, and development.

I have advocated first-hand as head of delegation to many negotiations and conferences on SA/LW and ammunition for destruction and other PSSM measures as an effective way to reduce both illicit proliferation and the risk of catastrophic explosions at arms depots that threaten civilians. Many technologies are available to destroy, secure, and mark these weapons. I witnessed in Ukraine that SA/LW ammunition can safely be destroyed with varying methods. We applauded The Journal’s decision to expand its scope in 2016 to cover this important set of issues.

The year 2020 presented all of us with exceptional challenges professionally and personally due to the COVID-19 pandemic. The United States has remained committed to HMA and weapons destruction and security, with funding reaching more than $259 million in 2020 alone, despite the significant and constantly evolving logistical challenges. In many places, our implementers have unmatched logistics capabilities that can enhance life-saving efforts. National and local authorities, the mine action sector, and various actors in the protection space have delivered countless risk education (RE) sessions around the world. However, geography, conflict, local cultural dynamics, and, most recently, the global pandemic continue to present obstacles to presenting traditional RE to at-risk communities. Over the past year-and-a-half in particular, The Journal has published articles on innovative RE methods that are vital to helping such communities thrive and live safely.

Congratulations to all those that have contributed to making The Journal of Conventional Weapons Destruction the premier publication in its field that it is today—and congratulations in particular to the Center for International Stabilization and Recovery at James Madison University. I hope you enjoy this special 25th edition of The Journal.

Steven Costner on a field visit to Zimbabwe. Photo courtesy of the U.S. Department of State.
PAST, PRESENT, FUTURE:
Mine Action in Motion

By Ambassador Stefano Toscano, Ph.D. [Geneva International Centre for Humanitarian Demining]

Highlighting Key Mine Action Developments

The story of mine action is one of an adaptive and solution-oriented sector. Time and again, mine action has developed new approaches, tools, and standards to meet evolving challenges and circumstances at the field level. A strong partnership among all key actors has characterized the sector since its early years and has been instrumental to its agility and evolution.

Over the last three decades, the sector has come to realize the paramount importance of national ownership. National mine action programs in countries such as Afghanistan, Cambodia, and Lebanon have evolved from being heavily supported or led by international technical advisors to assuming complete responsibility for programmatic decision-making, with only limited support from the United Nations or other international stakeholders. National ownership has been decisive in ensuring that mine action be increasingly mainstreamed into governmental structures and programs, allowing synergies with ministries dealing with issues such as economic development, disability, and education. Thanks to the hard work of committed local actors and support from international technical advisors, local expertise and technical capacity have developed over the years.

The process of strategic planning has played a significant role in supporting this evolution towards increased national ownership. Developing comprehensive national strategies, under the leadership of the national authorities, is instrumental to ensuring that all actors involved pull in the same direction and mobilize the resources needed for operational activities. In the same vein, the Anti-Personnel Mine Ban Convention (APMBC) and the Convention on Cluster Munitions (CMC) have promoted in recent years multistakeholder approaches that foster better planning, cooperation, and coordination at national levels the so-called individualized and country-coalition approaches.

At a technical level, the sector has managed to agree on, establish, and codify all of the key areas of mine action operations through the International Mine Action Standards (IMAS). The development of these global guidelines that outline good practice for mine action is unique within conventional disarmament—both in terms of the sophistication of their governance and in their uptake at the operational level within the sector. The IMAS have evolved to integrate learning; new policies, structures, and methodologies are adopted within a common, transparent, and accountable framework. The IMAS are integral to the high level of confidence enjoyed by the sector, an aspect of great significance given its particular role in helping to render communities safe from explosive hazards.

The evolution of land release within the IMAS stands out as an example of the role that standards have played in moving mine action forward within a humanitarian framework. Land release represents the evolution of the pillar formerly called demining and an initial focus on removing (and counting) mines to a new approach that focuses on contaminated land and the socioeconomic consequences resulting from it. Land release also recognizes that removing contamination relies on both analytical and technical processes: non-technical survey (NTS), technical survey (TS), and clearance were developed as a system based on sound and transparent risk management and enhanced efficiency over an approach that required all land suspected of contamination to be demined or fully cleared. Millions of square meters of contaminated land have been cancelled from national databases as a result of better analysis and information gathering during NTS. This has saved millions of dollars in mine action resources, allowing for more meaningful investments and ultimately helping to save countless lives.

The mainstreaming of gender and diversity (G&D) considerations at the strategic and operational levels has gained considerable traction in recent years, out of the imperative to ensure that mine action interventions include and benefit all. The sector has improved its ability to integrate G&D in its work and to ensure that the issue is addressed from both the ethical and technical dimensions. Today, operational teams routinely collect data on how different target groups are affected by explosive contamination and tailor resources to address these needs so that more people benefit from mine action. In addition, the transformative role of mine action toward empowering women is by now fully acknowledged.
The Role of Innovation

As the mine action sector has matured, innovation has continued to shape and reshape approaches. To be sure, this has not happened in isolation: new ideas and methods have often been the result of partnerships, bringing together experts from different backgrounds, civil society, academia, and commercial companies, but also relying heavily on contextual knowledge gathered through interaction with beneficiary communities. Promoting innovation through such channels as the biennial Technology Workshops has proven to be a good way of bringing product developers and potential users together to exchange experiences and opinions.

The importance of sound information management to allow for evidence-based decision-making is now undisputed. Our ability to accurately understand and depict the problem, including the type and location of explosive ordnance (EO) contamination in a given working context, is a fundamental pre-requisite to the design of effective responses at all levels. Information management systems have improved continuously, not least thanks to the ability of the sector to harness the potential of new and evolving technologies—particularly geographic information systems.

The evolution of modern land release processes combined with technological advances in mapping facilitated a shift from early “big hand, small map” approaches, whereby rapid survey processes led at times to the inclusion of large suspected hazardous areas (SHAs) in national databases, thus complicating the task of turning them into confirmed hazardous areas (CHAs) afterward. It might appear straightforward from today’s perspective; however, countries such as Angola and Sri Lanka benefitted significantly from progress in information management in the early 2000s, when accurate polygon mapping was made possible by a combination of improved survey techniques and the possibility to equip survey and risk education teams with handheld GDP devices, accurate to a matter of meters. Further improvements in the way that practitioners understand evidence and engage with communities are also ensuring that the location of contamination is judged far more accurately today than ever before. Recent successes in Sri Lanka are testament to this, where 19 sq km—approximately 50 percent of the recorded mined problem—were cancelled during a 2016/2017 baseline survey.

Early hopes that emerging detection technology would provide some sort of silver bullet for the sector might have been dashed; however, significant progress has been made. The range of tools available continues to expand, and the sector is finding new and innovative ways to harness technology. Countries like Cambodia and Zimbabwe have benefitted from the deployment of new dual sensor technology, combining magnetic and GPR detection to reduce the time spent investigating false signals. In Bosnia and Herzegovina, the sector is exploring new methods to train, equip, and deploy animals in survey and detection roles, such as the SMART mine detection dog (MDD) system. Globally, innovative ways of deploying machines of different shapes and sizes have emerged, from the handheld strimmers that have sped up manual clearance, helping Mozambique move toward completion, to the bespoke demining machines that use heavy tillers capable of quickly processing large areas under the right conditions. And we are only beginning to see the potential of more recent innovations in remote sensing and artificial intelligence.

Innovation is not limited to new tools, equipment, and operational methods: the sector is finding more sophisticated ways of looking at the bigger picture such as measuring progress in terms of outcomes and impact. In 2017, the Geneva International Centre for Humanitarian Demining (GICHD) and the United Nations Development Programme (UNDP) produced a joint study articulating the linkages between mine action and the sustainable development goals (SDGs), pointing to the latter as a perfectly adequate framework to measure the broader transformational impact of mine action. Several affected states now include the SDGs in their national mine action strategies, such as Bosnia and Herzegovina, which included mine action achievements in its national reports on SDG implementation for the first time in 2020, illustrating the direct contribution of mine action in achieving sustainable development. The APMBG Oslo Action Plan, approved at the Fourth Review Conference in 2019, is the first of its kind to include measurable actions associated with clear indicators that can be used to track progress at the global level.

Next Steps: The Way Ahead

Mine action is and will remain first and foremost a response to a humanitarian imperative generated by EO contamination, and as such, part of broader humanitarian endeavors. Looking ahead, the sector is increasingly called upon to work in or close to conflict zones, environments often characterized by instability, weak state institutions, and the presence of armed groups. Regrettably, humanitarian actors face a shrinking operational space in these environments, with less room to maneuver and more security threats. Mine action will need to find new ways to operate in these environments, and to cooperate and coordinate with the broader humanitarian community.

Conflicts are increasingly urbanized, as is the damage they cause. This has created tremendous human misery and displaced millions of people. Urban settings with dense infrastructure EO contamination makes it difficult to locate it safely. EO being buried under rubble
The current COVID-19 global pandemic represents both a challenge and an opportunity to increase our efforts toward stronger national ownership and the localization of responses. Mine action should, indeed, be “as local as possible and as international as necessary,” to quote UN Secretary General, António Guterres.

in many cases, and in an environment where metal contamination negates the use of metal detection, new procedures and equipment are needed and under development. Further, refugees, internally displaced persons, and returnees are particularly vulnerable to risks from EO, emphasizing the importance of developing new methods and technologies in the field of explosive ordnance risk education (EORE).

Victim-operated improvised explosive devices (IEDs), especially those located in complex urban environments, provide yet another challenge that mine action operators are called to address. Due to their varying composition, detection that does not focus on metal but on some of the common attributes of IEDs such as “crush wires” (these can be concealed in urban dwellings under carpets or other imperceptible locations) are enhancing the speed of operations and the safety of staff. However, further work on how to address IEDs is required.

Mine action has an enabling role towards reconstruction and development and, more broadly, the achievement of the SDGs—it’s overall relevance. It is therefore essential for mine action to be placed firmly within the so-called triple nexus. More work is needed on this front to ensure and document mine action’s transformative impact on humanitarian, developmental, and peace-building efforts. Sound information management can play an integral part in this. The recent standardization of IMAS global minimum data requirements combined with a shift towards fully GIS-based information management systems such as Information Management System for Mine Action (IMSMA) Core will make it possible for comparable data to be aggregated and analyzed to support sound prioritization and operational decision-making.

The current COVID-19 global pandemic represents both a challenge and an opportunity to increase our efforts toward stronger national ownership and the localization of responses. Mine action should, indeed, be “as local as possible and as international as necessary,” to quote UN Secretary General, António Guterres. The sector has shown great resilience and adaptability in adjusting to the new realities presented by the pandemic. The increased use of modern technologies such as digital tools and platforms has been an integral component, as was the remarkable flexibility and support shown by donors. The pandemic also illustrated the importance and wealth of on-site/local expertise and local partners that can assume key responsibilities in the implementation of mine action programs. This is true especially in contexts where a solid mine action architecture is in place, delineating clear roles and responsibilities among different governmental agencies and nongovernmental, international partners. In these contexts, mine action might serve as an inspiration for other sectors regarding the delivery of public services.

Mine action was and is in motion. It has evolved significantly over the past three decades and will continue to do so as new challenges emerge. Finding the right balance, timing, and sequencing between the necessary humanitarian support to provide in immediate, post-conflict situations and the longer-term imperative to help strengthen national and local institutions will be paramount. As Desmond Tutu said “we need to stop just pulling people out of the river, we need to go upstream and find out why they are falling in.” In so doing, the sector will continue to work towards making itself redundant. As it should.

See endnotes page 146

Ambassador Stefano Toscano, Ph.D.
Director
Geneva International Centre for Humanitarian Demining

Ambassador Stefano Toscano has been the Director of the Geneva International Centre for Humanitarian Demining (GICHD) since January 2014, bringing extensive experience in multilateral diplomacy and human security affairs following a rich career with the Swiss Ministry of Foreign Affairs. As diplomatic collaborator in Bern (1998-2002), Ambassador Toscano was in charge of the small arms portfolio and thereby grew familiar with the importance and potential of the humanitarian disarmament agenda. As a Counselor at the Swiss Mission to the United Nations in New York (2002-2006), he was in charge of humanitarian, environmental, and migration affairs before serving as Vice Chairman of the 2nd Committee of the U.N. General Assembly. After returning to Switzerland in 2006, Mr. Toscano was Head of Section, Humanitarian Policy and Migration, at the Human Security Division of the Political Directorate, then Deputy Head of Division. In the three-and-a-half years before joining the GICHD, he was the Deputy Chief of Mission at the Swiss Embassy in Cairo. Ambassador Toscano holds a Ph.D. in natural science from the Swiss Federal Institute of Technology in Zurich and a master’s degree in international relations from the University of San Diego.
MINE ACTION: The Early Years

By Ian Mansfield [Mine Action Consultant]

At the global level, the year 1997 was undoubtedly the pinnacle of interest in mine action. This was the year that saw the award of the Nobel Peace Prize to Jody Williams and the International Campaign to Ban Land Mines (ICBL), the tragic death of Diana, Princess of Wales, the opening of the Anti-Personnel Mine Ban Convention (APMBC) for signature in Ottawa, the establishment of the United Nations Mine Action Service (UNMAS) as the UN focal point for mine action, the formation of the Geneva International Centre for Humanitarian Demining (GICHD), the genesis of the Mine Action Support Group (MASG), and the first publication of this Journal. However, these events did not just happen overnight; there was a full decade of work and commitment leading up to these significant achievements. This article looks at the challenges and successes of the early days of humanitarian mine action (HMA), particularly in the areas of coordination, standardization, and information sharing.

The Early Days

After the two world wars and other smaller-scale conventional wars, it was generally accepted that when hostilities finished, the military would be responsible for the clearance of landmines and explosive remnants of war (ERW). In guerrilla wars or irregular conflicts, the minefields were not marked and the landmines were not recorded, they were simply abandoned after the fighting ended.

Afghanistan. However, this situation changed dramatically after the Soviet withdrawal from Afghanistan at the end of the 1980s. There were millions of landmines in Afghanistan and, with millions of refugees in neighboring Pakistan and Iran expected to quickly return home, a humanitarian catastrophe was looming. In October 1988, the United Nations Office for the Coordination of Humanitarian Assistance to Afghanistan (UNOCHA) launched a humanitarian appeal for funding to train and equip Afghan civilians to clear landmines. The response to the appeal was not great, with only Germany, Japan, and the United States pledging money. Other countries still viewed the issue as a "military" activity and instead offered military advisers to assist.

UNOCHA, under the leadership of Martin Barber, made the best of what was offered, and in 1989, seven countries provided teams of military engineers and bomb disposal experts. The contributing countries were Australia, Canada, New Zealand, Norway, Turkey, the United Kingdom, and the United States. The initial concept was to train large numbers of Afghan refugees in basic mine clearance techniques at camps near Peshawar and Quetta, and then when they went home to their towns and villages, they would clear mines—an early form of the "village demining" concept. However, it was quickly realized that mine clearance needed to be undertaken on a more organized and controlled basis, and that other activities like survey and risk education also needed to be undertaken. UNOCHA looked for civilian implementing partners but there were none, so the United Nations oversaw the creation of specialist Afghan nongovernmental organizations (NGOs) to undertake survey, clearance, and risk education tasks. A number of international organizations also were established at this time.

Cambodia. The next HMA program to be established was in 1992, when the UN Transitional Authority in Cambodia (UNTAC) peacekeeping mission oversaw elections in Cambodia. Included in their mission was a requirement to address the landmine problem, so UNTAC established a Mine Clearance and Training Unit (MCTU). Once the newly elected Cambodian government was formed, a Royal Decree redefined the national mine action structure, which was now
led by an inter-ministerial governing council. This body was chaired at a senior level by the then Minister for Information, Ieng Mouly. The coordination level body was called the Cambodian Mine Action Centre (CMAC), and while it was civilian in nature, the initial stages of its setup relied on foreign military advisers from Canada, as well as Australia, Belgium, the Netherlands, and New Zealand, along with some civilian advisers from Handicap International (now Humanity and Inclusion) and Norwegian People’s Aid (NPA). Soon after it was formed, and after some interim arrangements including Pan Sothy acting as the director for a time, the Cambodian government appointed the mercurial Sam Sotha as the Director-General of CMAC, who in effect became the first formally-appointed national mine action director in the world, and who oversaw the establishment of a completely nationally-owned mine action program.

It is interesting to note that the name CMAC was the first formal use of the term “mine action.” The term was not precisely defined but was used to project a positive approach to dealing with landmines and reflect that the sector was now involved in more activities than just mine clearance. The other UN programs to begin in the early-1990s were in Angola and Mozambique. In both these cases, the mine action programs started as part of the peacekeeping missions: the United Nations Verification Mission to Angola (UNAVEM) and the United Nations Operations in Mozambique (UNOMOZ). Due to the mandates of both peacekeeping missions, it took some years before nationally-owned programs could evolve.

Kuwait. Another significant mine clearance activity also took place around the same time. At the end of the First Gulf War in February 1991, Kuwait was littered with landmines and other ERW. The government of Kuwait had money, so they divided the country into seven sectors and offered commercial contracts worth about US$100 million per sector. Within two years the country was cleared. While this was not regarded as a humanitarian mine clearance program, it did offer up some important lessons to the emerging humanitarian programs overseen or supported by the United Nations. The first was that mine clearance was not mission impossible, and that large areas of land or huge quantities of ordnance could be cleared—it just took time or money, and Kuwait had the money. Unfortunately, the commercial companies involved were not allowed to share information with each other, and valuable information on types of ordnance, clearance techniques, safety, costs, etc., was not readily available. Sadly, over eighty deaths were estimated to have occurred during these clearance efforts. Also, the Kuwait Government kept changing the clearance criteria and many organizations had to go over the same ground two or three times, until the government was satisfied that the ground was cleared. The experience of Kuwait highlighted the need for a precise elaboration of the desired end-state, good coordination, common operating and safety standards, and the importance of information sharing.

The sector grows quickly. By the end of the 1990’s, the United Nations was assisting a growing number of countries with funding, technical support, training, and the provision of equipment. These included Bosnia and Herzegovina, Chad, Croatia, Jordan, Laos, Thailand, and Yemen, with many more mine-affected countries requesting UN support. The donor response was also growing rapidly and in 1999, for example, the United States provided US$79 million dollars to thirty-five countries for mine action.

National Level Coordination

The first four HMA programs in Afghanistan, Angola, Cambodia, and Mozambique were all supported by the United Nations. However, they began independently at the country level and were overseen by different parts of the United Nations. As a result, different organizational and coordination models emerged, with the two most different being in Afghanistan and Cambodia.

In Afghanistan, due to the absence of a recognized government from 1989 onwards, UNOCHA was responsible for policy decisions, liaison with neighboring countries and other international agencies, dealing with emerging Afghan authorities, resource mobilization, setting of priorities and standards, etc., effectively playing the role of what today we term the national authority. A separate office within UNOCHA oversaw the day-to-day tasking and operations of the implementing partners, undertaking quality management functions, collecting and storing data—the functions of a mine action center. The specialist Afghan and international NGOs were the operators, and they implemented tasks like risk education, survey, battle area clearance, and mine clearance. The first national level strategic plan for the Mine Clearance Programme – Afghanistan was issued in 1992, and this drew together all components of the program and listed the common goals and objectives to be achieved in that year.

In contrast, CMAC initially performed all functions and was established to be the government policy-advising agency and the operational coordinator. However, CMAC also had its own mine clearance teams, which they funded, tasked, and managed. Coordination by CMAC was reasonably effective in the early years, but as time went by, CMAC became focused on their own operations and funding needs. Because international NGOs like Mines Advisory Group (MAG), The HALO Trust (HALO), and NPA were also operating in-country, leading to competition for funding, confusion about roles, and some duplication of effort, a separate national authority and regulatory agency was later created to resolve the inherent conflict of interest at CMAC.

By the mid-1990s, as a lead actor, the United Nations saw that these different national coordination models had emerged with varying degrees of success. In response, the then Department of Humanitarian Affairs (DHA) commissioned an ambitious four-country study in 1996. The study team was led by Bob Eaton, and the team undertook visits to Afghanistan, Angola, Cambodia, and Mozambique to look at
how the programs were organized and what coordination measures were used. The results of the study were published in four country booklets and one summary edition. The study noted the shift within the international community from viewing mine action primarily as a military problem to that of a humanitarian and development situation, with an emphasis on developing a strong national capacity. On coordination arrangements, the study found that “the Afghan institutional architecture, involving a strong central coordination and oversight mechanism, and autonomous but affiliated mine action NGOs, helps secure the viability, sustainability and accountability of the program, while maximizing flexibility, plurality of methodologies, and a keen sense of competitiveness and productivity.”

Unfortunately, the study was issued just as DHA was transferring its responsibility for mine action to the newly formed UNMAS and the study did not receive the recognition it deserved. However, the key findings from the study have become the accepted way that most national mine action programs are now organized: a central national authority deals with policy and regulatory issues, a mine action center is responsible for the day-to-day coordination of activities, and a range of mine action operators are responsible for undertaking a range of tasks.

Global Level Coordination

Whereas it took some years for an agreed model for national level coordination to evolve, global coordination is still a work in progress. Because of its involvement in setting up the early mine action programs, along with its global reach, the United Nations has played a key role in improving global coordination. In 1993, the United Nations General Assembly included in the agenda of its 48th session, for the first time, a separate item on “Assistance in mine clearance.” Following an extensive discussion, the General Assembly asked the Secretary-General to prepare a comprehensive report on the problems caused by landmines and on the measures needed to strengthen UN efforts relating to mine clearance. The Secretary-General’s report was presented to the 49th session of the General Assembly in 1994 and outlined the situation with regards to landmine contamination around the world and the measures needed to address the problem. The resolution also welcomed the establishment of a United Nations Voluntary Trust Fund (UN VTF) for mine clearance and requested the Secretary-General to consider “convening an international meeting on mine clearance, to include a meeting of experts and a meeting of potential donors, in order to promote the work of the UN and international cooperation in this field.”

An international meeting was subsequently held in Geneva from 5–7 July, 1995. The meeting was attended by many member States, international organizations, national authorities, and NGOs, and was opened by Secretary-General Boutros Boutros-Ghali. For the first time, the international community could see the human face of the landmine tragedy through twelve-year-old amputee, Ms. Song Kosal, a Cambodian landmine survivor who spoke quietly but powerfully at the opening session. The meeting had a wide-ranging agenda including general statements and the announcement of contributions to the UN VTF, along with expert panels that discussed technical aspects of mine clearance.

At the operational or field level, different UN headquarters and agencies had varying degrees of responsibilities and commitment to mine action. In 1997, UNMAS was formed, located within the Department of Peacekeeping Operations (DPKO). As the focal point within the UN system for all mine action matters, UNMAS has coordinated the work of the fourteen involved UN funds, programs, and agencies. The first UN policy document was issued in 1998, which clearly set out the roles and responsibilities of all UN actors. An Inter-Agency Coordination Group – Mine Action (IACG-MA) was established at the principals level and various other working-level committees were formed. The United Nations has also played a role in organizing international meetings, such as the annual meeting of National Mine Action Directors and UN Advisers (NMD-UN) that have served both as an information sharing platform as well as enhancing global coordination.

Although not a coordination mechanism per se, the mine action community has benefited from the focus provided by the International Campaign to Ban Landmines (ICBL). The civil society Campaign had its origins in October 1992 when six international NGOs formalized their anti-landmine efforts. The ICBL’s work has helped draw attention to the global landmine issue by identifying priority countries,
providing factual data about the landmine crisis, and drawing donor support to the issue. One of the first major activities of the Campaign was the preparation by the Vietnam Veterans of America Foundation (VVAF) of a major study published in 1995 called *After the Guns Fall Silent: The Enduring Legacy of Landmines* by Jody Williams and Shawn Roberts. This ambitious project attempted to quantify landmine contamination in what was then being recognized as a growing problem. Even at this stage, the report was able to document landmine or ERW accidents in sixty-four countries. While it was difficult to draw a lot of conclusions from the report because all the data was collected differently, it was the inspiration for the Landmine Monitor report. Today, the *Landmine and Cluster Munition Monitor* is the accepted source of all landmine and ERW factual data. Of course, with the entry into force of the APMBC in 1999, the annual meetings of States Parties are now one of the most effective mechanisms for enhanced global coordination in the sector.

The mine action sector has been heavily dependent on support from aid donors. Over the years, significant amounts of donor money have been provided to national authorities, UN agencies, and NGOs. Donor coordination has been difficult, because all donors have their own set of priorities, based on historical links, geographical considerations, and domestic politics, all overlaid onto humanitarian or development needs. However, all donors agree that mine action covers the nexus of peacebuilding, humanitarian assistance, and development. In the late 1990s, donors again saw the need to promote a coordinated response to mine action. As an initiative of Norway, the Mine Action Support Group (MASG) was formed in New York in 1998. MASG "endeavors to coordinate the humanitarian mine action programs of the world's major donor states, harmonize the prioritization of their respective mine action programs, and increase donor support for mine action where it is most needed." The MASG now meets twice per year, once in Geneva and once in New York.

**Standardization**

As mentioned previously, the initial mine clearance programs evolved in isolation and originally received technical advice from foreign military advisers. As these programs were operating in isolation, the various military contingents adapted their own military training, procedures, techniques, and often equipment to meet the new requirement of humanitarian demining. This led to the adoption of different standards of work in each country. In addition, there were many animated discussions at the growing number of international meetings about the various techniques for manual demining, the utility of machines, along with heated debates about the use of dogs for mine detection. As a result and because they were unfamiliar with mine action, many donors said that they were receiving conflicting advice from partners seeking funding and often asked, "what is the way forward?" Donors encouraged the United Nations and others to devise an agreed set of standards for mine action operations.

This call was heeded in July 1996 when the United Nations, with support from the government of Denmark, arranged a meeting on the outskirts of Copenhagen to develop a set of international standards for mine action. After five days of discussion, a draft framework set of standard topics titled the "International Standards for Humanitarian Mine Clearance Operations" were developed. A smaller group of experts met in December 1996 in Jalalabad, Afghanistan, to finalize the standards. Subsequently, a first edition of the standards was published by UNMAS in March 1997. These standards were later further developed by UNMAS and the GICHD to include other components of mine action and were renamed to become the International Mine Action Standards (IMAS), with the first edition produced in October 2001. Credit is due to Bill van Ree for the foresight to adopt an International Organization for Standardization (ISO) approach for the standards, and subsequently to Noel Mulliner and Alastair McAslan who managed the detailed drafting and preparation of the IMAS.

**Information Sharing**

International or national staff working in the four original country programs did not have the opportunity to meet with each other, to share information, or to travel and visit other programs. Each program developed its own structure, procedures, and techniques quite independently.

The only cross-pollination came from visits by people like Alister Crab or Phil Bean, who were engaged by donors to undertake evaluations of the various projects they were funding around the world. These visits were a great opportunity to hear what was happening in other countries,
share information, and to consider the applicability of new ideas. In response to the growing call for programs to meet and interact, the first international meeting for HMA programs was held in Vienna, Austria, in May 1993 and was organized by the Scheibel mine detector company. Representatives from the four UN programs attended (Afghanistan, Angola, Cambodia, and Mozambique), along with some commercial companies that had been involved in Kuwait. The meeting provided the first real opportunity for national and international staff from the various programs to discuss issues of common concern.

In June 1994, the Swedish National Defence Research Institute (FOA) organized a meeting in Stockholm, where attendees included a diverse range of people, including those who designed and made landmines, sellers of military equipment, UN officials, military officers, national representatives from mine-affected countries, and campaigners against landmines. Needless to say, there were many active and heated discussions among this group. One simple exchange highlighted the changing nature of mine action. During his presentation, an NGO deminer showed a photo of a landmine. An earnest young military officer jumped and said, “you cannot show that, it is classified information,” to which the NGO deminer said “I dug this landmine up last week with my own bare hands, and I will show it to whomever I like.” After the Stockholm meeting, numerous international meetings were held; however, they divided naturally into two categories: those held to promote the ban on landmines and others designed to allow field programs to share their experiences with other countries and operators.

In the pre-internet age, written publications were an important method of disseminating information. Many publications have come and gone, but some have endured. The UN launched a publication called The Landmine in 1997. This booklet was published quarterly and detailed the work of UN agencies in mine action, although the publication only lasted a few years. Since 1999, the United States has published To Walk the Earth in Safety, which outlines the conventional weapons destruction work funded by the United States. In 1997, the Mine Action Information Center (now the Center for International Stabilization and Recovery) first published the Journal of Humanitarian Demining. In 2016, the publication name changed to The Journal of Conventional Weapons Destruction, funded by the U.S. Department of State, to expand its scope to include the destruction of small arms and light weapons.

Looking Forward?

The evolution and success of mine action has been rapid and dramatic, not just because of the dire consequences of getting it wrong, but because at all stages the individuals and organizations that guided the sector did the best that they could at the time within the limitations of available technology and resources. Lessons learned with the benefit of hindsight, the application of emerging technology, and particularly the widespread use of management information and communication systems, point to ways where improvements have and can continue to be made across the spectrum of the mine action pillars. Recalling the history and the lessons (sometimes painfully learned) should not be forgotten. Active researchers would do well to review the last twenty-five years’ worth of Journal articles, as they illustrate the evolution of mine action, the topics of concern in their day, and the successes in terms of best practice that could be shared. Moving forward, seeking improvements to efficiency and safety in challenging environments is not a choice; it must happen in concert with ongoing humanitarian, development, and peace-building needs if we are ever to succeed and rid the world of the impact of mines and many other ERW.

See endnotes page 146

BIOGRAPHY

Ian Mansfield
Mine Action Consultant

Ian Mansfield works as a mine action consultant and has been the secretariat of the Mine Action Support Group since 2011. Previously he was the Deputy Director of the Geneva International Centre for Humanitarian Demining and the team leader of the United Nations Development Programme Mine Action Team in New York. Earlier, he was the UN mine action program manager in Afghanistan, Laos, and Bosnia and Herzegovina. In 2017, he published a memoir, Stepping into a Minefield.
APPLYING “ALL REASONABLE EFFORT” IN THE FALKLAND ISLANDS MINE CLEARANCE PROGRAMME: Encouraging Efficient, Confident, and Timely Evidence-Based Land Release Decision Making

By David Hewitson and Guy Marot [Fenix Insight Ltd.]

The Falkland Islands Mine Clearance Programme (FI MCP) ran from 2009 to 2020, through five operational phases, some lasting only a few months, some extending across several years. A core objective was to release land as efficiently as possible, only applying technical assets to those specific areas of land that justified such attention. This article describes the approach that was adopted to determine whether all reasonable effort (ARE) had been applied to each task in such a way that current (and future) stakeholders would have confidence in that decision so as to manage the fear of mines being missed.

Two organizations were contracted by the UK government to deliver the FI MCP: the land release contractor (LRC), most recently SafeLane Global; and the demining program office (DPO) provided by Fenix Insight Ltd. Additionally, a strategic adviser (Alistair Craib) provided advice, oversight, and contracting input. Around 20,000 anti-personnel (AP) and 5,000 anti-vehicle (AV) mines were declared as laid at the time of the 1982 conflict. In addition to explosive remnants of war (ERW) resulting from ground fighting, naval bombardment, and the abandonment of ammunition, a submunition threat was also present. Some military clearance took place in the immediate aftermath of the conflict but was stopped following a number of accidents to clearance personnel. From 2009 to the declaration of completion at the end of 2020, the FI MCP released over 23 million m² from 127 hazardous areas, clearing over 11,000 landmines within 2.3 million m² of cleared ground.

Contractual and Stakeholder Expectations

When the program started in 2009, there was both a contractual requirement to exceed the International Mine Action Standards (IMAS) and a high level of uncertainty among local stakeholders who feared that mines would be missed, deminers would die, and the environment would be unacceptably damaged by clearance operations. All three fears expressed by locals were addressed during the first phase of operations through a combination of thorough processes and procedures, a high level of transparency, engagement of local environmental stakeholders, and a program of public visits to working sites to demonstrate the quality and reliability of the work.

Every clearance program faces an identical fear: that mines might be missed. How this is addressed has huge implications for the cost, duration, and efficiency of program operations. The project efficiency risk is that the risk of missing mines will be addressed through the clearance of areas that don’t need it just in case. Such an approach imposes avoidable costs (often at significant levels) as well as delays, combined with stakeholder dissatisfaction, impatience, and implications for international treaty compliance. Professional, reputational, and contractual fears about missing mines are further compounded when there is additional uncertainty about legal liability. The FI MCP was contracted under English Law in a context in which criminal and civil liability, including corporate manslaughter cases, are established and often publicized.

The stated objective of the program was to release designated land by “applying all reasonable effort to ... remove all suspicion of mines/ERW ... and to reduce the remaining risk from explosive hazards to as low as reasonably practicable (ALARP).”2
ALARP and ARE are distinct but closely-related terms. They sit either side of the decision to release point in the land release process: the application of ARE to an area confirmed or suspected of containing explosive ordnance (EO) hazards should result in a residual risk that is ALARP. There are no recognized, defined criteria for what constitutes either ARE or ALARP, although guidance exists in a number of areas, including in IMAS and in UK Health and Safety Executive (HSE) publications.¹

The approach adopted in the Falkland Islands was based on a number of basic principles:

- The word *reasonable* in both ARE and ALARP indicates an expectation of logical, transparent reasoning based upon reliable evidence to support decision-making.
- The effort encapsulated in ARE is not just the physical effort of clearing land but includes enabling effort in training people, selecting and using appropriate equipment, establishing and implementing effective quality and information management systems, and using evidence to support decisions (Figure 1).
- The decision to declare that ARE has been applied and that no further activity is required before releasing the site only has value if other stakeholders agree.

The challenge, implicit within the concept of ARE, is to recognize that ARE has been applied at the earliest point in a land release task without undershooting the decision (i.e., releasing land before it is completely clear of EO hazards). The inevitable natural inclination is to overshoot—processing more land than is absolutely necessary, just to be on the safe side. In most real-world cases there is at least some uncertainty. That means that some overshoot will be unavoidable if all stakeholders are to agree with the decision. There were some sites in the Falkland Islands where large numbers of mines were present, regularly laid out, undisturbed, and fully recorded, taking the ARE decision as close to the theoretical earliest point as is realistically possible (with fewer than 10 m² cleared per mine found). Alternatively, there were others sites where there was no record, substantial changes had occurred since the conflict, and only one or two mines remained in large areas, making it much harder to assess ARE (resulting in over 15,000 m³ per mine).

Figure 1. Conceptual illustration of the enabling and task level approach to all reasonable effort (ARE).
*Developed by David Hewitson for the GICHD.*
A lack of stakeholder confidence in released land often arises from uncertainty about why key land-release decisions were taken. Task documentation frequently consists of a disparate collection of paperwork that can be hard for an individual reader, especially one not familiar with the task, to understand holistically. Even an expert will often have significant questions when reviewing such documents about what happened and why. While everything may have made complete sense to managers on the ground at the time of the work, if the task documentation does not provide clear and accessible explanations, then later readers are left feeling unsure about what went on and why, and IMAS 07.14 defines risk as “the effect of uncertainty on objectives.”

A future developer looking to use the land for a public project may determine that further technical activity is necessary just in case. Any such action diminishes, and in some cases wholly destroys the worth of the original work, with all its costs, use of resources, and physical risk.

In 2010, co-author David Hewitson worked with Bob Eaton of the Survey Action Centre to develop a process-driven approach to land release for the Tajikistan Mine Action Centre. The project included development of a core document that would tell the story of the site. The document aimed to explain:

- what EO to expect at the site (and why);
- how these expectations were reflected in the operational plan;
- what was actually found during operations; and
- what decisions were taken during operations in light of what was actually found.

Readers of the completed document should understand the task process from start to finish as a connected narrative that makes sense and leaves them confident in the decision to release the land as safe for use. Other associated documents, such as daily narrative logs, detailed mapping, quality management records, and certificates should also be available for reference where necessary. However, the site implementation plan (SIP) would be the heart of the documented explanation of what happened. The process (Figure 2) and associated documentation developed during that work was adopted in the FI MCP.

**Stage 1: Tasking**

In accordance with broader contractual requirements, a task order specifies the hazardous area to be processed but does not specify land release methods or any other technical details.

**Stage 2: Information Collection**

A fundamental part of the ARE process is identifying, accessing, and making use of all available information—not just information about the intended task site but also about the wider context of operations and contamination, including evidence from previously completed tasks. In the FI MCP, information was available from a number of sources:

- original Argentine records in Spanish created by the minelaying organizations and available for many (but not all) sites, including sketch maps, number and types of mines, among other details.
- translated UK military records in English; essentially the same as the original records (although with occasional transcription errors), including additional, limited details from 1982 at those sites where UK military clearance took place, and information about clearance (usually of individual visible mines) that occurred over subsequent years.
- information in published historical accounts.
- information from interviews with veterans.
- interviews with local people who were present before, during, and after the conflict.

Further information became available as the clearance program progressed:

- comparison of what was actually found on the ground during previous clearance operations versus information in minefield records, allowing a general assessment of the reliability of records as well as results of detailed analysis (such as error brackets for distances and bearings recorded on maps).
- other lessons learned during operations.
- real-world operational key performance indicators (KPIs).

Significant effort to identify and access potentially relevant information was applied by the LRC throughout the program, recognizing the importance of doing so to drive confident and credible decision-making.

**Stage 3: Analysis and Planning**

In addition to analysis of the expected threat type, detectability, and distribution, planning included geometric analysis of the expected arrangement of mines: in rows and panels, orientation, and separation. A key concept was that of the minimum survey target (MST): the smallest associated packet of mines defined in terms of numbers of mines, numbers of rows, separation of rows, and separation of panels.

In some cases, planners might have confidence that they were looking for a combination of multiple rows of mines in several panels. In others there might be no record but evidence that, if mines were present, they would be in at least a certain quantity and arrangement (based on evidence that mines had never been laid in less than a given arrangement). On other occasions, particularly in areas that had been subject to partial historical clearance, the MST might be a single mine.

The analysis of the MST drove decisions about the width and separation of targeted technical survey (TS) lanes as well as those cases (where the MST was one or a very small number of mines) when targeted block clearance would be employed. Geometric analysis of the MST was applied to ensure confidence that any targeted TS could not go through a contaminated area without encountering at least one piece of evidence of mines present, nor could adjacent lanes go either side of a contaminated area (bracketing).

In many areas the third dimension of depth was also important, reflecting the effects of peat or sand accumulation on top of the original mine contamination layer. Further analysis was conducted to identify the most appropriate areas to target during TS. Where present, records often used paces or
As units of distance, bearings were taken using handheld compasses, and reference points had often disappeared or were hard to identify. Part of the ARE approach included analysis effort using reverse engineering on completion of site operations to compare the locations of actual finds, with distances and directions, against details in records. This allowed pool of error assessments during planning for subsequent tasks of where mines might be (if they were still in undisturbed rows) or had originally been (if identifying areas requiring block clearance). Moreover, the closing the loop effort was an important part of the overall approach to demonstrating the reasoning aspect of ARE decisions.

The resulting plan provided program managers, as well as those who would sign clearance certificates, with confidence that if no evidence of mines was found in an area, then it could reasonably be concluded that no mines were present. In doing so, the analysis laid the foundation for the decision-making that would take place during the operational phase to identify when ARE had been applied and when it was justified to stop operations and declare the area safe for release.

**Stage 4: Initial Review**

The draft plan, prepared by the LRC, was reviewed by the DPO. Any comments or questions were resolved before sign-off by both parties. The process was both transparent and represented clear liability risk sharing throughout.

**Stage 5: Implementation**

Implementation followed the agreed plan but with a constant review process considering the implications of new information, whether it was the discovery of mines where predicted or the absence of mines where expected. New information could reinforce confidence.
Figure 3. Example of key decisions in the field review and change log (Site SA 077). Note inclusion of environmental remediation in the effort applied at the task site.

<table>
<thead>
<tr>
<th>Date of Review</th>
<th>Event/Reason for Review</th>
<th>Description/Required Changes</th>
<th>LRC Manager</th>
<th>FI DPO</th>
</tr>
</thead>
<tbody>
<tr>
<td>31 January 2018</td>
<td>Switching Decision</td>
<td>The LRC conducted a detailed</td>
<td>Signs to agree changes and confirm implementation</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>review of the threat posed by</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>mines using a combination of</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>reconciliation against records</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>or verification of the ground</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>and has concluded that it is</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>safe for deminers to switch</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>activities from mine clearance</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>to BAC.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 February 2018</td>
<td>Clearance Complete</td>
<td>Having reviewed all available</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>information the residual risk</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>from Explosive Remnants of</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>War including landmines is</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>now assessed to be ALARP and</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>that further technical survey/demolition action would not be justifiable.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20 February 2018</td>
<td>Remediation complete</td>
<td>All fences and posts (where appropriate) have been cleared.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Marking sticks and string lifted, MMDs filled in and appropriate environmental remediation completed. No further practical activity is required.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

in the planning assumptions or call them into question. Whenever the unfolding situation allowed refinement of the plan, or where it demanded a rethink, such considerations were documented in the Field Review and Change Log section of the SIP (Figures 3 and 4).

In each case the LRC would discuss their thinking with the DPO, and (once accepted) the decision log in the SIP would be signed by both parties. The relationship was one of cooperative independence. The DPO was prepared to ask for and review any evidence, and to question the reasoning behind decisions to ensure that whatever was captured in the record would make sense to future readers without prior knowledge of the task.

Through the logs, key decisions were captured about when it was appropriate to declare the site mine free, allowing a switch to battle area clearance (BAC) methods, as well as the point at which ARE had been applied in full. In every case, the countersignature by the DPO helped both the general credibility of the decisions and ensured that any perception of liability risk was shared between the DPO and the LRC, reducing the risk of conducting extended clearance just in case, while encouraging early and efficient completion of operations.

The LRC’s high-quality survey and mapping was a key component of the decision-making process, allowing LRC managers and DPO reviewers to see the evidence on site in a clear geographical context. Review and comparison of what was found against information in records, as well as evidence gained at previous sites, helped identify areas where missing mine drills (MMDs) were required. The SIP provided a collaborative approach to looking at what had been found, where definite or potential gaps might be present, why those gaps exist, and what the extent of any additional clearance would be to show that ARE had been applied.

**Stage 6: Final Review**

At the end of every task a post-completion analysis and management review were carried out and captured in the SIP. Their purpose was to close the loop between the experience gained on the specific task and the wider body of accumulated evidence-based knowledge that would feed into planning of future tasks.

The analysis and review addressed:
- results of quality assurance and quality control inspections
- results of any nonconformities, accidents, or complaints
- how reliably planning information related to what was actually found
- efficiency of switching between TS, mine clearance, and BAC activities
- identification of any new information that might call into question wider planning assumptions
- recommendations for improvement, including follow-up actions
- KPI results

<table>
<thead>
<tr>
<th>23 Mar 15</th>
<th>The second mines dump has been discovered at the northern end of stretch C during an overhead drone flight. This dump sits inside two hollows approx. 10m apart. Caution is to be exercised when accessing this area as the previous dump was confirmed to contain nuisance mining.</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 Mar 15</td>
<td>A full investigation using manual clearance drills will take place in and around the area of the mines dump/s. This will be followed by an evaluation based on the findings. This will be a one man task, over watched by the supervisor.</td>
</tr>
</tbody>
</table>

Figure 4. Logging of a technical response to newly discovered information (SA 059).
Conclusions

Some suggest that the FI MCP was easy because of the availability of records for which many other programs don’t have comparable, available information sources. Although certainly true that records are helpful, for many sites in the Falkland Islands they were either unavailable or of limited use. Additionally, partial clearance immediately after the conflict left a situation of utter uncertainty. Even where records are reliable, there is still a responsibility on mine action operators to make best use of those records to drive efficiency, achieve safe release of land at the earliest possible opportunity, reduce the demands on public money, and make resources available for other work.

Throughout the FI MCP, both the LRC and DPO placed constant, rigorous emphasis on the collection and use of information to drive decision-making about when ARE had been applied in such a way that other stakeholders would understand and accept those decisions. The SIP helped program planners and monitors to focus on the task at hand. It helped them to think about what they were doing and why, and encouraged them to consider all relevant factors (enabling and on-site) that fell under the umbrella of ARE. The performance indicators captured at the end of every task provided a solid basis for the planning of both individual sites and projections for overall program progress.

Most importantly, the completed SIP provides a transparent, comprehensive record of the decisions taken and evidence associated, all the way through the task life cycle: from initial planning, to in-progress operational decision-making, to the final decision to declare

<table>
<thead>
<tr>
<th>Observations, conclusions, actions required</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Results of quality-assurance and quality-control inspections.</strong></td>
</tr>
<tr>
<td>There were no QA observations. Post clearance quality control sampling revealed no non-conformities.</td>
</tr>
<tr>
<td><strong>Land release process performance (key performance indicators/ration).</strong></td>
</tr>
<tr>
<td>• Average demining rate 11.12 m²/deminer/day (6hr)</td>
</tr>
<tr>
<td>• Average efficiency 9.49%</td>
</tr>
<tr>
<td>• Average deminer day/mine 0.85 deminer days/mine</td>
</tr>
<tr>
<td>• BAC rate 656.21 m²/deminer/day</td>
</tr>
<tr>
<td><strong>Quality non-conformances, complaints, accidents.</strong> Nil</td>
</tr>
<tr>
<td><strong>Recommendations for improvement.</strong> Nil</td>
</tr>
<tr>
<td><strong>Follow-up actions arising from the review.</strong> Nil</td>
</tr>
</tbody>
</table>

Figure 5. Extract from SIP for site SA 053, including standardized KPIs.
Penguins are not heavy enough to detonate landmines and roamed freely among the minefields.

that ARE had been applied and the land was safe to release, to (equally importantly) the feedback loop to support improved ARE decision-making at later sites.

At every stage, and in every respect, the common thread in the way that FI MCP program managers approached their task was through relentless, comprehensive, and careful collection and use of operational contextual and performance data, constantly reducing uncertainty, and by extension risk, in every aspect of the program—from technical procedures to prioritization and planning at both task and strategic levels. The methods used, in particular the SIP, were founded on original work carried out in Tajikistan and refined for the needs of the FI MCP, but are applicable to any mine action program.

One experienced and knowledgeable mine action practitioner who visited the Falkland Islands' program said that, before they arrived, they thought that the FI MCP's approach to documenting land release planning and decision-making would prove excessive. By the time they left they were firmly of the opinion that the SIP approach should actually be the minimum applied in any mine action program.

David Hewitson
Fenix Insight Ltd.

David Hewitson has been working in humanitarian mine action for over thirty years. He conducted practical clearance of landmines in Afghanistan, Angola, Cambodia, and Mozambique and established and managed field programs. In 1995, he founded a commercial demining company and employed more than 3,000 people in projects all over the world. For the last ten years he has worked as co-founder and director at Fenix Insight Ltd. He was the overseeing Director for the Falkland Islands Demining Programme Office (FIDO) contract with the UK government. He has drafted a number of International Mine Action Standards (IMAS) as well as other publications and was instrumental in the conception and development of the standards compliance tool at www.mineaction.net. He engages in technical field operations as well as wider governmental and institutional advisory work. Before joining the mine action sector, he served in surface ships and submarines in the Royal Navy. He has a degree in Aeronautical and Astronautical Engineering.

Guy Marot OBE
Fenix Insight Ltd.

Guy Marot OBE was the Programme Manager for the Demining Programme Office in the Falklands Islands responsible for implementing the policies of the UK National Mine Action Authority and, as such, responsible for monitoring, inspection, and reporting of all activities of the Land Release Contractor. Marot served for twenty-six years in the British Army, within the Corps of Royal Engineers in a variety of roles, the majority in explosive ordnance disposal and IED search. He had operational tours in Northern Ireland, Bosnia, and Iraq with other emergency deployments such as commanding the Joint Service Explosive Ordnance Disposal Detachment in the Falkland Islands in 1988. Since leaving the army, he has undertaken numerous projects in the humanitarian, commercial demining, and unexploded ordnance clearance industries. He was the project manager for the clearance of part of the last minefields left in Europe from WW2. In 2011, he was the local Head of the Weapon Contamination Unit for the International Committee of the Red Cross in Libya in 2011, the Republic of Congo in 2012, and South Sudan in early 2014.
THE EXPLOITATION OF LANDMINES IN THE Falkland Islands

By Colin King [ Fenix Insight Ltd. ]

Background

Throughout the eleven-year mine clearance program in the Falkland Islands, the exploitation (disassembly, detailed analysis, and testing) of live mines was a regular feature. In addition to assessing the condition of the mines in order to optimize the safety and efficiency of the clearance process, there was intense interest in the subject of long-term residual risk.

The rigorous demining program was highly successful, and the Falkland Islands have now been declared clear. However, a mine recently washed up on the shore near the Capital, Stanley, and it’s possible that others will do so over the next few years. It is also clear that findings from exploitation work in the Falkland Islands can make a significant contribution to the understanding of residual risk in other mine-affected regions.

During the final phases of the program, the discovery of Israeli No. 4 anti-personnel (AP) mines triggered a request from SafeLane Global, the land release contractor (LRC) and Demining Programme Office (DPO) for a technical assessment of their condition. Initially, this took the form of a remote desktop study based on images of recovered mines, which were compared to inert examples and technical data held by Fenix Insight Ltd. The aim was to consider the likely effects of ageing and their implications for the handling and disposal of the mines.

Soon after, the LRC also began to encounter Argentinian M1 and Israeli No. 6 anti-tank (AT) mines, as well as Argentinian FMK-1 AP mines. Once again, as the clearance program entered its final phase, questions of residual risk, handling, and disposal were raised, and an exploitation visit was planned in order to assess

- the general condition of the mines
- the functionality of fusing mechanisms
- the viability of energetic materials
- the implications of changes for risk

The work was conducted in March 2019 by Colin King, Technical Director of Fenix Insight Ltd, assisted by Max Grace, Fenix Operations Assistant, and supported by Guy Marot, who ran the DPO.

Risk Assessment

Risk assessment is always a fundamental part of the planning process and follows a well-established Fenix protocol. It considers the likelihood and potential consequence of each hazard in order to allocate a combined risk score, often involving multiple team members in order to capture technical and procedural considerations across a range of scenarios. Where appropriate, controls are then applied to manage the risk to make it as low as reasonably practicable (ALARP).

Previous deployments have illustrated the value of this process when, for example, the worst-case scenario of a firing pin remaining lodged in a live detonator was found to have occurred in several mines.

Logistics

A temporary ammunition processing building (APB) was set up at Yorke Bay, outside Stanley, in a shipping container with a workbench and vice, a generator, and lighting. A specialist tool kit was brought from the United Kingdom to supplement the tools and equipment retained from previous exploitation phases; this included jigs built by Fenix for the disassembly of machine-assembled mines. The only power tools were a large commercial band saw and a cordless drill.
Mines, recovered by the LRC during clearance operations were retained in open sandbag bunkers within the minefield fences and therefore well away from public access. Their continued exposure to the weather meant that mines were not subjected to artificially dry conditions that might have altered their state. The M1, No. 6, and No. 4 mines had been dug up in sand and processed through the sifting system; they had therefore been subjected to significant disturbance, possibly including substantial pressure and vibration.

### Methodology

The workflow followed a standard Fenix process map for exploitation activity. For each mine type, this involved full disassembly and examination of critical components. In order to assess the capability of a mine to operate as designed, the three main areas of interest were:

- the integrity of the casing
- the functionality of the fuze mechanism
- the viability of the explosive compositions

It is well established that secondary high explosives such as TNT remain capable of detonation for many years; this is illustrated by the continuing viability of ammunition from World War I after more than a century. Since the main charge is almost always found intact, the key element in the explosive train is the detonator. No matter what the condition of the body, the fuze mechanism, or the main charge, a mine is incapable of functioning as designed unless the detonator is serviceable. The testing of detonators was therefore critical to the real-world evaluation of the risk posed by these mines during the final stages of clearance, and for the prediction of long-term residual risk in other regions.

A simple rig was improvised to allow a spring-loaded striker to be released from behind the cover of the shipping container, while the test was captured on video. The initiation mechanism was improvised from a recovered No. 4 mine fuze, with the components restored to full functionality and checked before each operation.

### Findings

Throughout the studies on the ageing of mines, the ingress of water has been established as the greatest single influence on the degradation of internal components. This in turn means that the integrity of the casing (its ability to remain waterproof) is important. The mines that were present in the Falkland Islands included significantly different designs and materials. Some of the plastic casings proved extremely robust, yet others had degraded badly. Some steel casings had thick external rust but still retained their integrity beneath, while a well-sealed fuze body effectively acts as a separate casing within a casing.

The vulnerability of internal components also varies substantially. Some fuzing mechanisms incorporate virtually impervious plastics and stainless steels, while others contain components made from rust-prone iron and mild steel. Explosive initiators also vary in design and vulnerability, some being seriously degraded by small amounts of salt water.

Previous phases of exploitation focused mainly on the plastic-cased mines encountered inland (SB-33, SB-81, P4B, and C3B), with findings suggesting that the entire population of mines in the Falkland Islands might be nearing the end of its operational life. However, the examination of four additional mine types (FMK-1, M1, No. 4, and No. 6) from coastal areas casts doubt on that conclusion, with all of these found to pose a continuing risk during the final stages of clearance. Additionally, unlike those seen previously, the SB-33 mines examined here showed no indication that they were nearing the ends of their operational lives.

A constant worry in old munitions is the interaction of primary explosives with some metals to form highly sensitive compounds. Fortunately, most mines of the types that were present in the Falkland Islands use aluminum or plastic detonator capsules, and there is no evidence that this is a problem.
The only consistent theme is the condition of the secondary explosive where, as expected, all of the main charges and boosters remained functional. In general, the risk from this bulk energetic material is only significant if an operational initiation train is also present. It’s not that this secondary explosive is safe, since it clearly retains the potential to cause accidents if mistreated, but detonation requires a level of energy input well beyond those involved in everyday events, such as bonfires or digging.

Quite often with aged ammunition, what you see is what you get; if it looks badly degraded then generally it is. But nothing better illustrates the need for exploitation, or the potential for counter-intuitive findings, than the Italian SB-81 and Argentinian M1 AT mines. Most of the SB-81 mines looked almost factory-fresh, while the M1 mines were heavily rusted and sometimes barely recognizable. However, the SB-81 striker springs were heavily corroded, and the detonators’ stab receptors were non-functional, rendering the mines incapable of operating as designed.

Meanwhile, underneath layers of rust, the M1 casings were largely intact, firmly encapsulating robust TNT charges. The M1 fuze has a heavy brass body, offering complete protection to the mechanical and energetic components within. Testing the detonator established beyond doubt that these mines were fully capable of functioning,
Image 10. Detonators from the SB-33 mines appeared virtually as-new, and were fully functional.

Image 12. The SB-81 striker springs had rusted away.

Image 11. Externally, most SB-81 mines appeared to be in excellent condition.

Image 13. The stab-receptors of the SB-81 detonators were no longer functional.

Key Conclusions on Residual Risk

The variety of designs and materials means that each mine component has its own level of vulnerability, combining to incline the entire mine towards resilience or susceptibility. The failure of one key component will usually prevent the mine from functioning as designed; however, the simultaneous failure of two key features adds a significant level of confidence, particularly if one failure relates to the fuzing mechanism, and the other is within the explosive train. This is the case for the SB-81 and C3B AT mines, which are the only two types that have washed ashore. Should this occur again, there is a high degree of confidence that these mines would not be operational.

The nature of the environmental influences is also important, accepting that the micro-climate in which mines are located may vary significantly, even if they are close together. For example, one mine may be partially buried in very wet ground, while another nearby may rest on the surface of well-drained soil but be exposed to sunlight.

The presence of sand and salt water added further ageing influences to those present inland, with sand having abrasive effects and blocking mechanisms, and salt water being more corrosive. This means that mines in coastal areas should deteriorate faster than similar types located inland, but this was not always found to be the case. P4B and SB-81 mines were definitely in worse condition than those recovered inland, yet the Italian SB-33 AP mines were better, possibly reflecting tighter insertion of the detonator plug to seal the mines.

Table 1 summarizes the findings and conclusions from the exploitation of mines recovered in and around coastal areas in the Falkland Islands as the clearance program neared conclusion. The findings might apply to these mine types in similar environments, if they were to be encountered in other regions.
Quite often with aged ammunition, what you see is what you get; if it looks badly degraded then generally it is.

<table>
<thead>
<tr>
<th>Designation</th>
<th>Technical findings</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>FMK-1</td>
<td>Resilient casing resulting in the fuze mechanism and explosive train being well preserved.</td>
<td>These mines could have remained functional for many years.</td>
</tr>
<tr>
<td>&quot;M1&quot;</td>
<td>Fuze mechanism and explosive train remain well preserved, despite heavily degraded external appearance.</td>
<td>Some mines were still fully functional.</td>
</tr>
<tr>
<td>SB-33</td>
<td>Mines in good condition, with fuze mechanism and explosive train (particularly detonators) very well preserved.</td>
<td>These mines could have remained functional for many years.</td>
</tr>
<tr>
<td>No. 4</td>
<td>Fuze mechanisms complete but seized. Explosive trains intact, with some detonators found to be functional.</td>
<td>Incapable of operating as designed. However, the presence of complete mechanical and explosive systems carried the risk of unintended initiation mechanisms.</td>
</tr>
<tr>
<td>No. 6</td>
<td>Fuze mechanisms complete but seized. Explosive trains intact, with the possibility that some detonators may remain functional.</td>
<td>Potentially capable of operation if subjected to substantial pressure or shock—could have been sensitized during extraction.</td>
</tr>
<tr>
<td>P4B</td>
<td>Loss of structural integrity, allowing ingress of water. Fuze mechanisms incomplete due to rusting of the striker spring. Detonators unlikely to function.</td>
<td>Two or more points of failure mean that these mines were unlikely to operate.</td>
</tr>
<tr>
<td>SB-81</td>
<td>Fuze mechanisms incomplete due to rusting of the striker spring. Detonators unlikely to function.</td>
<td>Two points of failure mean that these mines were unlikely to operate.</td>
</tr>
</tbody>
</table>

Table 1.

Recommendations

The results of the exploitation work were briefed to the demining team leaders and management, and a number of recommendations were made. In particular, it was recommended that the LRC consider the potential risk of initiation during the excavation or siting process with the M1 and No. 6 AT mines. They were also warned of the possibility of sensitization during these processes, which could substantially lower the operating threshold, and to therefore apply appropriate additional control measures. As a result of these findings, appropriate adjustments to operating procedures were implemented.

Following the end of the clearance program, it was also recommended that awareness messages and education on residual risks should include images of the mines as they now appear: aged, rather than as new.

Conclusion

Inevitably, mine populations will continue to degrade to the point where all eventually become safe. However, where previous studies indicated that this state might be achieved relatively soon, findings from this recent work suggest that some mine types can remain functional for many years, even in the harshest environments.

This conclusion, along with some of the surprising and counterintuitive technical findings, reinforces the need for exploitation work to provide a sound foundation for evidence-based decision-making. The global issue of residual risk from landmines is simply too important to be based on assumption or myth.

Biography

Colin King
Technical Director
Fenix Insight Ltd.

Colin King served as a bomb disposal officer in the British Army, with operational tours including the Falkland Islands, Persian Gulf, Bosnia and Herzegovina, and Kosovo. He instructed at the British EOD School and spent many years in military intelligence, also leading the first British team to train Afghan deminers before his final tour with the Gurkhas.

He is now the technical director of Fenix Insight Ltd, with tasks including the disassembly and analysis of live munitions in conflict zones throughout the world. King also writes the leading technical reference work on EOD for Janes Information Group.
Direct EORE session to repairmen in the marked area of the communal borehole in Komyshevuvakha, Luhansk region, Ukraine. Image courtesy of DRC-DDG / 2020 / Sychak.

LINKING MINE ACTION AND DEVELOPMENT: The Case of Komyshevuvakha

The protracted crisis in Ukraine raises many developmental, humanitarian, and mine action challenges, and while these are interconnected, the response to them continues to be dichotomous. In part perpetuated by donor preferences and reinforced by technical specialty, humanitarian mine action (HMA) organizations often run parallel to the rest, leaving much of the potential for integration untapped. At the onset of the conflict in 2014, Danish Refugee Council-Danish Demining Group (DRC-DDG) returned to Ukraine and became the first international nongovernmental organization (INGO) to initiate a response to the acute need for HMA in its eastern regions. Throughout, DRC-DDG has been leveraging its diverse expertise in humanitarian, development, and HMA programming. This article presents a case study from a project funded by the European Union on DRC-DDG’s latest iteration of linking HMA and development.

Integration Explained. Case studies are key to building collective knowledge but are futile if not positioned within the broader body of work. When compared to the rich tradition of the discourse on development,1 HMA is indeed more novel.2 But it is the integration between and within the two that is more recent, conceptually dating to the start of the millennium.3 HMA has since focused on activities that aim to “reduce the social, economic, and environmental impact” of explosive ordnance (EO).4 However, little has been done on classifying the linkages between HMA and development, or providing an overview of their entire spectrum. Many have fallen trap to the existing ambiguity, especially since integration has become something of a buzzword,5 making it difficult—albeit not impossible—for practitioners to learn from or contribute to the efforts of integrated HMA and development.

We can compare and contrast HMA-development integrations along the lines of dimension, level, degree, time, and type. The Geneva International Centre for Humanitarian Demining’s (GICHD) guidelines make the dimensional distinction: integrated mine action and linking mine action and development (LMAD).6 The former is dedicated solely to the integration between HMA pillars; the latter refers to integrating HMA with development per se. Moreover, several levels of LMAD are mentioned—communal, subnational, national, and international—with integration ideally present at all. In his article in The Journal of ERW and Mine Action, “Linking Mine Action and Development: Local-level Benefits and Challenges,” Russell Gasser also proposed five possible degrees of connectivity within LMAD: no relationship, leader-follower, coordination, support/promote, and integration.7 Yet another crucial clarification is offered by Ted Paterson
and Eric Filippino in their article, "The Road to Mine Action and Development: The Life-Cycle Perspective of Mine Action," where they describe that relationships between HMA and development change over time, gradually shifting from conflict and stabilization to reconstruction and traditional development. Lastly, authors have written on their country-specific experiences with LMAD, linking HMA either more broadly within Millennium and Sustainable Development Goals or with particular spheres of development, with economic being one of the oft-quoted examples. Where does this leave DRC-DDG's experience in Komyshevskhia?

Currently limited in the measurement of its actual efficacy, the case of Komyshevskhia primarily seeks to contribute to the collective implementational know-how of the HMA community. Following the previously mentioned classification, this case study is classified as both integrated HMA and LMAD. DRC-DDG routinely links all HMA-pillar activities in Ukraine. In this article, an integration of humanitarian demining (including non-technical survey [NTS] and marking) and explosive ordnance risk education (EORE) will be described. However, Komyshevskhia is also an example of LMAD, showing the link between integrated HMA on one side, as well as livelihoods, protection (i.e., infrastructural reconstruction), and legal assistance on the development side. Both took place at the community level during a time when the ongoing conflict in Ukraine is steadily transitioning toward stabilization. According to Gasser's degrees, this case study would, indeed, represent an integration due to the fact that the development impact took precedence over the mine action aspect. The present case study will provide insights into DRC-DDG's approach to LMAD and the lessons learned thus far—but not the final impact of the interventions. Given that most activities occurred between autumn 2020 and summer 2021 during the COVID-19 pandemic, DRC-DDG will only be able to unveil the measurable impact of the interventions pending the final project evaluation in autumn 2021. Having positioned the case study, an introduction to its theoretical and operational framework follows.

Due to the complexity of integrating several programs, tried and tested tools crucially support LMAD projects. DRC-DDG utilized the area-based development (ABD) approach, given its proven applicability in countries with similar backgrounds. Studies from Serbia, Montenegro, and Bosnia and Herzegovina illustrate the successes of the ABD in marginalized rural locations of post-conflict, post-socialist countries with development situations similar to Ukraine's. Alternatives such as the International Humanitarian Demining Development (IHDD) concept were deemed outdated and contextually unsuitable. Admittedly, the ABD is not without its limitations: it is most suited to emergency response rather than fully-fledged development; limited in promoting large-scale reforms, it favors decentralized governance; and financially constrained, it fits best to community development. The ABD thus targets "specific geographical areas in a country, characterized by a
particular complex development problem, through an integrated, inclusive, participatory, and flexible approach.

Demining and Development in Donbas. As categorized in the ABD, conflict (and the consequent EO contamination) continues to be a major developmental and humanitarian problem for eastern Ukraine. Entering its seventh year, the “forgotten crisis” in Ukraine is far from being over, as the armed conflict continues in the eastern regions of Luhansk and Donetsk. Consequent to the conflict between the Government of Ukraine and the so-called de facto authorities in 2014, massive EO contamination (from 100 to 7,000 sq km) is now assessed to exist, keeping Ukraine among the top five countries in the world per EO casualties in 2019. DRC-DDG’s internal database recorded 2,197 casualties (resulting from 1,206 incidents) from June 2014 to July 2021 in government-controlled areas (GCA) and non-government-controlled areas (NGCA). Major deterrence to understanding the full scope of the issue are the lack of systematic survey and inhibited access to the NGCA. The most prevalent types of encountered EO are the TM-62M, TM-62P, OZM-72s, and MON series mines—placed by both conventional and nuisance mine-laying—as well as tripwire-initiated hand grenades and unexploded ordnance (UXO). With safety and access concerns preventing humanitarian clearance operations in the 5-km buffer zone, the 427-km long contact line is especially EO-ridden. The costs of the conflict, however, worsened an already decaying economy.

The second ABD-listed developmental problem affecting Luhansk and Donetsk regions is poverty. The 2021 Humanitarian Needs Overview in Ukraine estimated 1.5 million people (particularly the elderly) need assistance related to poor living standards, high unemployment or loss of livelihoods, and food insecurity. Isolated settlements close to the contact line are especially affected given long distances to industrial centers, the lack of large businesses, and significant safety concerns related to the cultivation of land. Exacerbated by the COVID-19 pandemic and massive wildfires in 2020, economic insecurity persists as the most pressing issue. The Luhansk regional development strategy (2021–2027) also listed an inefficient economy as one of seven barriers to its development, recognizing that it currently represents one of the poorest regions in Ukraine. Of the two mentioned regions, DRC-DDG preferred Luhansk due to the location of its HMA operational base there and thus the practicality for day-to-day demining operations. DRC-DDG then analyzed the intersectionality of both conflict- and poverty-affectedness, and identified six target areas: Hirske, Muratove, Novotoshkivske, Triokhizbenka, Troitske, and Komyshuvakha.

The Case of Komyshuvakha. Despite many unique traits, Komyshuvakha is typical for the conflict-affected Popasna district, Luhansk region, and thereby much of Donbas, Ukraine. This urban village is home to a 3,200-strong community of various national, socioeconomic, and age groups. Many citizens have lived here all their lives, while others settled upon displacement (two percent). As the administrative center to six dispersed settlements—Druzhba, Nyrkove, Oleksandropillia, Pryvillia, Viktorivka, and Vyskryva—Komyshuvakha serves as a place of congregation for commerce, schooling, celebration, and the like. Seventeen shops, two schools and kindergartens, as well as

Figure 1. LMAD project in Komyshuvakha, Ukraine, 2020–2021. Image courtesy of DRC-DDG / 2021 / Holodniak and Shapovalov.
post offices, a pharmacy, a clinic, and a cemetery provide some of the essential services to the residents. Agricultural fields are used as the primary source of sustenance, supplemented by foraging in the surrounding forests. The linear pattern of the village follows the railway tracks and central road, connecting Komyshuvakha to the city of Popasna and onward to the NGCA. However, Komyshuvakha faces many challenges, and DRC-DDG employed the first instance of the LMAD to assess these comprehensively.

Integrating needs assessments between (and within) HMA and developmental programs has increased efficiency and inclusivity, and has improved the capacities of staff. Within the scope of this project, DRC-DDG had four specialized fact-finding teams available—NTS, EORE, livelihoods, and protection—whose assessments were correlated. For example, protection and livelihoods asked beneficiaries carefully-selected, HMA-related questions and, upon learning of potential contamination, conveyed information to the NTS team. Similarly, NTS and EORE teams were able to seek and share information on livelihood and protection-related topics. Having four integrated teams on the ground expanded the outreach, especially in terms of accessing a larger pool of people from different socioeconomic statuses. Lastly, given that each team held specialized knowledge, terminology, and methodologies, short trainings and frequent coordination meetings were initiated for cross-training. This reinforced EO awareness among the livelihoods and protection teams and further mainstreamed protection principles among HMA teams. As per the ABD approach, DRC-DDG was able to holistically discern the most pressing needs in Komyshuvakha:

- Four confirmed hazardous areas (CHAs) of 508,703 sq m of contamination were identified (see Figure 1): two designated as minefields and two as former battle areas. They were all agricultural areas bordering on two entry-exit roads with key communal and infrastructural objects (borehole, cemetery, railroad tracks, and forest belts).
- Agriculture and animal husbandry were found to be key entry points for economic reinvigoration (with most beneficiaries seeking either micro-business or value-chain livelihood grants for milking or fodder machines, mini-cultivators, barns, hay cutters, seeders, corn grinders, press piker, harvesters, cattle, and the like).
- Fourteen renovations of social infrastructure were proposed by active citizen groups around three recurring themes: improving access to water, renovating roads, and equipping spaces for youth.

No matter how comprehensive LMAD projects are, they will inevitably require concessions, compromises, and cooperation. For six priority communities, DRC-DDG had three demining teams (with NTS capacities) as well as EORE, livelihoods, and protection teams at its disposal; discounting middle management and support staff, thirty people were directly engaged. Moreover, it had approximately EUR 260,000 available for its livelihood and community-based initiative (CBI) grants. Aware of its limitations, DRC-DDG reached out to a number of international organizations as well as to local, district, and regional authorities to find external support. For Komyshuvakha alone, regional authorities decided to renovate the central road. One of the polygons (SES-MF-0067a) was delegated to the State Emergency Services of Ukraine under a different DRC-DDG project. Then, DRC-DDG designed the results chain (see Figure 2) in line with the available project inputs:

- Three (and later four) demining teams were deployed using a combination of NTS, technical survey, manual mine clearance, and battle area clearance.

Figure 2. Results chain of DRC-DDG LMAD project in Komyshuvakha, Ukraine. Image courtesy of DRC-DDG / 2020 / Vovk.
• One EORE team conducted a variety of door-to-door and school- and community-based EORE direct sessions (including the distribution of informational leaflets). It also set up three custom-made community EORE informational boards.

• Two CBI's (repairing a borehole and establishing a youth center) were initiated, totaling nearly EUR 35,000. The village council in Komshuvaka co-invested an additional EUR 2,500.

• Twenty-six micro-business and value-chain grants were also distributed by DRC-DDG.

A results chain also served as the basis for a diversified, contextualized, longitudinal, and summative monitoring and evaluation (M&E) system. Measurable links between HMA and development have historically been missing. Dr. Lewis Rasmussen calls for new demonstrable impact analytics as to how HMA serves development goals (and arguably vice versa), a claim that has gained increasing focus among the international community. But to anyone pursuing LMAD projects, this still represents a pioneering exercise. DRC-DDG developed a two-fold M&E system that measures (1) the impacts of individual activities (e.g., EORE continues being measured with pre- and post-tests) and (2) links between HMA and livelihoods and protection (i.e., diversified). The M&E of (1) followed established standard operating procedures but also represented an important fail-safe mechanism for the second, innovative one. Testing new M&E approaches is perilous, as all organizations remain accountable to both donors and beneficiaries, neither of which can afford failure. Alternatively, the M&E of (2) cannot be a one-fit-for-all system, and each community ought to have unique, responsive results chains and corresponding M&E (i.e., contextualized). Moreover, anyone measuring effects on development must appreciate its steady pace. More equipment and access to land and water might be all an individual needs, but the impact on communal prosperity will take a few harvests to materialize. This means that LMAD projects ought to allow for longitudinal M&E. Finally, a successful LMAD for DRC-DDG will achieve a context-specific development goal to which HMA as well as livelihoods and protection activities contribute. In Komshuvaka, only substantiated beneficial changes to income, access to social infrastructure, and physical safety will achieve an LMAD. Said differently, the whole integration equals the sum of its HMA and development parts (i.e., summative). This brings us to the final ABD step: management and implementation.

LMAD projects will benefit from a centralized management arrangement and flexible implementation. Because LMAD usually contains several specialized programs managed by different people, the tendency to split responsibilities between them rarely fosters the required cooperation and patience for integration. It is not uncommon for different managers to try and assert sometimes contradictory timelines and activities for fear of underachieving their specific program targets. For DRC-DDG, it thus worked better for a coordinator to hold the sole responsibility over the LMAD project while receiving technical guidance from the operations, protection, and livelihoods managers. To further minimize the risks of detrimental clashes, projects should seek the most flexible activities to integrate with HMA. Individual financial grants are one example of flexibility, meeting almost any justifiable livelihood need. CBIs are another instance given that the community can identify and prioritize any and all pressing social necessities. While DRC-DDG worked across Komshuvaka (and its adjacent settlements), one example stands out.

From Mines to Milk. The intersection of the needs for livelihoods support, access to water, legal assistance, and clearance of EO
contamination exemplifies that multifaceted crises call for multifaceted solutions. As mentioned earlier, the priority entry point for improving the economic wellbeing of the people in Komshuvakhka were agriculture and animal husbandry. Yet, the farmers and other residents faced major issues with access to water: they only had it available for fifteen minutes, four times a day. In such circumstances, financial co-investments alone would not have sufficed for the revitalization of livelihoods, as both animals and field crops require reliable access to water to flourish. The lack of water was a consequence of a key communal borehole (supplying drinking water to some 600 households) being broken, having reduced hydraulic discharge due to silting, and its location situated between two EO-contaminated fields. In fear of the latter, the community was unable to carry out the necessary repairs. To make matters worse, the ownership of the land around the borehole was further complicated by the conflict. The land originally belonged to a private railway company that became separated from the GCA once the contact line with the NGCA was established. For years, this impasse seemed insurmountable. Amidst the COVID-19 pandemic in 2020, DRC-DDG took on the challenge.

LMAD projects do not exclude the concurrent integration of HMA pillars; in fact, they additionally benefit from them. Before any work on the borehole could start, DRC-DDG had to first ensure that the area was safe from EO contamination. NTS was conducted, and markings delineated the safe zone. EORE direct sessions were then provided to the repairmen, increasing their knowledge of safe behavior. Subsequently, DRC-DDG demining teams marked the rest of the polygons with mine signs, followed by door-to-door and community- and school-based EORE direct sessions across Komshuvakhka and connected settlements. However, DRC-DDG noticed that the mine signs were repeatedly stolen overnight. This is not rare in poverty-stricken communities where mine signs can be sold for scrap metal in exchange for additional income. Daily briefings between HMA teams raised the issue, and the demining and EORE teams decided to complement the mine signs with community EORE informational boards. Several participatory sessions were organized with the residents to stimulate the ownership. The boards were produced from durable plastic to avoid further looting and placed at strategic points across the community (at the polygons, school, and village council).

HMA organizations should not forget that development activities also require special care and expertise. Three (and later four) demining teams continued with clearance on the outside of the safe zone, leaving the space for livelihoods, protection, and legal assistance teams to proceed. DRC-DDG CBI methodology was uniquely designed to facilitate participatory, inclusive, and integrated developmental processes. It began with joint consultations between the Komshuvakhka village council, local nongovernmental organization (NGO) Komroz, as well as vested farmers and other residents, whom the legal assistance team supported in resolving the housing, land, and property (HLP) rights issue around the borehole. Furthermore, the protection team conducted specialized trainings on budgeting, management, implementation, reporting, monitoring, etc. for the local NGO, which took on the responsibility for the CBI. Ownership of developmental processes often secures their sustainability and builds local capacities. The village council co-invested in the borehole repairs, the residents provided in-kind work contributions, and the NGO utilized DRC-DDG’s grant to contract and oversee a specialized company for repairs of the
borehole. Simultaneously, the livelihoods team connected the farmers with this process and its stakeholders, providing grants to those able to capitalize from the improved access to water either by strengthening local value chains, expanding and offering additional employment, or replenishing their diminished livelihood capacities.

Conclusion. The case study of Komyshevakhya highlighted a number of lessons learned on implementing projects linking HMA and development. However, a gap in the initial literature/desk reviews prevented further knowledge-creation within the HMA community. A potential classification for LMAD case studies was proposed, encouraging future authors to clarify the dimensions, levels, degrees, types, and timing of their LMAD initiatives. The ABD approach was then introduced as one example of a guiding (theoretical and practical) tool. Through the case study of Komyshevakhya, the following LMAD lessons were elaborated:

- Theoretical guidance supports LMAD projects with a tried and tested vision.
- No matter how comprehensive LMAD projects are, they will require external support (either financial or in expertise).
- Integrated needs assessments are more efficient, inclusive, and improve staff capacities.
- LMAD M&E systems should be diversified, contextualized, longitudinal, and summative.
- LMAD benefit from a centralized management arrangement and flexible implementation.
- LMAD stand to gain from concurrent integration of HMA pillars.
- HMA and development activities require special care and expertise.

Disclaimer. This document covers the issues of humanitarian assistance activities, which are carried out with the financial support of the European Union. The views expressed in this document shall in no way be construed as the official position of the European Union. The European Commission is not responsible for any use of the information it contains.

See endnotes page 146
DEVELOPING NATIONAL LANDMINE CLEARANCE CAPACITY IN Ukraine

By Tobias Hewitt and Ronan Shenhav [ The HALO Trust ]

The mine action sector in Ukraine has seen significant growth and progression since the outbreak of hostilities along the eastern border in 2014. Continued development of government capacity is required to respond to the scale of landmine and explosive remnants of war (ERW) contamination. The HALO Trust (HALO) has supported the Ukrainian authorities to address mine contamination since 2015, through survey and large-scale mine clearance, as well as by assisting state entities such as the State Emergency Services (SES) to strengthen humanitarian mine clearance practices and procedures. HALO’s ongoing capacity-development efforts aim to enhance existing resources in order to establish a multifaceted, sustainable, and independent mine action sector capable of dealing with current and future challenges. This article explores the obstacles and opportunities in national capacity building in Ukraine, lessons from HALO’s ongoing demining training, and key priorities for Ukraine to deal with operational challenges of mine clearance.

Since the outbreak of the conflict in 2014, eastern Ukraine has become severely contaminated with landmines and ERW, with the fifth highest annual mine/ERW casualty rate in the world.1 Ukrainian authorities have responded with a range of efforts, building on previous experience in clearing ERW from World Wars I and II. However, humanitarian demining is relatively new in Ukraine, where national coordination efforts, clearance operations, and legislation are still being developed.

The HALO Trust (HALO) started operations in eastern Ukraine in 2015. The organization has grown into the largest humanitarian mine action (HMA) operator in Ukraine, employing 450 Ukrainian staff (350 men and 100 women). Although more surveying is needed to reveal the true scale of the contamination, non-technical survey (NTS) has so far identified over 300 hazardous areas (234 confirmed, 75 suspected hazardous areas) covering a surface area of twenty-six million sq m with a variety of explosive threats, including anti-personnel mines, antivehicle mines, other unexploded ordnance (UXO), and abandoned ordnance (AXO). To date, HALO’s deminers have cleared over 7.5 million sq m of previously contaminated land across Donetsk and Luhansk regions, and work is ongoing.

HALO supports the efforts of Ukrainian authorities to assume national ownership of mine action in line with the International Mine Action Standards (IMAS). Ongoing capacity-development efforts have focused on all aspects of the HMA process, including accreditation, survey, data management, clearance, explosive ordnance disposal (EOD), explosive ordnance risk education (EORE), and quality control (QC). In addition to providing technical support to strengthen national coordinating bodies, HALO provides training courses to the authorities, building on HALO’s globally tried and tested training model. Since early 2020, this has focused on support and the long-term mentorship of the SES, which is the Ukrainian government’s main HMA entity.

Recent legislative developments have outlined an upcoming restructuring of the Ukrainian mine action sector. The Law ‘On Mine Action in Ukraine’ was adopted in December 2018 and came into force in January 2019. A subsequent amendment was passed in December 2020, which enabled the establishment of a national mine action authority (NMAA) and two national mine action centers (NMAC). These institutions are expected to become operational and take over responsibility of coordinating the response of national and international operators by the end of 2021. Since they will draw from the existing capacity present within the sector, it is crucial that current actors follow IMAS to ensure their continued success and sustainability.

This article outlines HALO’s ongoing efforts to strengthen national mine action capacity in Ukraine, building on three decades of global expertise. Highlighting lessons learned from HALO’s training and mentorship, the article explores challenges and opportunities in mine clearance capacity building, priorities to overcome obstacles in the field, and recommendations for future capacity-building efforts to enable Ukraine to rid itself of its explosive legacy of war.
The Ukrainian Mine Action Sector

The Legacy of the Second World War. At the time of publication (summer 2021), a functioning NMAA still needs to be established in Ukraine. However, Ukraine has a functional mine action sector with decades of experience in dealing with mines and ERW left behind by World Wars I and II. Between 1945 and 2000, an estimated three million items of ERW were removed from Ukrainian soil with military engineers finishing clearance of most of the affected areas by the mid-1970s. Although the extent of the remaining residue is unknown, by the year 2000 the Ukrainian authorities estimated that approximately one million items of ERW remained, mostly spread across unpopulated areas in central and southern Ukraine.8
A strong mine action response by the Ukrainian Armed Forces under the Ministry of Defence (MOD) and by the SES has emerged as a result of this deadly legacy. The National Police, Special Transport Service, and Border Guard Service also have EOD units to respond to explosive threats in their areas of operation in a more limited capacity. In 2001, the MOD set up a demining center aimed at training deminers at the Military Engineering Institute in Kamianets-Podilskyi in western Ukraine. The Demining Center has since become the main authority on national coordination and data-collection efforts to map explosive hazards. Since 2008, the center has also been the inspection authority for state operators conducting mine clearance.

The SES has a wide array of responsibilities for the protection of civilians, including emergency response, search and rescue, firefighting, industrial safety, administration of the Chernobyl exclusion zone, as well as EOD response. While the MOD is not currently engaged in humanitarian demining and only focuses on military demining in areas of military presence, the SES covers EOD response in all other areas of the country where mines and ERW affect civilian lives or infrastructure.

Before the conflict began, the SES employed forty demining teams with a total of 490 personnel across the country. According to government data, the SES destroyed more than 220,000 items of ERW in 2012, including 2,143 aircraft bombs, and cleared 18.4 sq km of previously contaminated land. Between 2014 and 2020, the SES cleared a further 372.6 sq km and removed a total of 202,555 explosive items.

National Mine Action Authority. The Ukrainian government has made several efforts to coordinate and regulate the national mine action response, and has undertaken steps to set up an NMAA since 2006. However, this process was put on hold as the conflict created an unforeseen escalation in mine/ERW contamination between 2014 and 2015. A wider response was required to address a broad new set of challenges, including NTS of vast tracts of contaminated land along the length of a 467-km-long contact line, the provision of assistance to hundreds of civilian mine survivors, as well as the regulation and oversight of national and international clearance operators to ensure adherence to IMAS.

Several attempts were made to draft in the years following the conflict. The main purpose of this law was to operationalize the national mine action response system and significantly enhance mine victim assistance and regulation for mine action operators. However, the law did not come into effect until January 2019. A further amendment was subsequently required to overcome constitutional obstacles, which was signed in December 2020. The latest amendment outlines the establishment of an NMAA (under the chairmanship of the MOD) as a regulatory body that oversees two NMAs:

1. The Mine Action Center under the Ministry of Defence (overseen by the military Demining Center in Kamianets-Podilskyi)
2. The Humanitarian Demining Center under the Ministry of Interior (overseen by the SES)

This development is a big step forward for the mine action sector and will further strengthen national efforts to regulate, coordinate, and prioritize survey and clearance operations. The NMAA will provide regulatory oversight for the two NMAs, who will be responsible for the accreditation of mine action operators, quality assurance (QA), and the adherence to international norms and standards. The two centers will be built on the basis of existing institutions and will draw from systems and knowledge already in place, which makes reinforcing the capacity of the SES and MOD of paramount importance.

National Mine Action Standards. The Ukrainian government has aimed to follow and implement IMAS ever since taking the first steps to regulate the mine action sector. As in other countries that are dealing with landmines, IMAS will need to be adapted to the local context and adjusted to the specific type of contamination through the development of national standards. With support of leading experts in the field of HMA—GICHD, UNDP, OSCE, DDG, FSD, and HALO—the Ukrainian MOD developed a provisional set of national mine action standards (NMAS) in late 2018. However, at the time of writing, NMAS have not been formally adopted. Once an NMAA is established, national authorities and national mine action operators will presumably adopt the NMAS and make them mandatory for all operators.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Explosive items destroyed</strong></td>
<td>3,000 to 4,000/year</td>
<td>64,272</td>
<td>220,000</td>
<td>100,000</td>
</tr>
<tr>
<td><strong>Area cleared</strong></td>
<td>N/A</td>
<td>7.8 sq km</td>
<td>18.4 sq km</td>
<td>5.94 sq km</td>
</tr>
</tbody>
</table>

Table 1. Explosive items destroyed and area cleared by the SES (1992–2020)
Demining Center was formally certified to conduct accreditation and QC of nongovernmental HMA operators in 2018.

Another major milestone was achieved in June 2019, when HALO became the first international mine action operator to successfully undergo external QA/QC inspection of cleared land by the MOD. The MOD’s inspection process involved selective sampling of cleared areas in line with the process established in IMAS. This was followed by the first ever formal handover of cleared land by an international operator in Ukraine. As a result, nineteen sites with an area of 710,000 sq m were officially handed over to local authorities. This process is ongoing and has greatly enhanced mutual learning between national authorities and international mine action operators.

Non-Technical Survey and Information Management. As the core component of the government’s HMA capacity in Ukraine, the SES teams respond to explosive devices found by local residents and conduct EOD spot tasks across eastern Ukraine to remove and destroy them. However, in order to strengthen an approach that goes beyond an EOD-only response, IMAS prescribes a process of humanitarian demining that includes NTS, technical survey, clearance, and QC. The foundation of any efficient clearance operation is therefore primarily reliant on the survey report indicating the specific threats, hazardous area parameters, and any other relevant considerations before clearance work can begin.

HALO uses a methodical approach to data collection that emphasizes due diligence and triangulates information from multiple sources. This information creates the starting point for (a) planning and prioritizing clearance tasks, (b) selecting appropriate clearance techniques, and (c) determining the size of the hazardous area. Survey information can also help outline what the intended humanitarian impact of clearance will be for the surrounding community, furthering the prioritization of clearance work. This data should furthermore feed into a national Information Management System for Mine
Action (IMSMA), which needs to be regulated on a national level and overseen by the NMAA.

In order to support this process, in 2018 HALO held comprehensive courses on NTS and information management for twenty national IMSMA operators from across the country and two instructors from the SES training center. The training aimed to strengthen surveying capacity to ensure that SES teams are compatible with the IMSMA format and follow IMAS. As each operator oversees the data management system in their region, the objective was to improve understanding of how data is collected, processed, and utilized through survey on the ground. These trainings were continued into 2020, focusing on building the operational capacity of all aspects of the HMA process.

Deminer Training. The main focus of HALO’s support to the SES has been strengthening mine clearance knowledge and practices. In 2020, closely mirroring the in-house training plan provided to all HALO demining staff, HALO implemented a five-week capacity development training program for fifty SES personnel from across the country at the SES Mariupol training center in southern Donetsk. The training generated understanding of—as well as showcased HALO’s application of—systematic mine clearance in line with IMAS.

Although the majority of SES participants had extensive prior experience responding to EOD threats, the training focused on building knowledge and skills around the basic principles of systematic humanitarian demining. All instructors were seasoned, senior Ukrainian HALO operations staff who had started their HALO careers as deminers. The outbreak of the COVID-19 pandemic postponed the initial training schedule, but the training restarted in the second half of 2020, and was divided into three sessions to limit the number of participants attending at one time. Social distancing and enhanced hygiene measures were also put in place and strictly monitored by senior HALO staff.

HALO’s Training Model. The demining training for the SES largely followed HALO’s tried and tested model for new, locally-recruited deminers. In Ukraine, HALO employs 450 local staff (350 men and 100 women) from a wide variety of backgrounds, many of whom are from mine-affected settlements in eastern Ukraine. They are not required to have a background in demining or EOD.

HALO’s demining training consists of a one-week theory exercise, three-weeks of practical training, and a one-week examination process, which cover all areas of manual mine clearance (aside from ordnance disposal, which HALO only provides for more senior staff). The theoretical component focuses on explaining current clearance techniques, which include a significant emphasis on the terminology and background of minefield equipment, marking, and humanitarian mine-clearance methodologies. During these sessions, trainees learn how to recognize different mine types, how devices and their internal components function, and how to identify certain markings or distinct features. Theory also provides an opportunity for new recruits to have a better understanding of HALO’s philosophy—the concept of humanitarian demining and the wider principles of mine action. For the SES, this component provided the added value of focusing on IMAS, signifying the need for a change in approach to demining and adoption of systematic mine-clearance methods.

The practical phase of the training was conducted on a training ground free from live explosives but that mimicked the look and conditions of a real minefield. Trainees learn the standard operating procedures (SOPs) of mine clearance, from proper equipment handling to specific types of clearance techniques to how to respond to a minefield accident. Due to the wide variety of threat types found in Ukraine,
Trainees are taught multiple clearance techniques. Training also imitates minefield safety procedures including wearing personal protection equipment (PPE) and following a set working schedule. Unlike other HALO programs worldwide, deminer training in Ukraine places a large emphasis on tripwire clearance as this is one of the most common threat types found.

Like HALO’s internal deminer training, the SES training concluded with two modules: medical training and final examinations. While HALO conducts an additional paramedic training for selected candidates, and basic medical training is taught to all trainees and focuses on procedures for responding to a minefield accident, stabilizing a minefield casualty, and responding to minor non-demining injuries (e.g., heat stroke, snake bites, sprained ankle, etc.). Final examinations are a combination of written tests and appraisals of practical work conducted on the training ground. Senior staff examining the trainees evaluate how well a specific area is prepared, processed, and cleared of any metal signals or dummy items. The test also involves appropriate tool selection, PPE wearing, and SOP adherence (e.g., proper clearance depth for signal excavations). Written examinations cover all modules taught during the training, including explosive item recognition and hypothetical scenarios that test trainees’ responses and adherence to safety procedures.

Minefield Mentorship. A pivotal aspect of HALO’s ongoing capacity development is its commitment to SES teams following the completion of deminer training and to ensuring that SES teams receive on-site mentorship. This means a senior member of HALO’s SES team leaders and supervisors can continue to grow within their respective roles.

To build on and sustain knowledge gained in their training, SES deminers were subsequently deployed to conduct clearance on a live minefield near the village of Hnutove, outside Mariupol in southern Donetsk region in November and December 2020. This was done under close supervision and mentorship from HALO, who worked alongside the SES personnel. HALO surveyed the area in 2017, and teams confirmed a threat of anti-vehicle mines and suspected a threat of ERW. Due to the presence of minimum-metal anti-vehicle mines, specifically the TM-62P3 variant, clearance required the use of the MineLab F3 metal detector with a UXO head attachment. Although more time consuming, use of this detector ensures that even the smallest minimum-metal signatures are found and properly excavated. To ensure the SES Mariupol detachment had the necessary tools, HALO provided four vehicles, PPE, and metal detectors purchased under an EU grant.

The participants included twenty-two staff, who were grouped in four teams of four deminers and one team leader, with a supervisor overseeing all teams. An additional SES paramedic was present on stand-by. Over the course of twenty-two working days, the four teams cleared a total of 1,552 sq ms (an average of 70 sq ms per day) during which they found a total of twenty-one items of ERW, including fifteen projectiles (23 mm and 30 mm), four rifle-projected grenades (VOG-17 and VOG-25), and two rocket-propelled grenades (PG-7S). The results of the training can be found in Table 2.

### Capacity-Building Challenges and Opportunities

**Training Outcomes.** Although this was only the first of several planned practical deployments for the SES, some preliminary outcomes shed light on the impact of this exercise. The main lessons learned for the SES staff deployed were three-fold. Firstly, by experiencing HALO’s clearance methodology, participants improved their understanding of the difference between targeted and systematic humanitarian mine clearance. Secondly, an important outcome of the training was increased awareness of safety standards, specifically in HALO’s extensive safety procedures, casualty evacuation procedures, and methods to calculate and maintain appropriate safety distances between deminers. Thirdly, participants’ exposure to HALO’s clearance methods provided SES staff with examples of how to overcome obstacles and improve operational efficiency. One example is that clearance methods such as the linear method require an additional level of teamwork with a three-person team working on rotation to improve efficiency. Participants were also taught about HALO’s methods to overcome harsh weather conditions such as using a salt-water solution to defrost frozen soil in the winter. Moreover, training covered aspects specifically aimed at supervisors and team leaders, such as ways to accurately track clearance progress on a map. This also shed light on efforts to reassess NTS data before clearance, establish the correct boundaries, and mark minefields appropriately. These aspects of the training focused not only on ensuring that all activities were conducted in line with best practice and IMAS, but also developed the necessary critical thinking to deal with obstacles and find creative solutions to problems that arise in the field.

<table>
<thead>
<tr>
<th>Activity Type</th>
<th>Week 1</th>
<th>Week 2</th>
<th>Week 3</th>
<th>Week 4</th>
<th>Week 5</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area cleared with linear method (m²)</td>
<td>22</td>
<td>408</td>
<td>476</td>
<td>456</td>
<td>190</td>
<td>1,552</td>
</tr>
<tr>
<td>Vegetation cutting with strimmer (m²)</td>
<td>200</td>
<td>100</td>
<td>10</td>
<td>370</td>
<td>180</td>
<td>860</td>
</tr>
<tr>
<td>Explosive devices found (#)</td>
<td>0</td>
<td>5</td>
<td>6</td>
<td>5</td>
<td>5</td>
<td>21</td>
</tr>
</tbody>
</table>

Table 2. Explosive items found and area cleared by the SES on Hnutove minefield (November–December 2020).
Reactive Versus Systematic Clearance. HALO expects the teams that were trained and mentored to further disseminate knowledge of humanitarian demining in Ukraine as they move back to their respective areas of operations. However, a fundamental shift in clearance approaches is often the hardest obstacle for mine action capacity development. One of the main challenges remaining for the SES is to fully grasp the difference between targeted and systematic humanitarian mine clearance, where the priority is to ensure the welfare of deminers through the strict adherence to safety standards and SOPs while simultaneously ensuring that 100% of a given area is made free from mines and ERW. In this regard, systematic clearance differs greatly from the more targeted reactive approach that is the default method used by the SES across Ukraine as part of their EOD response. A reactionary approach to clearing individual items is not enough to ensure that the land is safe for civilians to return to their homes and everyday routines. A systematic and thorough approach, carried out with a precise methodology and with several layers of QC, is required to be certain that no explosive hazards remain. Additional exposure to other aspects of the HMA process—including NTS, GIS and quality management—will support the paradigm shift towards systematic clearance in the future.

Looking Ahead

Sustainability. An inherent concern with any form of capacity building is a loss of knowledge due to staff rotation, and when trained people take knowledge and skills with them upon leaving. HALO’s next step is therefore to train up SES instructors who will be able to conduct their own deminer training for new SES personnel. Under an upcoming multi-year capacity-development project funded by the government of the Netherlands, HALO will provide long-term mentorship and guidance to these instructors. This will enable sustainable oversight to ensure that new deminers are taught to the highest standards when they join the SES or the new NMAC. The instructors will also hold annual refresher training for people who have already undergone training.

Beyond the plans outlined previously, in order to deal with the scale and nature of the mine contamination in Ukraine, future national mine clearance training will need to focus on a set of approaches that address all operational challenges in the country. SES demining teams will benefit from more exposure to different types of hazardous areas, which require a wide range of clearance methods, including battlefield area clearance, mechanical clearance, as well as more traditional methods to clear minimum-metal anti-vehicle mines and devices laid with tripwires.

For future training, HALO will continue to develop knowledge of these methods in future training courses and will constantly re-evaluate its techniques, equipment, and practices in order to ensure maximum operational efficiency. To date, HALO has introduced the use of remote-controlled vegetation cutters to speed up tripwire clearance, hand-held detectors with ground-penetrating radar in combination with a “rapid excavation” technique to increase clearance rates for minimum-metal anti-vehicle mines, and innovations in NTS and information management. As clearance is always subject to change, deminer training for the SES should therefore not be considered a one-off exercise. New techniques can be taught as they evolve or when new equipment can be purchased in a cost-effective, sustainable manner. There will never be a silver bullet for mine clearance, but innovation and refinement of current methodologies will play a key role in ongoing development.

<table>
<thead>
<tr>
<th>Training Course</th>
<th>Participants</th>
<th>Date</th>
<th>Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Technical Survey</td>
<td>12</td>
<td>Feb 2020</td>
<td>6</td>
</tr>
<tr>
<td>Medical/First Aid</td>
<td>10</td>
<td>Feb 2020</td>
<td>10</td>
</tr>
<tr>
<td>GIS/Information Management</td>
<td>5</td>
<td>Mar 2020</td>
<td>5</td>
</tr>
<tr>
<td>Explosive Ordnance Disposal</td>
<td>10</td>
<td>Mar 2020</td>
<td>12</td>
</tr>
<tr>
<td>Demining (Group 1)</td>
<td>18</td>
<td>Jul-Aug 2020</td>
<td>34</td>
</tr>
<tr>
<td>Demining (Group 2)</td>
<td>22</td>
<td>Aug-Sep 2020</td>
<td>34</td>
</tr>
<tr>
<td>Demining (Group 3)</td>
<td>10</td>
<td>Oct-Nov 2020</td>
<td>34</td>
</tr>
<tr>
<td>Minefield Deployment (Group 1)</td>
<td>22</td>
<td>Nov-Dec 2020</td>
<td>22</td>
</tr>
<tr>
<td>Minefield Deployment (Group 2)</td>
<td>22</td>
<td>March 2021</td>
<td>30+</td>
</tr>
<tr>
<td>Quality Management</td>
<td>2</td>
<td>Spring 2021</td>
<td>3</td>
</tr>
<tr>
<td>EORE Instructor Training</td>
<td>15</td>
<td>Spring 2021</td>
<td>5</td>
</tr>
<tr>
<td>Demining Instructor Training</td>
<td>50</td>
<td>2021-2024</td>
<td>TBD</td>
</tr>
<tr>
<td>NTS Refresher Training</td>
<td>10</td>
<td>2021-2022</td>
<td>TBD</td>
</tr>
</tbody>
</table>

Table 3. Training courses for the SES completed and planned by HALO.
Lastly, capacity development efforts will need to be coordinated with other actors engaged in this activity. The syllabus provided to the SES will only be effective if all organizations have a common approach, standards, and principles. HALO continues to engage with other experts in the HMA field in Ukraine to ensure that a standardized training package is provided. This will not only allow for easier adjustment to HMA principles but also for a smoother shift toward the use of systematic mine clearance, safety standards, and operational efficiency.

In the long-term, increased experience with conducting humanitarian clearance that goes beyond reactive, targeted EOD spot tasks will lead to an increased national capacity that is capable of independently addressing challenges and obstacles in Ukraine. This will enable Ukraine to adapt existing procedures to IMAS as well as local specificities. Future training should not simply focus on implementing a set of rules that need to be strictly followed but on teaching the adaptability needed to apply these rules and find solutions to overcome future obstacles.

**Future Training Objectives.** HALO will continue to offer ongoing mentoring to SES deminers, as a new rotation of twenty-two SES personnel are scheduled to continue clearance in Hnutove in the fall of 2021. They will undergo similar exposure to HALO’s clearance methodologies as the previous group, and HALO will continue to oversee their work to ensure understanding and adherence to all standards and procedures. In addition to demining training, HALO plans to hold a number of additional training sessions for SES staff on quality management, EORE, and NTS.

The recently adopted legislation mandates a quality-management capacity for both NMAGs. The new NMAG overseen by the SES (the Humanitarian Demining Center) will become responsible for accreditation, quality management, and operational coordination of HMA in the near future. HALO will therefore extend its support to the SES in this field through comprehensive quality-management training. Similarly, QA/QC training can be extended to cover using appropriate detector types, looking at site maps to determine exactly which methods were applied.

In the longer term, HALO aims to support the SES with the formation of an NTS team by providing a full training package covering all practical and theoretical aspects of survey to a small group of SES personnel with previous mine-clearance experience. The four-week course would focus on NTS procedures, mine and ammunition recognition, GIS, and data management. After the training is complete, HALO would then oversee the deployment and mentorship of the survey team. With HALO mentorship, several SES survey teams could lay the groundwork for future clearance activity. By creating and fostering a multifaceted, mine-clearance apparatus, the SES’s internal capacity would thereby become a self-sustaining entity to conduct systematic humanitarian mine clearance.

See endnotes page 147

---

**Biographies**

**Tobias Hewitt**
Location Manager
The HALO Trust
Tobias Hewitt is currently Location Manager for HALO Ukraine, responsible for overseeing mine-clearance operations in the southern Donets region. Hewitt has worked for HALO since 2016 with postings in Abkhazia, Cambodia, Karabakh, Nagorno, and Somalia. He has a bachelor’s degree in film from the University of California, Santa Cruz, and a master’s degree in international development from the University of Edinburgh.

**Ronan Shenkov**
Programme Officer
The HALO Trust
Ronan Shenkov has worked as Programme Officer for HALO Ukraine since 2019. He is responsible for overseeing monitoring, project development, donor reporting, and liaison. Before joining HALO, he worked in international development and as a researcher focusing on water management and energy security in Tajikistan. Shenkov studied modern history and international security at the University of Groningen.
Armed conflict has been ongoing in the east of Ukraine since 2014 and continues to have a fundamentally devastating impact on children, women, and men. With continuing hostilities and the COVID-19 pandemic exacerbating the dire humanitarian situation in the region, 3.4 million people are projected to be in need of humanitarian assistance in 2021. The elderly, persons with disabilities, female-headed households, and children are among the most vulnerable. Additionally, the large-scale population displacement from government and nongovernment controlled areas (GCA and NGCA respectively) of Donetsk and Luhansk Oblasts, separated by the 427-km-long contact line, remains one of the highest concerns.

Unexploded ordnance (UXO) and landmines present a particular threat to the civilian population in this type of “frozen conflict.” Many villages and towns on and near the contact line have not been evacuated as the occupants refuse to move or have no other place to relocate; and as a result, civilians carry on living and working near military installations. These civilians live alongside heavily fortified and mined checkpoints with daily artillery bombardments being commonplace. The population are exposed to mines and UXO as a part of daily life, and civilian casualties directly attributable to such hazards are growing. Mines and UXO also are denying citizens access to services such as water or, in the longer term, in the way in which they use the land: Many hectares of good farmland have been seeded with mines, impacting local livelihoods. Therefore, humanitarian mine action (HMA) remains one of the most important parts of the humanitarian response where, in certain areas, explosive ordnance risk education (EORE) is the only applicable HMA pillar for saving lives of civilians.

Over the years, the majority of HMA interventions have been completed in the GCA rather than in the NGCA. Access by international nongovernmental organizations (INGOs), particularly HMA, to the NGCA has been problematic since the conflict began. The provision of EORE has been a challenge, and very little of the at-risk population in the NGCA have received information about explosive hazards. The provision of EORE via the more traditional methods of direct presentation sessions to children and adults in their communities or in schools is generally not permitted. This is due to a perception by NGCA de facto authorities that EORE is a potential threat to security and may be used as propaganda by Ukraine. In 2020, FSD, with funding from the U.S. Department of State, began a project with the express objective of developing methods to target residents living in the NGCA. One approach is to access workers and members of the public who are required to cross the contact line to attend to administrative or work-related issues while they are in the GCA, and the second involves the use of social media applications to target the population that cannot travel to the GCA.

FSD The Swiss Foundation for Mine Action (FSD) is one of a small number of HMA INGOs operating in Ukraine. FSD began in late 2014 with mine risk education teams, then added community liaison and non-technical survey in 2015. Since 2016, FSD has conducted physical clearance projects and continued to expand its knowledge of the impact that explosive ordnance (EO) hazards have on the people living in the region.
EORE at Crossing Points

There are five entry/exit crossing points (EECPs) between the GCA and NGCA along the contact line in eastern Ukraine. Before the COVID-19 pandemic, between 1 and 1.25 million people used these EECPs each month, with the vast majority (over 90 percent) of the crossings originating in the NGCA. The majority of people crossing the EECPs are over the age of sixty and are mostly doing so to attend to issues related to pensions/social payments or to withdraw cash. This results in a consistent opportunity to engage a significant proportion of the NGCA population at the EECPs and at the various Ukraine government pension offices that are located close to the EECPs. Thus, FSD provides short, direct, and/or face-to-face EORE presentations and/or safety briefings at these locations, specifically targeting people visiting from the NGCA. Unfortunately, the COVID-19 pandemic has caused significant challenges to the implementation of this activity. On 21 March 2020, the contact line was sealed off to help curb the spread of the virus in the conflict-affected areas. Movement through the EECPs remains restricted and highly unstable due to the COVID-19 pandemic prevention measures adopted by the government of Ukraine and the NGCA de facto authorities. As of May 2021, these restrictions are still enforced, and of the five EECPs, only two are operational.

Thus, significant challenges revolve around the closure of the EECPs, and subsequent uncertainties surround the full reopening of the EECPs for normal use. Presently, very few people are permitted to cross through the two open EECPs into the GCA from the NGCA, and the crossing conditions for affected populations remain tense. In numerous cases, people were refused exit or were approved to exit but refused entry by the other “side.” In addition to COVID-19 restrictions, temporary closures and weather conditions also dramatically affected the number of crossings in 2020. The number of individual crossings from 21 March 2020 until the end of the year represented less than 3 percent of the level of crossings recorded in 2019 during the same period.

However, FSD EORE teams have been at the operational EECPs (Stanitsia, Luhanska, and Novotroitske) from May 2020 until the present and able to conduct safety briefings for NGCA residents. The briefings normally take up to ten minutes and are provided to people as they wait in line. The key modules of a traditional EORE session are discussed with the affected population, including safe and unsafe behavior, reporting mechanisms, mine/UXO recognition, etc. The EORE team uses informational folders and posters containing pictures that help trainers promote safe behavior and provide visual briefings. Various types of education materials are also distributed. As the distribution of EORE materials is heavily regulated, each type of product is designed in two languages (Russian and Ukrainian) to prevent any potential problems with authorities. While UNICEF approved FSD’s EORE materials for children, there is no functioning national authority at present to approve EORE materials for adults; however, all FSD EORE materials conform to IMAS standards. FSD teams use a variety of printed materials, including a pocket-sized brochure summarizing key EORE messages, a coloring page designed for children, and an A5-sized leaflet describing safe/unsafe behavior and reporting mechanisms. The leaflet also contains a QR code that allows access to the project-dedicated social media landing page, which provides more EORE-specific information to those who are interested.

Digital EORE

FSD’s second approach to reach NGCA residents involves the use of social media to target those who cannot travel to the GCA. Inspired by a trial conducted in 2020 of the use of targeted social media advertisements (i.e., Facebook [FB] ads) for delivery of EORE in Iraq, FSD is conducting a similar trial of the use of FB and Vkontakte (VK, the Russian version of FB) ads in eastern Ukraine, with an emphasis on reaching users living in the NGCA. The FSD conducted the trial over a six-month period in 2020 and decided to continue the trial project into 2021. As there was a significant lack of EORE available via the social media sphere, especially in the NGCA, the media campaign objectives were to increase awareness about the explosive ordnance (EO) threat and introduce the consequences of risk-taking behavior. Moreover, the campaign sought to build a strong communication tool through positive dialogue in a constructive educational atmosphere. Therefore, FSD designed an online platform with fun and non-traditional formats to discuss the EO threat. The trial was divided into two modules: The first module focused on Facebook over the first three months of the trial (June–August 2020), and the second focused on VK over three subsequent
A media content plan for the campaign consisted of various types of materials for at-risk communities. Comprising different types of material, each post covered one of several possible topics of the traditional EORE session: EO recognition, identifying potentially hazardous areas, official marking (red warning sign with the message “Danger Mines”), unofficial marking (crossed sticks or homemade signs), unsafe behavior, safe behavior toward EO, what to do in case of an emergency, or reporting. Some posts contained images, which matched the various types of vegetation and weather conditions normally found in the region, and encouraged beneficiaries to identify the explosive hazards they found.

Challenges during the interactive portion of the media campaign involved the use of specific terminology, and adherence to neutrality principles in posts and comments. Moreover, the Ukrainian government currently restricts in-country access to VK. On the national level,

Ukrainian-based internet service providers (ISPs) are not permitted to conduct any activities using VK. However, people in the NGCA can access VK through Russian infrastructure. Therefore, neither FSD nor Ukrainian public relations specialists had practical experience or skills in conducting a targeted media campaign in Ukraine utilizing VK as a platform. However, FSD was able to find a method to conduct the VK media campaign using an independent PR company. The posting target was twenty-one posts per month.

The first month of each module was used to develop brand awareness. Over this period (the active phase), the target audience would become acquainted with the BezMin page. During the second and third months, the audience, now aware of the brand, began to show more interest in the posts and were keen to interact with and subscribe to the page. The highest number of followers was reached during the second and the third months of each module.
As seen in Figure 1, 901 followers were attracted over the first three months of the FB module's active phase, while only 101 new followers joined the FB page over the following three months where the FB campaign was “dormant.” By comparison, the active phase of the VK campaign had less than half the total number of followers when compared to FB during the same phase of the trial. Whereas the active phases reflect when the PR company was actively posting material to both FB and VK, the dormant phases reflect when no new posts were made to FB or VK. Demonstrating trends for both FB and VK, Figure 1 indicates that the most cost-effective use of available funding and beneficiary coverage for any social media campaign involves maintaining a high tempo of activity for at least six months. In order to maintain growth and reach a greater number of beneficiaries, the duration of future media campaigns was increased to six months. When measured by physical interactions with the ads, the FB module seemed significantly more successful across both the GCA and NGCA; however, an analysis of users' locations indicated that for NGCA residents (the target audience for the trial), VK was more popular than FB. Moreover, the number of resident VK users in the NGCA is much higher than FB users, which led FSD to conclude VK was more popular in NGCA than FB.

Another distinct difference between VK and FB was usage age. VK permits children from the age of twelve to register, and children are its second largest demographic. Alternatively, FB requires users to be thirteen or older and is not as popular with children. Over the three months, the VK campaign reached 26,548 persons under the age of eighteen, compared to only 704 children reached in the FB campaign. The VK network has a larger number of groups from educational institutions compared to FB. One of the major achievements of the VK media campaign trial is the fact that BezMin posts were reposted by various accounts and/or groups managed by educational establishments. For example, FSD's posts about unsafe behavior were reposted by a student group from the Civil Protection Institute in Luhansk People's Republic, which had 179 followers. BezMin was seen as a trustworthy source of information, and the method of delivery appeared to be appropriate and understandable.

More than half of BezMin users on FB (55 percent) are female, while the majority of interactions (reposts, clicks, and comments) were made by males; the major age group was in the 35–44 range. On VK, 52 percent of active users of the BezMin page were males. The major age group is the same as in FB. The second largest age group were users under the age of eighteen. Geographically, 73 percent of VK beneficiaries were from the NGCA; 5 percent were based in the parts of Donetsk and Luhansk Oblasts in the GCA; and only 2 percent were located in other areas of Ukraine. The location of 18 percent (or 34,979) of beneficiaries was not identified by VK social media; the use of a virtual private network (VPN) to enter the VK social media is likely to be the reason for this.

Map of eastern Ukraine 2021: GCA, NGCA, contact line and EECPs.
**Beneficiaries.** Over the three active months of the FB module, the advertisements were shown 311,133 times; each unique individual saw the ad an average of 4.62 times during this period. The total number of unique beneficiaries was 67,301. Over the three active months of the VK module, the advertisements were shown 1,007,343 times to 192,399 unique beneficiaries; each unique individual saw the VK ad an average of 5.24 times (VK ads are considerably cheaper than FB). When comparing the number of unique beneficiaries, the VK campaign might seem more successful than the FB campaign; however, FB requires users to “click through” (i.e., interact) to see the ad, whereas VK displays the ad and does not require interaction. Table 1 provides a breakdown of actual interactions with the published materials, which is usually measured by number of clicks, reposts, comments, and likes.

During the social media campaign, there was a number of NGCA cities that had beneficiaries covered by FB and VK. However, residents of Amvrosievka, Kadyivka, Khartsyzsk, Kirovskoye, Lozove, Lutugino, Makeevka, Perevalsk, Pervomaysk, Rovenky, Snezne, Torez, and Veselaya Gora were covered by only one social media provider. Moreover, the FB campaign was able to reach internally displaced persons (IDPs) all over Ukraine. When these IDPs do return home to the NGCA, they will have an increased knowledge about safe behavior and how to protect themselves from explosive threats.

During the planning phase for the trial it was assumed that the target audience would use mobile devices rather than desktops or laptops. The campaign determined that the hardware (smartphone, tablet, etc.) used to access FB or VK has a significant influence on the overall success of the media campaign. To view published posts, 92 percent of VK followers and 88 percent of FB followers used mobile devices. Therefore, all informational material was designed for mobile devices and included high-resolution pictures, appropriate formatting, and selective keywords. For wider coverage of the target audience, the Russian language was used in both the campaigns and associated material for the NGCA audience. Some GCA followers criticize this approach; however, it was stressed that BezMin is a non-political educational platform, which aims to increase the awareness about explosive hazards. When there was a need to provide a link to a source of information, an international (not Russian/Ukrainian) source was used for this purpose. Quoting international sources prevents accusations of information being false or propaganda.

The feedback has been overwhelmingly positive. The posts were designed to encourage beneficiaries to engage in online discussions regarding explosive threats, to ask questions, and to share opinions. For this reason, FSD used its staff to monitor the interactions. Monitoring included follow-up responses to questions, giving professional feedback, sharing best practices of safe behavior, and amending the page content based on audience requests. FSD was able to ensure the posts were targeted to the specific needs and concerns of the affected population. For example, posts might ask, “Have you ever seen a minefield?” Beneficiaries could respond by sharing pictures or locations of the contaminated areas in their respective communities. The page became a platform for the discussion of EO-related information, potential hazardous areas, and unsafe behavior trends.

**Conclusion**

However, current EORE-sector thinking is that digital EORE campaigns seem to be most effective when complementing, not replacing, other EORE activities at an interpersonal or face-to-face level. In this way, digital EORE becomes a highly cost-effective force multiplier, increasing reach and coverage while reinforcing messages provided through non-digital means of delivery.

The BezMin landing page was a platform that was well accepted in both VK and FB modules, and the information presented is important and relevant to the residents of the conflict-affected areas (both the GCA and NGCA) of eastern Ukraine. The campaign also had the welcome benefit of reaching IDPs who relocated to other parts of Ukraine away from the conflict area.

<table>
<thead>
<tr>
<th>MODULE/EVENT</th>
<th>CLICKS</th>
<th>REPOSTS</th>
<th>LIKES</th>
<th>OTHER INTERACTIONS AND COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facebook (Jun–Aug 2020)</td>
<td>6,331</td>
<td>418</td>
<td>2,316</td>
<td>3,883</td>
</tr>
<tr>
<td>Vkontakte (Sept–Nov 2020)</td>
<td>3,918</td>
<td>32</td>
<td>715</td>
<td>99</td>
</tr>
</tbody>
</table>

Table 1. Social media interactions.
Moreover, the BezmIn posts are accessible at any time convenient to the beneficiary. Large numbers of people can be reached in a specific area, overcoming obstacles posed by security, geography, and complex operating environments that limit the delivery of face-to-face EORE. The flexibility of a social media campaign allows the EORE provider to target specific age, gender, or demographic groups depending on the project's priorities. However, it is less effective when the target audience is the elderly or young children under the age of twelve. Moreover, immediately after an incident or accident involving EO and civilians occurs, posts can be made as a form of “emergency” EORE.

This pilot project shows the potential of using social media for EORE in areas with a reasonable communications network. Digital tools are less effective in areas with poor internet connectivity or reduced mobile data coverage. Nevertheless, the ongoing success of a social media campaign relies on regular, new, and interesting content. A lack of new posts equates to a decrease of a beneficiary’s interest and leads to the decrease of EO-threat awareness. The social media campaign can have long-term benefits as long as it is maintained and operational.

In the NGCA at present, where physical access is very difficult or not possible at all, the FSD social media campaign (a trial) is one of very few alternatives for residents to access information about EO and to interact with an EORE professional. While the conflict is ongoing, continuation of the social media campaigns is crucial for raising awareness and promoting safe behavior in the conflict-affected communities in eastern Ukraine. As a result of additional funding from the U.S. Department of State, the social media campaign is continuing through 2021. 

See endnotes page 147
EXPLOSIVE ORDNANCE RISK EDUCATION IN Ukraine DURING THE COVID-19 PANDEMIC

All modern conflicts bring dangers of explosive remnants of war (ERW), including unexploded ordnance (UXO), abandoned explosive ordnance (AXO), improvised explosive devices (IEDs), and/or landmines, and the conflict in eastern Ukraine is no exception. While the conflict is still ongoing, it is currently in a state of relative stalemate, limited to shelling, sniper fire, and small skirmishes along the 280-mile line of contact. However, civilians are still directly at risk as a result of military actions but also indirectly as a result of ERW and landmines, which are scattered across the region due to the frequent shifting of the line of contact that occurred during the early stages of the conflict. Kicked-out munitions from unplanned explosions at ammunition stores also pose a threat to civilians across the country.

ERW contamination is now a major problem in the Donetsk and Luhansk regions of eastern Ukraine, and an estimated 3.4 million people are at risk of ERW and landmines, including over 490,000 children. While an increasing number of government agencies and nongovernmental organizations have been addressing the issue since the beginning of the crisis, recent risk education (RE) efforts have been hampered by the ongoing COVID-19 pandemic, which has heavily affected Ukraine. The HALO Trust (HALO) has been working in Ukraine since the end of 2015 and conducting RE sessions since 2016. With support from the United States, United Kingdom, European Union, the Netherlands, Finland, Switzerland, and the United Nations Children’s Fund (UNICEF), HALO has conducted over 6,600 RE sessions over the past five years at schools, kindergartens, places of worship, workplaces, community centers, and individual households to raise awareness of the dangers of ERW and landmines. During the pandemic, HALO successfully transitioned to a hybrid approach to explosive ordnance risk education (EORE), including continued in-person seminars, where permitted, and online educational sessions. HALO also successfully tested the viability of using virtual reality (VR) for this aspect of humanitarian mine action (HMA). This article explains the path HALO has taken to be able to continue to provide effective RE to civilians in eastern Ukraine despite the COVID-19 pandemic.

The Ukraine Context

HALO has identified 317 hazardous and contaminated sites, totaling over 28 sq km of contamination including mines, UXO, and IEDs in eastern Ukraine from the recent conflict. Non-technical survey is, however, still ongoing. As of 26 May 2021, HALO has recorded 2,449 casualties from mines and ERW in eastern Ukraine, of which 1,040 were civilians. The presence of mines and UXO not only presents a deadly threat to civilians but also restricts their freedom of movement and limits economic and educational opportunities by inhibiting access to cultivable land and educational institutions. While the majority of threats lie in Luhansk and Donetsk regions, the explosion of ammunition stores and warehouses in the neighboring Kharkiv, Zaporizhzhia, and Dnipropetrovsk regions have also contributed to the threat from UXO in Ukraine.

The COVID-19 pandemic has severely affected the populace of Ukraine and has impacted many areas of HALO’s efforts towards alleviating the second-order effects of the crisis on the civilian population. As of September 2021, Ukraine has recorded more than 2 million cases of COVID-19 with over 53,000 reported deaths.

At the time of writing, in Ukraine, masks are mandatory in communal indoor spaces, many educational institutes are on a remote learning basis, and the government has restricted gatherings to a maximum of fifty people provided there is sufficient space for social distancing measures. Different regions have imposed diverse sets of restrictions as well, further complicating responses to the pandemic and necessitating a more flexible approach to EORE.
Risk Education in Ukraine Before the Pandemic

HALO has been conducting RE sessions across eastern Ukraine since 2016. In 2018, HALO received its first grant solely for conducting RE in Ukraine from the United Kingdom's Conflict, Security, and Stability Fund (CSSF), allowing the program to continuously conduct RE activities on an ongoing basis. As of September 2021, HALO's EORE team consists of twelve instructors divided into four teams that devote their time entirely to RE efforts. Before 2018, HALO focused primarily on sessions at schools and community centers, but after the explosion of an ammunition warehouse in Ichnya, Chernihiv Oblast in 2018, HALO redirected its RE approach to target each household within a 30 km radius from the warehouse. As a result, HALO visited 2,436 households in 90 settlements, providing RE to a total of 11,146 individuals, reaching the maximum number of people possible within the contamination zone.

HALO has since adapted this response to regions in the immediate vicinity to the line of contact where the risk from ERW is greatest. The RE teams then attempt to cover the entire territory of the regions by working their way out from the line of contact in a westward direction covering as many settlements as possible.

Before the global COVID-19 outbreak, HALO's program in Ukraine implemented a more traditional approach to RE relying on face-to-face group sessions. These sessions, as with all of HALO's RE methods, were based on the United Nations Inter-Agency Coordination Group-endorsed International Mine Action Standards (IMAS) known as EORE. EORE plays a central role in long-term mine clearance and explosive ordnance disposal (EOD) projects and is one of the five pillars of HMA. One of the central elements of EORE is flexibility, which allows EORE programs to react and adapt quickly to changes in circumstances, increased conflict severity, and pandemics.

In practical terms, HALO's EORE efforts primarily consist of providing RE sessions to at-risk communities. The main locations of EORE seminars tend to be schools, but workplaces, community centers, religious organizations, and individual households can be targeted as well and have become increasingly important, allowing us to reach specific target groups within the population. However, the pandemic has restricted HALO's ability to travel and provide community, workplace, and household sessions. While currently mainly focused on children who might be unaware of the dangers of ERW, adults also benefit from RE sessions but are a more challenging demographic to reach due to their work schedules and frequent reluctance to attend sessions.

Map of HALO's RE efforts in eastern Ukraine.

All graphics courtesy of The HALO Trust.
HALO aims to reach all demographic groups in Ukraine, with slightly different strategies to providing the same information to children and adults. While the most at-risk group is adult men, accounting for 67 percent of all civilian accidents (in which the casualty is known), many incidents also occur when children come across an article of ordnance. In many of these cases, children tamper with the explosive object, which is the most frequent action leading to civilian mine and ERW casualties and accounts for 24 percent of all civilian casualties in general recorded by HALO in Ukraine. In order to maximize the effectiveness of the campaign, HALO’s approach includes teaching parents of children who have previously attended an RE session. This ensures that the adults receive the same safety training as their children. In addition, when conducting EORE, HALO limits class size to a maximum of thirty individuals.

HALO’s Approach to Risk Education During the Pandemic

Initial stages of the COVID-19 pandemic. During the initial months of the pandemic in 2020, HALO benefited from UNICEF support, which provided a large supply of RE materials (leaflets, school notebooks, comic books, stickers, coloring books, and posters). Access to these materials enabled HALO to continue providing RE information without personal contact. While no direct EORE sessions were given, HALO teams visited 310,000 households in the government-controlled areas (GCA) of Luhansk and Donetsk Oblasts, totaling 182 settlements, distributing materials to over 740,000 individuals via post boxes and posters in communal locations. HALO used this opportunity to also distribute information related to the pandemic and to reduce general exposure to COVID-19.

While the pandemic limited indoor in-person interactions, HALO made use of larger indoor and outdoor locations in school grounds, summer camps, and community centers to provide RE to both children and adults. While this allowed HALO to continue the provision of RE despite the pandemic, many school districts were understandably reluctant to allow in-person teaching despite the precautions taken. In the early autumn of 2020, HALO RE teams transitioned to a hybrid education model to protect both children and employees from COVID-19 exposure and the harsher winter temperatures, which created limitations for holding outdoor sessions in schools that found themselves under restrictive COVID regulations. HALO held online sessions when certain school districts were under restrictions while continuing to provide in-person sessions, where permitted.

Online education. While nothing can truly substitute in-person interaction, as of September 2021, HALO had conducted over 362 sessions reaching 8,203 individuals since the beginning of the pandemic.4

Besides reducing the risk of infection, this new approach has allowed EORE instructors to be more flexible, mobile, and to reach more students in more complicated situations, such as during the pandemic, as instructors can work throughout Ukraine without requiring additional funding for travel. While distance learning requires more thoughtful planning, a reduction in travel time equals an increase in RE sessions delivered. Additionally, monitoring is now easier due to the ability to record each session, answer any questions retroactively, and detect any issues that need to be addressed. HALO predominantly uses Zoom and Microsoft Teams if schools use those software applications themselves.

The challenges of online education are mostly related to technological hindrances, as many individuals and schools do not have the necessary equipment or a reliable internet connection. Teachers are often not familiar with distance learning techniques, lack the technical knowledge installation or funding but also uses Zoom and Microsoft Teams if schools use those software applications themselves.
related to online learning, such as multimedia projector set up or software installation, or have difficulty enforcing discipline and participation in class. In addition, due to the pandemic, many schools are reluctant to move classes around to access the multimedia equipment, which is sparse and often only in one or two rooms per school building.8

Despite the challenges, online education is a sufficient interim replacement for in-person RE sessions. By taking a proactive approach to the preparation, organization, and conducting of online sessions, HALO has seen positive results based on the children's interest, discipline, activity during online lessons, as well as feedback from teachers and parents.

Next Steps and Technology Adaptation for Wider Use

Ukraine, HALO acts as a technical advisor to UNICEF concerning the development and testing of EORE and the production of training materials. In spring 2021, UNICEF, with technical expertise from HALO, developed a virtual reality EORE software tool, and HALO began implementing it as a pilot scheme for the use of VR in the provision of RE. HALO's VR program uses real locations from eastern Ukraine paired with real-life examples of ERW in conjunction with voiceovers giving instructional safety messages to create simulations of minefields and UXO located in buildings and fields. These simulations were different for each age category, taking into account the participants' abilities to perceive and assimilate information according to their age.

VR simulations have proved useful in schools to increase engagement and attention in children to highlight a variety of situations in which individuals might find themselves threatened by ERW. While VR sessions are unable to replace the effectiveness of traditional in-person events, they provide an effective tool for knowledge consolidation after RE sessions. VR users are mentally, emotionally, and physically immersed in a situation, which stimulates their senses, allowing them to interact with the environment and preparing them for real-world conditions.9

As the pandemic continues, and its effects are likely to be felt for years to come, HALO's new mobile and hybrid approach to EORE in Ukraine has shown potential. Depending on suitability, this approach can be adapted for other RE projects and programs across the world both during and after the COVID-19 pandemic. See endnotes page 147

Hybrid risk education. Looking ahead to post-pandemic times, the lessons learned from providing RE to the people of Ukraine during the COVID-19 pandemic can provide opportunities for increased effectiveness of EORE projects globally.

Taking a hybrid approach utilizing both in-person and online RE sessions can involve students who are absent from in-person events due to illnesses, homeschooling, or remote locations, and can simultaneously engage their parents via online platforms. Intentionally targeting parents and their children simultaneously is a new approach to risk education, which can help consolidate knowledge in both age groups and may stimulate further discussion of the topic between adults and children.

New technologies. The use of newer technologies may also help to improve the effectiveness of EORE delivery in the near future. In
LANDMINE CLEARANCE AND SOCIOECONOMIC DEVELOPMENT: A Study in Colombia

Teams visit the landowner of the first minefield cleared by HALO in Nariño, El Morro, in the small town of Puerto Venus.

All images courtesy of The HALO Trust.

By Oliver Ford, Amasia Zargarian [The HALO Trust], and Eric Keefer [Office of Weapons Removal and Abatement, Bureau of Political-Military Affairs, U.S. Department of State]

The HALO Trust (HALO) arrived in Colombia in 2009 and, once accredited, began operations in 2013. HALO is currently the largest civilian humanitarian demining organization in the country, operating in twenty-five municipalities across eight departments. The United States has supported HALO from the outset in Colombia and remains the single biggest donor for demining in the country. In 2019, through U.S. Department of State support, HALO began an innovative study to investigate the causal link between landmine clearance and socioeconomic development in Colombia. The study focused on two municipalities in the south of Antioquia Department—Nariño and La Unión—both of which were declared landmine-free by HALO in 2016. The following article describes the methodology behind this project, challenges faced during implementation, and the ultimate results of the study. It also seeks to demonstrate, more broadly, why such studies are vital for understanding the medium- to long-term effects of landmine removal in communities previously affected by explosive remnants of war (ERW).

Context

Colombia has suffered over fifty years of internal conflict, principally between the Fuerzas Armadas Revolucionarias de Colombia—Ejército del Pueblo (FARC-EP) and the government of Colombia. A peace accord was ratified between the two sides in 2016. Improvised landmines first appeared in 1990 and were used by non-state armed groups to protect strategic locations, access routes, and guerrilla camps. Their widespread use left behind a deadly legacy of explosive contamination throughout the country. As of May 2021, over 12,000 landmine accidents have been recorded across Colombia, with more than a fifth of those occurring in Antioquia, affording it the unfortunate accolade of the department with the most accidents nationally. In Nariño and La Unión, there have been thirty-five recorded accidents caused by ERW, twenty-nine of which occurred in Nariño and six in La Unión.
In 2013, with US funding, HALO began its first humanitarian demining operations in Colombia in Nariño. Over the next three years, HALO cleared nearly 114,000 sq m of hazardous area—the equivalent of more than twenty-one football fields—and disposed of dozens of explosive devices. In La Unión, meanwhile, HALO conducted non-technical survey (NTS) across the municipality, but no explosive contamination or minefields were identified. The Colombian military had conducted demining operations in La Unión prior to HALO’s arrival, but it had not yet been certified as free of mines.

In October 2016, thanks to continued funding from the United States, both Nariño and La Unión were declared landmine-free by the government of Colombia, making them the first municipalities in Colombia to be formally handed over by a civilian organization, a historic milestone made possible by HALO’s work. This intervention set the conditions for local rural communities to live in a landmine-free environment, enabling socioeconomic development and the safe return of internally displaced persons (IDPs).

Project Goal and Key Areas of Investigation

In 2019, more than three years after the declaration of Nariño and La Unión as landmine-free, HALO secured US support to return to the municipalities to conduct the first in-depth post-clearance assessment of its kind in Colombia. HALO selected these municipalities for the study as they had been mine-free for longer than any other municipality handed over by a civilian organization. The three-year period of being landmine free meant that a sufficient amount of time had passed to be able to measure the effects of landmine clearance on various aspects of social and economic life. Although it was widely understood that the clearance of landmines brought benefits to communities previously affected by ERW, there was little concrete evidence to support the assumptions of the positive impacts of humanitarian mine clearance in Colombia. With this in mind, the Department of State and HALO sought to investigate the causal link between humanitarian mine clearance activities and socioeconomic development in the landmine-free municipalities of Nariño and La Unión, Antioquia.

The key areas investigated were:
1. **Productive land use** included cleared land and increased agricultural productivity.
2. **Economic benefit** increased property value and monthly income.
3. **Social benefit** increased connectivity within communities, return of IDPs, and reduced levels of fear.
4. **Municipal economic growth** increased principally through the collection of property tax.
5. **Implementation of development projects** included improvements in the standard of living through municipal and third-party investment in rural community projects.
6. **Employment** consisted of hiring local staff from the region.

The full investigation report is published on HALO’s website and is available for download here.³

Methodology

This project was implemented in collaboration with two prominent economists—Professors Raúl Castro-Rodríguez and Jorge Armando Rueda—from La Universidad de los Andes, Bogotá, one of Colombia’s leading universities. Professors Castro and Rueda provided a macro view of the economic impact of demining at a municipal level, as well as support in the design of household survey forms and in the analysis of the data collected by HALO.

HALO conducted the investigation over a fourteen-month period (extended somewhat due to the COVID-19 pandemic) in four phases: planning and training, data collection, data analysis, and final report preparation. As there was no pre-clearance survey conducted in Nariño and La Unión, and no previous studies of this kind conducted in Colombia, HALO reconstructed a baseline in order to create a starting point from which to measure the level of socioeconomic
development in the two municipalities. This was principally achieved through desk-based research as well as retrospective questioning during household surveys.

Through these household surveys, HALO gathered data from three main groups: direct beneficiaries of clearance, indirect beneficiaries of clearance, and a control group (residents of veredas, where no contamination was identified). Information was also gathered from key informants such as vereda presidents and members of the municipal governments. In total, HALO conducted 699 household surveys across the two municipalities.

**Investigation Results**

The key findings of this investigation provided concrete evidence for a causal link between humanitarian demining and socioeconomic development in Colombia. Furthermore, the investigation has produced a viable set of indicators that provide the humanitarian demining sector in Colombia with the appropriate tools to similarly measure impact across the country.

This former minefield (Figure 2) in El Bosque vereda was handed over to the local community in June 2016 and was the last minefield to be cleared in Nariño. The land has since been put to productive use by a local farmer who is growing coffee and avocados as well as grazing his animals.

Once all the data was collected, HALO and the supporting professors carried out in-depth analysis of the information gathered through survey and key informant interviews. As both the original demining activities and the more recent data collection were carried out by HALO, the participation of well-respected third-party moderators—in this case Professors Castro and Rueda—was important to ensure the impartiality and reliability of results.

**Productive land use.** Aside from the previously contaminated land that was cleared, there was a significant increase in overall agricultural productivity in surrounding areas as a result of the removal of explosive devices. The removal of the threat posed by landmines and other explosive ordnance has allowed landowners to use their land with confidence, resulting in higher levels of productivity. The amount of land in productive use today (for cultivation and grazing) has increased by an average of 66 percent in Nariño from when landmines first appeared. Thanks to clearance, there have been significant improvements in access routes through paved roads, improving social connectivity as well as access to services such as public transport, schools, and medical facilities.
Table 1. Sample questionnaire used by HALO staff.

<table>
<thead>
<tr>
<th>Direct Beneficiary Households</th>
<th>Indirect Beneficiary Households</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before Clearance</td>
</tr>
<tr>
<td>Q: How fearful was/is your household to live and work in your vereda?</td>
<td></td>
</tr>
<tr>
<td>Extremely fearful</td>
<td>69%</td>
</tr>
<tr>
<td>Fearful</td>
<td>26%</td>
</tr>
<tr>
<td>Somewhat fearful</td>
<td>3%</td>
</tr>
<tr>
<td>Not fearful at all</td>
<td>3%</td>
</tr>
<tr>
<td>Q: How fearful was/is your household to use your own land?</td>
<td></td>
</tr>
<tr>
<td>Extremely fearful</td>
<td>62%</td>
</tr>
<tr>
<td>Fearful</td>
<td>19%</td>
</tr>
<tr>
<td>Somewhat fearful</td>
<td>6%</td>
</tr>
<tr>
<td>Not fearful at all</td>
<td>13%</td>
</tr>
</tbody>
</table>

Property value. An unexpected finding of this investigation was the profound effect that the presence of landmines has had on property values in the municipality of Nariño. Where landmines were present, property values decreased by an average of 83 percent. Once clearance was completed and the municipality was declared landmine-free, a significant rise in property values followed at more than a 480 percent average increase. In La Unión, where no explosive contamination was identified, property prices increased yearly, and land is considerably more valuable there than in Nariño. As a result of the lack of growth in property value during the twenty years when landmines and other explosives were present in Nariño, property value is still significantly lower from what it would be had landmines never been laid in the municipality.

Social benefit. In almost all cases, the three target groups reported an improvement in social connectivity. To assess the changes in social connectivity, HALO implemented a line of questioning that reported beneficiaries’ attitudes toward certain activities before HALO’s arrival and after clearance activities. A few examples of the questions asked and results reported are captured in Table 1.

The overall results showed improvements in the capacity to share resources, the capacity to work together, and the sense of connectivity with the rest of the municipality. As shown in Table 1, levels of fear were also significantly reduced, and direct and indirect beneficiary households reported an improved sense of security in

Figure 1. Map of cleared land.
conducting day-to-day activities such as working and transiting through their vereda. The peace of mind provided through the clearance of landmines and the increase in psychological wellbeing are almost impossible to quantify, but they are an integral part of the service that demining organizations in Colombia can provide to communities affected by conflict.

According to the information gathered, 772 displaced families (646 families from Nariño and 126 families from La Unión) have returned since their displacement, a process that cannot legally happen until clearance is completed. This in itself is a noteworthy achievement that can be directly attributed to HALO’s work, as this would not have been possible without humanitarian demining.

**Implementation of development projects.** The presence or even suspicion of landmines acts as a roadblock to development projects, as these are unable to begin until a municipality is declared landmine-free. This was the case in La Unión, where the implementation of key development projects followed the mine-free declaration in 2016, enabled by land release through NTS of individual veredas and eventually the entire municipality. HALO identified fourteen projects aimed at improving the socioeconomic wellbeing of rural communities, implemented by local governmental and private organizations after 2016. For instance, projects providing septic tanks, home improvements, and safe, efficient stoves have boosted the quality of life for rural families. Furthermore, these communities received tools and training that will help diversify crop cultivations and generate income. The implementation of such projects is inherently sustainable, as it builds capacity within the community for individuals to provide for themselves into the future.

**Application of Results**

The findings of this investigation have highlighted a critical need for accelerated socioeconomic development in rural Colombia. As described previously, the current system requires an entire municipality to be declared landmine-free before the implementation of development projects, which hampers the rate of development for some of Colombia’s most vulnerable communities. In some cases, a vereda may be declared landmine-free but ineligible for any additional support for years to come until humanitarian demining activities are completed in the rest of the municipality. Fortunately, the government of Colombia is considering changes to this system for approving development projects, supported by the results of this investigation.

As part of this project, HALO held a seminar in March 2021 to share the findings of the investigation with the humanitarian demining sector in Colombia, demonstrating what is possible in terms of impact measurement. Following the seminar, the Office of the High Commissioner for Peace (OACP) and the Swiss Foundation for Mine Action (FSO) are holding talks as to how this type of investigation can be replicated across the country. Doing so will allow Colombians to not only better understand the true value of landmine clearance but also help the government identify where support is needed for communities affected by ERW.

The framework and methodology established during this study can be easily replicated, not only in Colombia but also in other countries affected by landmines. By better articulating the medium- to long-term outcomes of humanitarian demining in a specific country context—and providing the evidence to support these findings—humanitarian organizations, governments, and their donor partners can more readily demonstrate the true benefit of landmine clearance.
Lessons Learned

Given this was the first investigation of its kind in Colombia, there are some critical lessons learned for future projects. As in all academic investigations, the reliability of data is the cornerstone of objective and informative results. The lack of baseline data and the need to depend on respondents’ recollection of times past indicate that there is a degree of inaccuracy that must be accounted for. In order to produce more reliable results, it is important that socioeconomic data is recorded at the earliest possible opportunity, prior to the start of landmine clearance or even NTS.

The inclusion of Professors Castro and Rueda as third-party participants was of monumental value to this investigation. Their input provided a level of objectivity otherwise impossible had HALO conducted the study alone. An unbiased third party also affords a higher degree of transparency and credibility in the reported outcomes.

William Otavalo (fourty-two) lives in the vereda of San Miguel in Nariño, working the land to support his family. In 2004, while working on a neighbor’s farm, William fell victim to an improvised landmine, sustaining a severe injury to his hand, burns to his body, and multiple shrapnel wounds. When the fighting intensified in Nariño in 2006, William and his family were forcibly displaced from their family home.

After William’s family eventually returned to their farm years later, they were fearful of the potential mines that lay hidden, and productive land remained abandoned. When HALO arrived in 2013, William provided invaluable information that led to the removal of twelve landmines from his land, preventing further injury. Thanks to the clearance on his property, William is now able to use all of his land with the confidence that it is safe and is grazing cattle that he has since purchased. The clearance of the mines on his land has also provided access to a fresh water source, which has in turn enabled him to start a fish farming project, bringing further economic stability to his family.
The United States is the leading contributor to humanitarian demining projects both globally and in Colombia, where US contributions have exceeded $159 million. Foreign assistance is an investment, and it is incumbent on the Department of State to demonstrate clearly to American taxpayers that their investment is achieving concrete results. To that end, the Department of State requires grant recipients to submit regular programmatic and financial reports on project performance, including project outputs. That information, though important for demonstrating progress, does not paint a complete picture of the full impact of US humanitarian demining assistance. To more holistically demonstrate its impact, the Department of State agreed to fund HALO’s pilot post-clearance impact assessment.

The Department of State has provided $92.5 million to support a variety of mine action initiatives in Colombia since the peace accord was signed in late 2016, with a significant majority of that assistance (approximately 79 percent) going toward land release operations in priority locations. That assistance directly benefits rural communities most affected by the long conflict with the FARC-EP, and it also directly enables other US and Colombian priority efforts, including coca eradication, development initiatives, and land restitution. Humanitarian demining work made these broader efforts possible, and the study’s findings provide clear and irrefutable evidence that land release generates positive socioeconomic outcomes.

The evidence produced by HALO’s study clearly demonstrates that humanitarian demining in Colombia has been a wise investment. Additionally, HALO’s efforts established a foundation for future monitoring and evaluation (M&E) initiatives in Colombia. In August 2021, HALO developed roving M&E teams to collect information from communities affected by explosive hazards at various stages of the demining process. These teams will provide additional information that further reinforces the link between humanitarian demining and socioeconomic development.

**Conclusions**

The evidence obtained during this investigation demonstrates a causal link between humanitarian mine clearance and socioeconomic development in Colombia. The presence of suspicion of landmines directly impedes the capacity of municipal governments and third parties to implement development projects, as well as the legal return of IDPs and processing of land restitution claims. The clearance of landmines and other explosive ordnance is the first step in creating the conditions for rapid socioeconomic development and an overall improvement in living conditions in rural areas affected by conflict. The increase in land value after clearance, as well as general increases in monthly income, will continuously help with creating wealth and reducing poverty levels across Nariño.

Though the socioeconomic situation in Nariño and La Unión has improved, the long-term benefits of land release through clearance and NTS are likely not to be seen for another five years or more. Importantly though, the foundations have now been laid for a stable and diverse economy. Continued donor support for humanitarian demining in conflict-affected communities across Colombia will enable and ensure the conditions for socioeconomic development, growth, and stability in the years to come.

“Through this study, we now have the scientific and academic evidence to be able to say, that in effect, there is positive psychological impact on communities, once the suspicion of landmines is removed, allowing for the return of displaced persons and processing of land restitution claims.”

~ Martha Isabel Hurtado, Deputy High Commissioner for Peace

**Biographies**

Oliver Ford
Monitoring & Evaluation Officer
The HALO Trust

Oliver Ford moved to Colombia from the United Kingdom in 2014 and joined HALO in 2017 as Program Officer. He was appointed to Monitoring & Evaluation Officer in 2019 and works to improve Colombia’s socioeconomic data collection and analysis to better understand the impact mine action generates in conflict-affected communities in Colombia.

Amasia Zargarian
Grants and Development Manager
The HALO Trust

Amasia Zargarian is the grants and development manager for The HALO Trust (USA), overseeing HALO’s US federal and private grants from Washington, DC. He first joined HALO in 2016, spending two years as the regional program officer for the Caucasus, based mainly in Nagorno-Karabakh and also supporting HALO’s Georgia and Abkhazia programs. Zargarian is a graduate of Stanford University, where he received his bachelor’s and master’s degrees.

Eric Keefer
Office of Weapons Removal and Abatement,
Bureau of Political-Military Affairs,
U.S. Department of State

Eric Keefer joined (PM/WRA) in 2014 as a Frasure-Kruzeldrew Memorial Fellow. He has supported the office’s Resource Management division and managed programs in Africa, the Middle East, and Latin America. Keefer received his bachelor’s and master’s degrees from James Madison University.
The COVID-19 pandemic has impacted the mine action sector globally. In this article, the authors look at how the pandemic has affected Colombia, specifically concentrating on how the pandemic has affected humanitarian demining (HD)-related activities. To do so, the Swiss Foundation for Demining (FSD) compared key HD indicators from 2019 to 2020 in order to evaluate the performance of HD operations in Colombia, and carried out an assessment among HD organizations (HDOs) operating in-country through the Quick Impact Survey on COVID-19 Impact on Humanitarian Operations. Moreover, the authors provide an example of community service activities and projects implemented by organizations during the pandemic. The results showed that between 2019 and 2020, there was a 20 percent decrease in the reported number of total square meters cleared in Colombia, as well as a reduction in the number of non-technical survey (NTS) tasks and clearance operations, explosive ordnance risk education (EORE) beneficiaries, and activities completed. Despite numerous lockdowns, the number of victims unfortunately increased by 45 percent (from 114 to 166 victims). Regarding fieldwork, all organizations reported a temporary suspension of operations (from two to six months in total), with clearance activities being the most affected. However, the great majority of organizations have re-directed a portion of funds to provide emergency humanitarian aid (food, hygiene kits, etc.) to the most vulnerable communities affected by the pandemic.
The COVID-19 pandemic, as well as all subsequent measures to control it, suddenly transformed the living dynamics of most citizens, impacting the socioeconomic, environmental, and cultural spheres. In Colombia, the first case of COVID-19 was confirmed on 6 March 2020. A week later, the government announced a national state of emergency, dedicating economic resources to help manage the crisis. On 20 March, the national mandatory lockdown began, which lasted several months. In fact, Colombia had one of the longest mandatory isolation periods globally. As of April 2021, 2,774,464 cases had been confirmed in Colombia, and 71,351 people had died from the disease.

Although it is too early to assess the magnitude of impacts caused by the containment measures, the alarming increase in unemployment impoverished millions of households. The crisis has unequally affected different regions of the country due to pre-existing social and economic gaps. Another worrying fact is the increase in human rights violations, with one of the most affected regions being Cauca, a Department with massive anti-personnel (AP) mine contamination—which ranks first, in comparison with other Departments, and represents almost a third of the country’s AP-mine victims. Furthermore, the prolonged confinement has exponentially increased femicides and other types of gender-based violence, which has disproportionately affected indigenous, afro-descendant, and peasant women, among others.

Regarding the mine action sector, several authors have identified specific effects, such as the suspension of programs, repatriation of international staff, temporary closure of worksites, travel restrictions imposed on staff, and limitations in victim assistance (VA) and EORE activities. Moreover, official data provided by the Office of the High Commissioner for Peace (OACP) was used to analyze the results of HD operations, victim assistance (VA), and EORE. Accordingly, with funds from The Office of Weapons Removal and Abatement in the U.S. State Department’s Bureau of Political-Military Affairs (PM/WR), FSD conducted a survey with accredited HDOs to assess other impacts where questions from the Quick Impact Survey on COVID-19 Impact on Humanitarian Operations were used as a guide to prepare a specific questionnaire adjusted to the context of HD activities in Colombia. Seven accredited organizations replied to the survey: five civilian HDOs and the United Nations Mine Action Service (UNMAS) and FSD.

### Impact on Indicators Related to Humanitarian Demining, Explosive Ordnance Risk Education, and Victim Assistance (2019 vs. 2020)

<table>
<thead>
<tr>
<th>INDICATOR</th>
<th>2019</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cumulative cleared square meters</td>
<td>1,625,006</td>
<td>1,293,304</td>
</tr>
<tr>
<td>Explosive ordnance items destroyed</td>
<td>474</td>
<td>203</td>
</tr>
<tr>
<td>EORE beneficiaries</td>
<td>199,305</td>
<td>54,878</td>
</tr>
<tr>
<td>Victims</td>
<td>114</td>
<td>166</td>
</tr>
</tbody>
</table>

Table 1. Comparison of indicators between 2019 and 2020.

As shown in Table 1, based on IMSMA data from the OACP, there was a 20 percent decrease in the reported number of total square meters cleared in Colombia in 2020 compared to 2019. This reduction was not so dramatic, given that military demining operators were not required to suspend operations during the most critical months of the pandemic. Hence, military operators carried out 88 percent of clearance operations (1,138,832 sq m). Although this ratio of military- to civilian-conducted clearance is normal in Colombia, civilian organizations cleared 30 percent of the total number of square meters in 2019 versus 12 percent in 2020. In regard to destroyed mines/explosive remnants of war (ERW) items, 57 percent less were destroyed in 2020 than in 2019. In terms of operations, 86 non-technical survey (NTS) tasks and 213 clearance operations were completed in 2019, compared to 15 and 183 in 2020. Regarding EORE activities, Table 1 shows the reduction in the number of beneficiaries and activities between 2019 and 2020. However, in 2020, EORE was prioritized in the most AP-mine-affected municipalities to try to maximize the impact of the reduced number of activities carried out.

Despite numerous lockdowns, the number of victims unfortunately increased by 45 percent, rising from 114 to 166 victims. Moreover, there was a higher proportion of afro-descendant (2019: 0, 2020: 19) and indigenous (2019: 1, 2020: 20) victims (20 percent in 2020 versus 1.7 percent out of the 2019 total). Nariño was the most affected region in both periods (2019: 38, 2020: 62) and faced a dramatic social crisis due to the murder of social leaders, threats to the civilian population, and clashes between illegal groups. Following the start of the pandemic, AP-mine-contaminated areas, which already had access limitations, were blocked until further notice due to security issues and government restrictions resulting from the pandemic. Throughout the pandemic, some existing challenges have increased: food insecurity, reduced access to education, health services, vaccinations, etc. Similarly, the uncertainty faced by people with disabilities caused by AP mines, who struggle to access health care services (prosthetics and rehabilitation), will be further exacerbated due to the current health system collapse. Ultimately, it is likely that productive use of released land will be delayed, and the difficulties in undertaking productive projects will be greater, causing further instability for survivors.

### Perceptions of HDOs

In regards to the impact caused by the pandemic, the measures imposed by the national and/or local authorities have impacted humanitarian operations at various levels. Seven civilian organizations, five of whom carried out demining operations, completed the Quick Impact Survey on COVID-19 Impact on Humanitarian Operations, and the most relevant findings follow.
Impact on Demining Operations

The data considered for this section corresponds only to information provided by HDOs.

<table>
<thead>
<tr>
<th>MEASURE</th>
<th>IMPACT</th>
</tr>
</thead>
</table>
| Movement restriction – closure of national borders | Suspension of operations (temporary)  
- Suspension of technical assistance in the field |
| Movement restriction – closure of international borders | Repatriation of international staff |
| Mandatory isolation – curfew      | Prohibition of on-site meetings and workshops  
- Reduction of EORE activities  
- Telework |
| Import – export restrictions     | Reduction on the availability of supplies |

Table 2. Measures and Impacts.

All HDOs surveyed reported a meaningful impact on demining operations among the five pillars of mine action (demining, EORE, VA, advocacy, and stockpile destruction).

Regarding fieldwork, all organizations reported a temporary suspension of operations (from two to six months in total). When inquiring about the causes of these suspensions or limitations against the normal conduct of activities, in addition to the suspension of operations from March to June 2020 imposed by the national government, organizations reported other external causes related to the pandemic and security issues: COVID cases in the allocated areas; road blockages by communities to prevent access; lack of supplies and suppliers; presence of illegal armed groups; adapting operation sites to face the pandemic; limited ground transportation; and lack of knowledge regarding risk prevention.

All these organizations adjusted their NTS, EORE, or community-liaison data-collection activities due to potential contagion risks for their staff. In addition, three out of five organizations that carried out demining operations reported that communication with their beneficiaries was severely affected, and all reported a medium impact regarding communication with local authorities.

When inquiring specifically about the degree of impact produced by some measures (Table 2), six out of seven organizations claimed that the impact due to the limitation of imported supplies was low, whereas the impact on traveling within the country was high for five organizations and medium for the remaining two. Some of the most frequent changes in organizational dynamics were the limitations on mobilizing staff and the implementation of telework. One organization reported the repatriation of international staff, although none suspended employment contracts. These measures were applied to national and international staff—except repatriation—in six organizations out of seven.

Organizations conducted specific activities that had different degrees of impact: three organizations experienced medium impact, two high, and two low. None of the organizations reported any impact on communications with donors, and only two organizations claimed to have some degree of impairment in the communication with other civilian organizations. Transportation suffered high and medium impacts for six of the organizations. Moreover, the reallocation of funds and cost reduction due to a decrease in funding did not represent a significant impact, five organizations reported it as low and two as medium.

More specifically, when the organizations were asked about the percentage of general economic impacts of the pandemic on the projects in relation to the initial budget, six organizations reported an impact between zero to 20 percent, and only one reported an impact between 20 to 40 percent. Four organizations allocated some activities focused on COVID-19-related actions such as providing supplies and other products to local communities. Lastly, six organizations implemented capacity-building activities with their staff during the suspension of operations.

![Figure 1. Measures taken by HDOs.](image)

Successful Experiences Implemented During the Crisis

One of the greatest challenges imposed by the pandemic was the inability to carry out on-site activities. In this regard, several organizations reported the use of virtual media. Some of the organizations used this tool to train their field staff, and one organization included human rights and gender training for all staff. Another organization resumed EORE activities through the design of social media campaigns, radio messages, and virtual workshops.

One organization discussed its strategy to reduce the contagion risk, and another one reported “zero contagion” within its operational teams and during its retraining sessions as a result of strict compliance
with its biosafety protocols. One organization established work periods, which were increased from three to five weeks to avoid recurring entry and exit movements from and into the sectors or municipalities. Likewise, tests were carried out for the access of staff after break periods. Ultimately, one organization carried out a project to mitigate the socioeconomic impacts of the pandemic on the community. FSD, in partnership with the local NGO Fundación Sembradores de Luz y Recolectores de Esperanza (https://sereza.org/)—led and composed by victims of the conflict with experience in assisting vulnerable communities—provided assistance in Bogotá, Colombia, by distributing hot meals, hygiene kits, face masks, etc., to indigenous internally displaced children, the homeless, Venezuelan refugees, elderly people, and families with no sources of income from May to December 2020.

**Conclusions**

Because of the conditions caused by the pandemic in Colombia, mine action activities have suffered setbacks in comparison with preceding years. The most affected component has been the humanitarian demining sector’s clearance activities. The increase in the number of mine victims, who reside in violence-affected areas of the country, is concerning, especially as it is disproportionately affecting the most vulnerable populations. Even though EORE activities have been allocated to these strongly affected areas, and innovative campaigns have been carried out through virtual media, the technological gap does not allow equitable access. Finally, there are two aspects that may hinder the projections made by the Colombian government to meet Colombia’s obligation under Article 5 of the Anti-Personnel Mine Ban Convention to remove all AP mines by 2025: the decrease of key operational indicators in 2020, and the uncertainty of the duration of the pandemic and a full return to full activities. 

*See endnotes page 148*

**The COVID-19 pandemic, as well as all subsequent measures to control it, suddenly transformed the living dynamics of most citizens, impacting the socioeconomic, environmental, and cultural spheres.**
THE HUMANITARIAN mine action (HMA) sector, as part of the wider security and peacebuilding field, has made significant gains related to gender equity in field operations. In recent years, women deminers have received increased donor and media attention. As a result, there now exists a wide breadth of texts, literature, documentaries, etc., about women who work to remove landmines and other explosives from the ground. The availability of this new information and recent increased public and media attention generates the following questions: Are the narratives accurate, and do women deminers agree with them? How do women deminers view the ways that they are represented in the media? What has been shared about female demining with the world? How can HMA organizations use information on women deminers’ experiences to make meaningful connections with the wider security and development sector?

A mixed-methods study was designed to understand and evaluate popular narratives about women deminers as they emerge in publicly-accessible and popular media. In addition to document collection and review from such sources, a survey was administered to women demining teams globally to ask them about these narratives and to capture their opinions on what has been written. Women deminers from at least three demining teams from different geographic regions (Southeast Asia, South/Central Asia, and the Middle East) answered the survey.

Findings from both datasets—a corpus of published narratives and results from this survey study—illustrate important themes about the current literature and, ultimately, provide important considerations for how women deminers are written about in the future. As a result of these intentional narratives, the potential exists to improve gender mainstreaming/equity outcomes for women demining teams as well as gender equity in other areas of security and peacekeeping. Specifically, the texts provide insights into women deminers’ motivations and occupational choices, but little information is discussed beyond these topics. Thus, the HMA sector should evolve the narratives surrounding women deminers using the techniques that have so far captured accurate portrayals to advance the role of women in the wider security and development sector. The next sections outline the structure of the study and the major themes portrayed in the popular media. These themes are then compared to the survey responses from women deminers.

**Materials and Methods**

Using a phenomenological framework and relying on theories in the field of rhetoric, the study collected qualitative data sources from a range of texts written about women deminers and from online surveys distributed to female demining teams. This design approach allowed for emergent themes and trends related to gender equality in post-conflict environments, particularly through a focus on the deminers’ roles as active participants in the peacebuilding and reconstruction processes. Texts created about women demining teams demonstrate the current popular view of deminers within their career field and the media. Rhetorical-framed insights into women deminers’ experiences in this unique space of post-conflict and peacebuilding also emerge from the collected surveys of the participants. In addition to knowing whether or not women deminers have access to the narratives written about them for public consumption, more information on how subjects consume and interpret those narratives now exist.

First, public and easily-accessible text-based content about women deminers were collected from an array of sources, including journals and news articles, and public relations pieces from HMA organizations (such as social media and blog posts). The sample size totaled fifty-two unique documents published between 2000 and 2021. The goal was to locate pieces that anyone would be able to find through a simple search, whether they were part of the HMA community or a member of the general public. Categorizing the documents by geographical region (Eastern Europe, Africa, South/Central Asia, South America,
<table>
<thead>
<tr>
<th>CODE</th>
<th>DEFINITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Descriptors (Character, Ability, Personality)</td>
<td>A word that describes a quality, personality trait, or characteristic of a woman deminer</td>
</tr>
<tr>
<td>Descriptors II (Physical Appearance)</td>
<td>A word or statement that describes a woman deminer’s physical appearance</td>
</tr>
<tr>
<td>Motherhood/Marriage</td>
<td>A statement that relates to the woman deminer’s status as a mother or wife</td>
</tr>
<tr>
<td>Assessments</td>
<td>A statement that assesses the women deminers’ quality of work or contributions to the demining profession</td>
</tr>
<tr>
<td>Motive</td>
<td>A statement that illustrates or discusses the motivations of women deminers</td>
</tr>
<tr>
<td>Occupational Choice</td>
<td>A statement that discusses the occupational choice of women deminers and/or the occupation’s relationship to family or cultural norms</td>
</tr>
</tbody>
</table>

**Table 1. Coding Scheme and Definitions.**

and Southeast Asia) ensured that women deminers from each region were nearly equal in representation. Using NVivo research software, the documents were coded using the scheme illustrated in Table 1. By reviewing the documents, emergent and recurring themes were assigned codes with specific definitions. The second column defines each individual code.

In addition to the document review and coding, anonymous surveys were created in QuestionPro, which were sent to representatives of HMA organizations to distribute to their women demining teams. Respondents had the opportunity to complete the survey in English, Arabic, or Spanish, but in some cases, surveys required translation to local languages. In such cases, local translators signed nondisclosure agreements and completed the translation work. The survey received forty-one unique responses from women deminers in at least three different regions of the world, including Southeast Asia, South/ Central Asia, and the Middle East. In addition to extracting quantitative data, the same coding scheme in Table 1 was used to compare the two datasets.

**Results**

These robust datasets provided a wealth of information about women deminers, their portrayals in the media, how these representations relate to women’s own self-reported experiences and perceptions, and how these portrayals are perceived by the female demining community. By far, the most prevalent topics discussed were the motivations and occupational choices of women deminers. In addition, a majority of the news articles were introductory in nature, meaning the author focused on introducing the idea that women deminers existed.

**Motivation**

After coding the documents, there were sixty-two unique references in thirty-three (or 63 percent) of the documents related to motivation. This article operationalizes motivation to mean a statement that illustrates or discusses the motivations of women to go into work as deminers. The deminer’s motivations as explained by the authors of the documents fall into three motivation categories: financial, personal, and humanitarian. Financial motivations relate to being unemployed or needing to support themselves/dependents. Personal motivations relate to self-fulfillment, being personally affected by the presence of landmines, or using demining as a means to reach a personal goal such as raising money for university fees. Humanitarian motivations relate to assisting others impacted by the presence of landmines and other unexploded ordinance, whether that is at the local or national level.

While all three were prevalent, humanitarian motivations were the most frequently cited in the documents. While the current body of available information suggests that women deminers are motivated by financial, personal, and/or humanitarian reasons, the survey results indicated financial motivations were more common. Understanding the motivations of women deminers is important in at least two respects. First, from the perspective of news articles or public relations pieces, which commonly introduce the concept of female demining teams, the authors answer a key question that their audience would ask: why would someone (and in this case, a woman, specifically) want to remove landmines or other explosives from the ground? Secondly, understanding motivations is key to HMA organizations’ efforts to successfully recruit and retain women employees.

The authors of the various texts make it clear that women are motivated to pursue demining work for personal and altruistic reasons. Likewise, survey respondents explained that they are drawn to their work for similar reasons and for the same type of motivations (humanitarian, personal, and financial). From this correlation, it seems that popular portrayals of women deminers as it relates to their motivations
have been accurate. However, there was one major difference between the datasets. While the most common motivations cited in the documents were humanitarian-related, the survey responses overwhelmingly described financial motivations. This difference is significant when it comes to understanding this population, their unique needs, and how security and peacebuilding operations might draw them into other aspects of their collective work.

**Occupational Choice**

One hundred and five unique references in thirty-five (67 percent) different texts related to occupational choice. As defined in Table 1, these references discussed the occupational choice of women deminers and/or the occupation’s relationship to family or cultural norms. Most references constitute the latter definition. The current literature illustrates the cultural and familial norms women face or overcome in order to enter and maintain their positions as deminers. Understanding this aspect of their role assists both the general public and the HMA community to better understand gendered elements of their experience. However, while illustrating that women succeeded in becoming deminers, these narratives do not explore how they overcame challenges relating to gender bias or subverted social norms. Readers also do not learn how these women may be able to parlay their demining experiences into future careers in the peace and security sector writ large.

Information related to occupation and cultural/family norms most often appeared in survey responses to the question “How would others outside your profession describe your work?” Describing conversations with family, friends, and the local community, women discussed experiences with gender-biased remarks, or initial surprise and acceptance. While the respondents outlined their motivations, they did not discuss their immediate or future career aspirations beyond demining. The discussion about occupational aspirations in different security, humanitarian, or peacebuilding careers did not emerge organically from the survey responses, and this may be an area to consider by HMA stakeholders or those conducting gender equity initiatives in-field as they evaluate their programming. When it came to their contributions to security and peacebuilding and their involvement in these sectors, the women’s responses focused specifically on their direct clearance activities.

Lastly, quantitative findings outlined in Table 2 demonstrate the survey respondents’ current view of popular narratives about women deminers, and 80 percent of survey respondents were aware of depictions of women deminers in the media. Of that group, a large majority (82 percent) agreed with the views or perceptions of women deminers that they had portrayed in the media. Interestingly, a majority of women deminers wanted to see more representation as it made them feel proud and recognized for their work; respondents felt that media depictions demonstrated women can be successful deminers. Feelings that these texts accurately portrayed women were overwhelmingly positive. This is significant as we compare these feelings to the personal conversations the women experience in their local communities where the opinions of others towards their career choices may be less accepting or positive.

**Sample Deminer Responses (Spring 2021 Survey)**

<table>
<thead>
<tr>
<th>SURVEY QUESTION</th>
<th>YES/AGREE</th>
<th>NO/DISAGREE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Are you aware female deminers are described in the media (for example, in the news, public relations pieces, documentaries, etc.)?</td>
<td>81%</td>
<td>19%</td>
</tr>
<tr>
<td>Do you agree with the views of perceptions of female deminers and their role in the media (for example, in the news, public relations pieces, documentaries, etc.)? Please explain your answer.</td>
<td>82%*</td>
<td>2%*</td>
</tr>
</tbody>
</table>

*Percentage of total 84% of responses to this question; five answers did not agree or disagree/were not applicable.

Table 2. Survey Qualitative Data

“I agree, for me as an individual in the group of female deminers, always make an effort and try to fulfill the assigned tasks. The media has helped bring to light the efforts what we are making to share difficulties with society. When I watch those shows, I feel so proud and confident that I can do it.”

“Yes, I agree, I would like the world to see that women are an effective element and can be in all positions and missions.”

“I do not agree with the opinion, because women are half of society, just as they work, learn and sacrifice, and can overcome all difficulties.”
Discussion

As popular narratives about women deminers (many perpetuated from within the HMA community) appear to be accurate from the results of the study, they have a positive effect on women demining teams. As other sectors of security and peacebuilding struggle with gender-related issues and underrepresentation, narratives about women deminers may be useful resources. Knowing this, a reader may be tempted to ask, "If it’s not broke, why fix it?" However, just as clearance and survey techniques continue to improve, the sector’s narratives can also evolve to better improve gender outcomes in the HMA community.

While these narratives are both accurate and informative, they remain focused on the introductory, surface-level elements of women’s stories. The documents reviewed spanned from 2000 to 2021, and the narrative has not changed much in that time. Authors continue to introduce and re-introduce the fact that women deminers exist and are contributing to security and peacebuilding efforts. Since Norwegian People’s Aid established the first all-female demining team in Kosovo in 1999, women have been officially clearing mines for over two decades. The issue with reusing this narrative is that it perpetuates the belief that women’s contributions are novel (or, at worst, an exception to "normal" operations). This is not to say that new demining teams with women or mixed gender teams will not be new in different locations in the future, but rather that the location itself is the novelty and not women’s contributions. There is much more that can be learned and shared about gender, humanitarianism, and peacebuilding. If women deminers were recognized for the longstanding roles they have played in security and peacebuilding, perhaps doors would open for more significant involvement. Specifically, the narratives can add new information and insights about women’s roles in post-conflict efforts rather than repeating some of the stories that are already in circulation. For this reason, the HMA community should reconsider what profession-related questions are asked of women deminers for the purpose of sharing their stories. By doing so, the community can better illustrate the role and impact of women deminers in HMA in order to recognize and learn from the decades-long contributions these women have made.

Thus, those interested in featuring the work of women deminers in popular media should consider ways to highlight the longevity of these contributions and to avoid portraying women’s involvement in demining operations as a novelty. Such intentional shifts to the popular narrative could enhance gender equity in the mine action sector as well as in the security and peacebuilding sectors more broadly. As well, survey results demonstrate that women deminers are both contributors to and consumers of these popular narratives. Women deminers have a unique perspective and an acquired skill set that can potentially be used or shared in the broader security and peace sectors. The current literature does not adequately contextualize women deminers within the extended security, peacebuilding, and humanitarian communities. Based on the largely financial motivations for women to become deminers in the first place, they may not have previously considered being a part of the broader security community and their future potential in different roles. Still, clearance operations are meant to be finite, and there is little data about what women do next after they are no longer deminers. One study suggests that women that do not reach the supervisory level often return to the social and economic role they had before they became deminers (Bini et al). This is a significant potential loss for the security and peacebuilding sector. Just as HMA clears safe paths for civilians, so too can it create pathways for women’s equality and greater involvement in post-conflict contexts.

See endnotes page 148

The issue with reusing this narrative is that it perpetuates the belief that women’s contributions are novel (or, at worst, an exception to “normal” operations).

BIOGRAPHY

Brenna Matlock
Senior Project Manager/Program Coordinator
Center for International Stabilization and Recovery

Brenna Matlock is the Senior Project Manager and Program Coordinator at the Center for International Stabilization and Recovery (CISR) at James Madison University (JMU). In this role, Matlock plans and implements CISR’s grants including the Senior Managers’ Course in Conventional Weapons Destruction (SMC). Since joining CISR in 2015 as a Project Manager/Research Associate, Matlock has assisted with planning and implementing five SMCs internationally and on-campus (Vietnam ’15, JMU ’16, and Croatia ’17, Tajikistan ’18, and JMU ’19), and instructed sessions related to effective presentation skills and HMA gender and diversity considerations. In addition, she coordinates and provides logistics for major project initiatives. These have included a fellowship program, large workshops, support to humanitarian GIS survey tools and mapping programs, and interdisciplinary projects at JMU. Matlock has a master’s degree in Writing, Rhetoric and Technical Communication from JMU.
DIGITAL REHABILITATION TECHNOLOGIES Deliver Hope for Survivors

By Abder Banoune [Humanity & Inclusion]

Humanity & Inclusion (HI) has been making prostheses and orthoses since its launch in refugee camps along the Thailand/Cambodia border in 1982, when it was known as Handicap International. The organization has since developed a global approach to disability, aiming to reduce poverty and situations of vulnerability, while working to ensure development and emergency responses are accessible to all. After nearly forty years of action, teams in fifty-five countries perform this critical work today.

At the Fourth Review Conference of the Anti-Personnel Mine Ban Convention (APMBC) in Oslo in November 2019, Ugandan conflict survivor Margaret Ochek Arach had a predicament. She told her fellow landmine campaigners that she was in desperate need of a new prosthetic leg, having lost her right leg during an ambush in 1998. Her current artificial limb caused her pain and made walking difficult. Yet despite being Ambassador for the International Campaign to Ban Landmines (ICBL), she was finding it difficult to obtain a new prosthesis.

Meanwhile, in Syria, two men were recovering from landmine accidents, with doctors needing to amputate a limb in each case. Mohamed was twenty-five years old when he encountered a landmine in 2015. And Zidan, a shepherd, was just eighteen when he grazed his cattle in an area that he didn’t know was mined. Zidan’s father had previously died, leaving him responsible for the family’s income. The effects of his injury would ricochet throughout his family.

The year 2019, the last year for which we have explosive ordnance (EO) casualty data, saw more than 5,550 people killed or injured by mines/explosive remnants of war (ERW). Of that total, at least 2,170 people died, and another 3,357 were injured.1 The majority of people who survive an EO accident acquire life-changing injuries, with a large number of these survivors requiring rehabilitation and prostheses. Yet access to both remains severely limited. An estimated 80 percent of persons with disabilities live in developing countries. However, only 5–15 percent of people living in low- and middle-income countries who require assistive devices and technologies can access them. What’s more, in low-income countries, rehabilitation services are often under-resourced and undeveloped. This is compounded in areas experiencing conflict. Poorly made or unadjusted prostheses can cause skin sores, pressure wounds, and muscle fatigue.

According to the Global Burden of Disease Study 2019, more than one-third of the world population, 2.4 billion people, would benefit from rehabilitation. Rehabilitation for persons with disabilities, among them EO survivors, requires adapted and accessible infrastructure, specialized care-providers, trained rehabilitation professionals, long-term interventions, and financial resources. Even when services are available, the most marginalized populations can rarely afford them. Poverty, stigma, and discrimination, as well as inaccessible information and infrastructure, combine to create what seem like insurmountable barriers for people with disabilities.

The gap between needs and available services is enormous. It limits an individual’s ability to reach and maintain functioning capacity, participate in education, find decent work, and become an active member
Geraldo (age six) shows off his new 3D-printed splint that he received from the HI rehabilitation center in Lomé, Togo. The splint will help to correct his right ankle.

*Image courtesy of Philippa Poussereau/HI.*

of society. A recent study by ATscale demonstrates that funding of four assistive products—hearing aids, prostheses, eyeglasses, and wheelchairs—would result in a nine-to-one return on investment.

HI has been making prostheses and orthoses since its launch in refugee camps along the Thailand/Cambodia border in 1982, when it was known as Handicap International. At that time, HI was the first humanitarian organization to meet emergency orthopedic needs. By setting up orthopedic centers and training competent local teams, HI used simple, locally-available equipment to provide immediate, effective, and practical services that met emergency orthopedic needs of thousands of EO survivors in need of a prosthetic limb, including many amputee survivors of anti-personnel mines. The organization has since developed a global approach to disability, aiming to reduce poverty and situations of vulnerability, while working to ensure development and emergency responses are accessible to all. After nearly forty years of action, teams in fifty-five countries perform this critical work today. Over decades of experience, often with support from agencies like USAID and the U.S. Department of State’s Bureau of Population, Refugees and Migration, teams have provided a range of rehabilitation services and trained local staff to provide quality care. Donor support has helped establish rehabilitation centers in dozens of countries, including Cambodia, Haiti, and Nepal, where USAID opened new clinics and provided professional training after the 2010 earthquake. Additionally, similar funding provided specialized care to people injured after the Nepal earthquake. Syrian refugees in Jordan and Lebanon, and refugees living in Kenya’s Dadaab and Kakuma camps have also benefited from such care. The Office of Weapons Removal and Abatement in the U.S. State Department’s Bureau of Political-Military Affairs (PM/WRA), as well as many other donors—the European Union, the Norwegian MFA, Australian Department of Foreign Affairs and Trade, Germany, and others—have contributed funding for victim assistance (VA) as part of broader mine action budgets to support the provision of rehabilitation and other services. In many countries, VA efforts have launched a national disability dynamic and supported the delivery of vital services for EO survivors and other persons with disabilities.

Even with dedicated donors and partnerships, however, the needs still outweigh the services that one international nongovernmental organization (NGO) using traditional methods can produce.
Orthoprosthete Mathieu Afetse (R) and printing technician Fabrice Djodji (L) check a 3D printer as it prints an orthosis at the HI facility in Lomé, Togo.

Image courtesy of Xaume Olleros/HI.

Digital Transformation

In 2016, the African Federation of Rehabilitation Professionals (FATO) met in Lomé, Togo, where Isabelle Urseau, Director of HI’s Rehabilitation Division, shared the results of a trial using digital technologies, including 3D printing, to provide physical rehabilitation and assistive support services.

The potential for digital technologies to transform the rehabilitation sector had been on Urseau's mind for years. She pitched the concept to HI's directors in 2014, unlocking EUR 70,000 of the organization's innovation funds from private donors.

Since then, Urseau’s teams have worked closely with private stakeholders, universities, research institutes, and local professional associations to put their hypothesis to the test: Digitalization combined with additional production could improve access to rehabilitation care and assistive devices for people with BO and other conflict-related injuries, including landmine survivors, as well as others with mobility issues. HI’s teams facilitate access and provide services ranging from mental health and psychosocial support to rehabilitation and inclusive education, as well as social and economic inclusion to survivors and other persons with disabilities alike. In 2019, HI's beneficiaries included at least 9,965 survivors of landmines or explosive weapons.

The next phases of the project benefited from a range of partnerships and funding. The Directorate-General for Development Cooperation and Humanitarian Aid of Belgium, the UK’s Foreign, Commonwealth & Development office, and Agence Française de Développement (AFD) all pitched in. To date, HI has piloted 3D-prosthetic and orthotic printing projects in six contexts: Madagascar, Mali, Niger, Syrian crisis-affected countries, Togo, and Uganda. In 2019 alone, the Syrian crisis response team...
saw 3,462 people with injuries caused by explosive weapons used in populated areas and 801 people affected by EO. Teams use small, lightweight 3D scanners to create digital molds of body parts, make adaptations according to the patients' needs using computer-modeling software, and then send it to the 3D printers. The printers create thousands of layers of thermoplastic to produce bespoke sockets that fit patients' limbs.

This work is part of what's now known as the TeleRehabilitation for All (TeReFa) initiative, providing complete rehabilitation services in post-conflict settings, in support of refugees fleeing conflict, and other underserved areas through local health partners, mobile teams, remote experts via telemedicine, and new technologies such as 3D printing to deliver orthopedic devices. The result is a digital ecosystem that is transforming the delivery of health care services.

As a part of the TeReFa initiative, HI conducted studies in different contexts—emergency, EO-contaminated conflict settings, development, and refugee camps—focusing on technological, clinical, and social aspects for patients and professionals. The results indicated that access to rehabilitation, prosthetic, and orthotic services increases physical independence, reduces vulnerability, mitigates the risk of exclusion, and contributes to improved quality of life. Products were able to meet patient expectations; requiring less time to customize 3D-printed devices that meet structural and mechanical needs; and reducing the need for infrastructure, equipment, and human resources to produce conventional prostheses and orthoses. Moreover, tele-rehabilitation compensates for the shortage of professionals on-site/in-country and improves communication by bringing qualified specialists closer to users who are accompanied by on-location health workers.

Nevertheless, difficulties remain: While 3D printing and tele-rehabilitation break down some of the barriers to rehabilitation in low- and middle-income settings, the price is comparable. In 2017, HI published "Pilot Testing of 3D Printing Technology for Transtibial Prosthesis in Complex Contexts (Togo, Madagascar, and Syria responses)," which demonstrated that there is a limited cost difference between the conventional production and 3D printing of orthopedic devices.

A shortage of qualified specialists poses another challenge. The World Health Organization (WHO) indicates that in many low- to middle-income countries, the density of skilled practitioners is below ten per one million population. The number of other health professionals who can deliver rehabilitation services is also extremely low. In Africa, Southeast Asia, and Western Pacific, the number of practicing prosthetic and orthotic specialists is less than one-tenth of the number required; there should be at least five prosthetic and orthotic professionals for every one million people.

The project has since expanded. So far, 234 people have received rehabilitation as well as orthoses or prostheses through the pilot phases (150 people received orthoses, and 84 people received prostheses), including Margaret, Mohamed, and Zidan, who each received 3D-printed devices and rehabilitation services through HI's 3D Printing Through Emergency Tele Rehab Access project (PETRA).

HI, as part of the IMPACTE 3D project, is using 3D technology as part of a clinical trial to build personalized orthoses for one hundred patients in Mali, Niger, and Togo.

Image courtesy of Xaume Olleros/HI.
From Bamboo to 3D Printing:
Evolution of Rehabilitative Care and Services to Survivors of Conflict

By Isabelle Urseau

In my 35-year career at Humanity & Inclusion, I've witnessed an evolution in rehabilitative technology, the services we provide, and how we structure them. In working with landslide survivors in Colombia, people living with long-term disabilities caused by leprosy or polio in India, and mine survivors in Mozambique, HI's goal has been to identify problems and find solutions.

Early on, rehabilitation was sometimes the only service HI provided to communities in the wake of emergencies or conflicts. But we recognized that wasn't enough. You can help a person strengthen their muscles, manage phantom pain, and learn to walk again with the help of a prosthesis, but the work should not end there. While people may be living with different injuries or disabilities, their needs were almost always the same: calling for a continuum of early care and a comprehensive approach of rehabilitation, psychosocial support, and inclusive education and/or employment. This is especially true in conflict-affected regions, where psychological trauma is compounded by insecurity, poverty, and a constant fear of losing life or limb from landmines and other explosive devices.

Over time, HI has developed effective, comprehensive health and rehabilitative practices, adopting a holistic approach meant to last long into the future. Providing rehabilitation, mental health, and social services was a start, but teams now ensure children with disabilities attend accessible schools and that entrepreneurs living with permanent injuries can maintain thriving businesses. HI also advocates for improved policies to create sustainable change. For example, HI's work in Nepal started in response to conflict, shifted to crisis mode after the 2015 earthquake, and is now focused on development supported by an established network of government actors, social services, and NGOs.

Similarly, HI's rehabilitation efforts and buy-in from stakeholders and institutes such as the WHO have evolved. In 1991, toward the end of Mozambique's fifteen-year conflict, I began working with mine survivors. At that time, we used locally-available materials to build orthoses and prostheses. I trained local technicians to construct assistive devices out of bamboo, leather, wood, and iron—materials we knew they could source locally—and collaborated with other institutions to import materials to produce low-cost, plastic orthoses and prostheses. In the face of emergencies, such as the earthquake in Haiti and the ongoing Syrian crisis, HI implemented emergency programs, providing people temporary prostheses that were later replaced with permanent ones once services were more established.

Fast forward to 2014, when we began workshopping the ideas of telerhabilitation and 3D printing to better serve people in isolated areas. Our goals were to improve communication, while cutting costs and transportation times. People were dubious at first, but in a world of emerging technology, testing and experimentation are essential, as are agility, frugality, and flexibility in conflict-affected regions.

When the COVID-19 pandemic hit, HI was able to expand existing telerhabilitation and 3D-printing programs to continue serving communities without interruption. As of mid-2021, we've fitted 250 people with 3D printed orthoses and prostheses through our pilot projects in Africa, produced 3D printed personal protective equipment, and conducted thousands of telerhabilitation sessions.

What remains universal is the need to work together to identify multiple solutions that answer specific needs and demands, while building sustainable capacity of local communities over time. What has changed is the digital transformation of rehabilitative care—including telerhabilitation and 3D printing—that enables users and local communities the opportunity to access care and respond quickly to individual needs.
Tabita is assessed for the 3D Project for a knee-foot-ankle orthosis to support her lower limbs.

Tabita is an eleven-year-old girl from South Sudan who now lives in Omugo refugee camp in Uganda with her family. When she was three years old, Tabita contracted polio, causing her legs to become noticeably weak. Unable to stand without support, she began using crutches to help her walk around the camp and go to school. The HI team helped Tabita with her mobility aids, which eased access to her school and gave her greater freedom to socialize with her friends. A psychosocial worker of the CRHR and Education Cannot Wait projects is working with Tabita and her family, helping her to manage her disability and strengthen her self-esteem. Images courtesy of Quain Nealy.

Tabita with friends and family in the Omugo refugee camp in Uganda.
What's Next?

In 2020, the European Union recognized HI, awarding the organization with a Horizon Prize for two innovations in humanitarian mine action and beyond, namely its 3D-printing innovation that represents an evolution in VA and its drone technology that greatly speeds up safe EO impact survey efforts.

In regards to the 3D-printing technology, HI’s technical experts are currently working to lower production costs. They’ve teamed up with the French National Institute for Applied Sciences (INSA) to test locally-sourced, recycled materials to produce prostheses and orthoses. Meanwhile, staff in Vietnam, thanks to USAID funding, are developing a new app to virtually connect rehabilitation professionals with patients, optimizing the transition of care from hospital to home and improving family-based, follow-up care. All of these digital initiatives should reinforce the organization’s capacity to reach more beneficiaries and improve their rehabilitation care.

In the coming years, HI staff will focus on scaling the technology and making it more sustainable. Plans include launching five regional hubs associated with local networks of rehabilitation centers and professionals, and ensuring proper technology transfer to our partners. Advocacy efforts to include rehabilitation services in eHealth strategies, and integration of assistive technology solutions in universal health coverage will be key activities to ensure the approach is adopted widely.

But for now, staff take great pride in the wins celebrated by Margaret, who should be back on the road advocating post-COVID; Mohamed, who has found work at home in Syria; and Zidan, who is once again tending his cattle and helping to keep his family afloat.

As of today, thirty-four States Parties of the APMBSC have reported a responsibility for a significant number of EO survivors within their national territory, and twelve States Parties of the Convention on Cluster Munitions have reported the same for cluster munition survivors. In addition, evidence show that mine and cluster munition casualties have been identified in other states and regions.

By adopting the Oslo Action Plan (OAP) in 2019, States Parties of the APMBSC have renewed their commitment to assist mine survivors, including providing rehabilitation services. In particular, the OAP notes the need to “take steps to ensure that, taking into account local, national and regional circumstances, all mine victims, including in rural and remote areas, have access to comprehensive rehabilitation services [...] this includes the provision of assistive devices, physiotherapy, occupational therapy and peer-to-peer support programs.” VA efforts and the provision of rehabilitation services is a continuous process that will allow us to advance toward an inclusive society where all persons with disabilities, including EO survivors, enjoy their human rights.

---

**Abder Banoune**
Rehab Specialist, Physical and Rehabilitation Division

Humanity & Inclusion

Based in Lyon, France, Abder Banoune has seventeen years of field experience with expertise in prosthetic and orthotic technology, and project management. After graduate studies in Algeria toward a career as an orthotist with a specialty in physical rehabilitation, he joined Humanity & Inclusion in 2001 as a P&O Technical Advisor, working in China and Yemen. From 2005 to 2018, Banoune worked with the International Committee of the Red Cross (ICRC), holding a variety of roles, including Physical Rehabilitation Project Manager, working in Ethiopia, Niger, Malawi, South Sudan, and Sudan. He completed a master’s degree in Management of Health and Social Services within the Business Administration School (ESCAE, Niamey), as well as a Certificate in Advanced Training in Leadership Management and Governance (Yale University School of Public Health). Banoune speaks French, English, and several Arabic dialects.
MENTAL HEALTH: Taking a Proactive Approach to Support Staff in Mine Action

By Laura Biscaglia, Abigail Jones, and Robert White
[Geneva International Centre for Humanitarian Demining]

As public awareness on mental health in the workplace has increased in recent years, the humanitarian sector—along with the CHS Alliance, the United Nations High Commissioner for Refugees, the Antares Foundation, and others—has been stressing the need for aid organizations to ensure that their duty of care responsibilities encompass the health, safety, security, and well-being of staff.

This article aims to contribute to existing conversations on how actors in the mine action (MA) sector can work together to promote mental health in the workplace as well as prevent and mitigate adverse mental health outcomes. The article is also a call to action for MA management and leadership teams to invest in staffs’ mental well-being. Through interviews with key stakeholders and desk-based review of existing literature, this article’s focus is two-fold. First, it provides an overview of stressors on the mental health of different profiles of humanitarian workers. Second, it conceptualizes poor mental health outcomes as an organizational risk factor.

Based on an understanding that mental health risk management cannot be based on a one-size-fits-all approach, systematically integrating mental health in risk management frameworks is important and is exemplified by the good practices employed by other sectors. Moreover, the conceptualization and treatment of adverse mental health outcomes requires the application of an intersectional lens to be culturally appropriate and adaptable to the varied sources of stress, risks, needs, and priorities of a diverse workforce. The interplay between people management, organizational culture, and mental health is critical for a holistic understanding of mental health in the workplace. This article highlights these three dimensions, specifically focusing on the impact of people management and organizational factors on mental health outcomes.
Key Definitions

Mental health can be defined as “a state of wellbeing in which an individual realizes his or her own abilities, can cope with the normal stresses of life, can work productively, and is able to make a contribution to his or her community.” An individual with poor mental health can experience “a broad range of problems with different symptoms generally characterized by some combination of abnormal thoughts, emotions, behaviors, and relationships with others,” as well as physical symptoms, such as digestive issues, chest pain, and migraines.

Stressors in Humanitarian Work

A growing body of research has suggested that humanitarian workers with diverse profiles and backgrounds, including those working in mine action, are at an increased risk of various adverse mental health outcomes. Within the humanitarian sector, stressors can be divided into four categories: a) situational, b) job-related, c) organizational, and d) personal.

A) SITUATIONAL STRESSORS
- Attacks on personal well-being
- Experience of humanitarian crises and/or emergency situations (i.e., war, armed conflict, natural and industrial disasters)
- Exposure to life-threatening events and/or secondary exposure to trauma
- Exposure to poverty and violence
- Insecurity in the area of operations
- Political, social, and cultural context
- Presence of explosive ordnance in the area of operations
- Physical health risks and limited availability of treatment facilities and medication
- Public health situation in the context of operations
- Relationship and power dynamics with the local population and authorities for both foreign and local staff

B) JOB-RELATED STRESSORS
- Difficult and/or isolated living conditions
- Dislocation: social, cultural, spiritual
- Employment in potentially hazardous professions
- Heavy workload and/or periods of inactivity
- Job insecurity related to funding cycles, restructuring, etc.
- Lack of clearly defined job role and responsibilities
- Lack of recognition or adequate compensation in accordance with job role and responsibilities
- Relationships and power dynamics within the team

C) ORGANIZATIONAL STRESSORS
- Bureaucratic decision-making processes
- Lack of investment in induction and career development
- Lack of training in safety and security protocols
- Leadership and management style
- “Macho” culture in the sector

D) PERSONAL STRESSORS
- Lack of alignment between personal and organizational values
- Limited contact with social support systems and networks
- Mismatch between high motivation and commitment (efforts) and rewards (both emotional and material) received at work
- Personal and family situation and/or responsibilities
- Poor self-care behavior/lack of healthy coping mechanisms
- Pre-existing mental health conditions for which adequate treatment and healthy coping mechanisms are not underway

Figure 1: Categories of stressors.

Historically, there has been a tendency in the humanitarian sector and beyond to place most of the responsibility for adverse mental health outcomes on biological factors, attitudes, behaviors, and lifestyle choices of the individual, which in public health research is commonly referred to as “victim-blaming.” However, an amassed body of public health and social science research indicates that mental health outcomes are in fact determined by a combination of situational, organizational, job-related, and personal stressors.

While interventions have generally focused on responding to the immediate aftermath of direct exposure to potentially traumatic events, the level of stress that an individual was experiencing at the time that a traumatic event took place can have important implications on the extent to which they will develop poor mental health outcomes.

Therefore, it could be expected that a staff member that was either bullied or was feeling very insecure in the workplace at the time of the traumatic event would have low levels of resilience to help them heal from the trauma. Equally, a staff member who is experiencing personal stressors unrelated to their work and work environment may be more likely to develop poor mental health outcomes.

Furthermore, chronic stress, often a result of organizational and job-related stressors, can be extremely debilitating. Commonly-cited sources of chronic stress in the workplace include poor leadership, lack of career opportunities, and bureaucracy. These chronic stressors potentially lead to burnout, disillusionment, and frustration, all of which can affect service delivery and, at times, result in staff turnover, which poses a significant risk to the ability of organizations to fulfil their mandate.
While interventions have generally focused on responding to the immediate aftermath of direct exposure to potentially traumatic events, the level of stress that an individual was experiencing at the time that a traumatic event took place can have important implications on the extent to which they will develop poor mental health outcomes.

~Liza Jachens, Webster University, Geneva

Organizations stand to benefit from considering elements outside the event in question, including “the mental state of the person when the event took place and the extent to which the working context to which the person returns is psychologically safe and supportive.” This is now widely recognized as a key determinant of mental health outcomes.

Applying an Intersectional Lens to the Stressors Faced by Humanitarian Workers

Humanitarian workers from diverse backgrounds also face different real and perceived safety and security risks. For example, research by Humanitarian Outcomes found that in South Sudan, perceived ethnic affiliations of national staff create safety, security, and operational obstacles. In other contexts, nationality, as well as perceived political and/or religious affiliation, can increase exposure to harm. Humanitarian workers of diverse profiles and backgrounds are also increasingly at risk of becoming victims of gender-based violence (GBV). Although anyone can become a victim of GBV, women in particular face higher vulnerability in many contexts. By applying an intersectional lens, it is evident that the diversity represented by humanitarian workers can contribute to their different experience of stressors.

Diversity considerations such as gender identity and expression, age, disability, ethnicity, race, religion, nationality, or sexual orientation can also increase exposure to safety and security risks, affecting staff mobility and ability to engage in healthy coping mechanisms, with potential repercussions on mental health outcomes. For example, members of the LGBTQ+ community, as well as individuals perceived to be part of it, may face specific safety and security risks in the contexts in which they operate (situational stressor). Furthermore, they may experience stigmatization, bias, and discrimination from their teams and organizations (organizational and job-related stressors), with potential negative repercussions on their mental health.

For employees with disabilities, the way in which an organization conceptualizes disability, as afflictions affecting an individual who needs to be cared for by others (medical/charity models of disability) or as being caused by the way in which society is organized (social model of disability) can affect a disabled individual’s perception and/or the success of their employment. The extent to which organizations focus their efforts on making all reasonable adjustments and removing barriers to the employment of humanitarian aid workers living with disabilities can have either a protective or detrimental effect on their mental health.

Just as stressors are different among diverse profiles of humanitarian workers, the prevalence of different types of mental health outcomes experienced can also vary significantly. More research is needed in the field of humanitarian work, yet statistical evidence from studies conducted in the general population in different social and cultural contexts indicates that women are more likely than men to suffer from post-traumatic stress disorder (PTSD), major depression, anxiety disorders, and burnout. Women who experience burnout are also reportedly at increased risk of hazardous alcohol consumption, and less likely than men to seek help for alcohol-related problems due to gender stereotypes and social stigma. However, substance use disorder and suicide are overall more frequent among men, partly linked to the fact that men across cultures are reportedly more prone to ignoring stressors and using unhealthy mechanisms such as hazardous alcohol consumption, substance use, and transactional sexual activities. These and other reckless coping behaviors can also negatively affect the beneficiary community as well as damage the reputation, performance, and funding opportunities of the organization.
Applying an Intersectional Lens to the Stressors Faced by Mine Action Staff

Mine action often takes place in places where staff face a multitude of security risks. In some contexts, mine action organizations and their staff are considered legitimate targets by armed non-state actors and are therefore at high risk of being abducted, killed, or injured. Furthermore, the prevalence of the use of improvised explosive devices means that deminers are now at greater risk of death or injury due to the unpredictability of these devices. In 2018, the Landmine and Cluster Munition Monitor identified twenty casualties among deminers in seven countries (four deminers were killed and sixteen injured). Research into mental health outcomes of explosive ordnance (EO) disposal technicians in the U.S. military suggests that exposure to the types of traumatic events described previously can influence the risk of developing negative mental health outcomes such as PTSD, anxiety disorders, and major depression.

When considering the mental health outcomes of mine action staff, the fact that the sector is traditionally male dominated and the common associations with traditionally constructed notions of masculinity (i.e., encouraging risk-taking, physical toughness, self-discipline, emotional control, or numbness), may be particularly relevant when assessing the mental health outcomes of men working in the sector. This assertion is broadly in line with research into the link between notions of masculinities in the military and how it negatively affects mental health outcomes. At the same time, generalized notions of masculinity are only one factor in a complex net of causation for mental health outcomes, and approaches that ignore other stressors can actually serve to further stigmatize men.

In some contexts, it is a common practice for field teams to be deployed to areas of operations far from their home for long periods of time. For mine action staff with family responsibilities, for example those who are deployed soon after the birth or adoption of children, being placed in areas of operations far away from their families can exacerbate stress. This could particularly be a challenge for deminers who are stationed for consecutive weeks in clearance locations compared to those who return home at the end of the working day. Furthermore, international staff of mine action organizations frequently reside in shared accommodations, where they not only lack privacy and personal space but are unable to leave the workplace for long periods of time. This is especially the case for those based in areas where mobility is restricted due to real and perceived safety and security concerns.

Understanding Mental Health as an Organizational Risk

Taking a proactive approach to the management of mental health and building resilience needs to be an objective within mine action. Numerous studies from the humanitarian field and other sectors with similarities to mine action, such as the military and the police, make a strong case for promoting the mental health of staff for organizational purposes. While this should be driven by ethical considerations and duty-of-care responsibilities, the negative ramifications of poor mental health on an organization’s capacity to fulfill its mandate cannot be discounted.

A Risk Management Approach to Mental Health

Different frameworks have been used to varying degrees of success to address mental health in the workplace as “[t]raditionally, mental health and psychosocial support (MHPSS) actions have been focused on the response and recovery phases of emergencies with the aims of reducing suffering and re-establishing functioning of those impacted ... However, recently this disaster management field has begun to expand beyond reactive approaches to encompassing more proactive disaster risk management (DRM), with the goal of disaster risk reduction (DRR).” Among these different approaches, a mental health risk management framework is relevant for the mine action sector, given how critical managing risk is in every aspect of mine action. According to International Mine Action Standards (IMAS) 07.14, “the purpose of risk management in mine action is to identify, assess, control and review risk wherever it may arise, such that mine action programmes, projects and activities are safe, efficient and effective in achieving their objectives.” IMAS 10.10 Safety and Occupational Health [S&OH] General Requirements states that “the need to reduce risk and to provide a safe working environment are fundamental principles of mine action management” and emphasizes the need for “developing work practices that contribute to risk reduction.”

Even though the title of IMAS 10.10 mentions “occupational health” there is no reference to the management of stressors or the effects, consequences, or impact of mental health on operations, only stating that “NMAA and employers […] should establish and maintain S&OH management systems.” To date, limited research has been conducted on organizational stressors in humanitarian work, prompting the need for future research to “develop and explore a hybrid risk assessment tool that draws from generic stress models while also including job- and context-specific stressors.”
Mental Health Risk Management for Mine Action

<table>
<thead>
<tr>
<th>CORE RISK AREAS CONSIDERED BY RISK MANAGERS</th>
<th>POTENTIAL IMPACTS OF STAFF BURNOUT AND MENTAL ILLNESS ON THE ORGANIZATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPERATIONAL</td>
<td>Unwell staff are more likely to make poor decisions and less likely to achieve desired objectives. Productivity is compromised by absenteeism, presenteeism, and turnover.</td>
</tr>
<tr>
<td>SAFETY, SECURITY</td>
<td>Unwell staff are more prone to accidents, illness, and security incidents.</td>
</tr>
<tr>
<td>FIDUCIARY</td>
<td>Unwell staff may underperform as stewards of financial resources. Financial losses can result from absenteeism, presenteeism, and turnover.</td>
</tr>
<tr>
<td>REPUTATIONAL</td>
<td>With impaired judgement, unwell staff may engage in toxic behaviors and misconduct, which could damage the organization’s image and reputation.</td>
</tr>
<tr>
<td>INFORMATION</td>
<td>Unwell staff may mishandle or lose data, or leave an organization with no handover.</td>
</tr>
<tr>
<td>LEGAL, COMPLIANCE</td>
<td>If staff become unwell as a result of the work, this calls into question whether applicable laws and regulations are being followed.</td>
</tr>
<tr>
<td>ETHICAL</td>
<td>Harm caused by inadequate duty of care and inequality in the protection and services provided to international staff versus national staff represents organizational failure to fulfill obligations to protect staff.</td>
</tr>
</tbody>
</table>

Table 1. Focus areas of risk for staff burnout and mental illness.

Within mine action there are many risks to consider when addressing the duty of care obligation: to promote mental and physical health, and avoid long-term exhaustion, burnout, injury, or illness.

The risk management framework should consider the potential impact on several core risk areas with varying degrees of severity and, based on these factors, develop criteria to monitor the ongoing management of staff mental health.

Mine action can look to other sectors in similar high-risk environments for examples of effective frameworks and approaches to managing mental health. These include the police, fire, and rescue services; paramedics; and national militaries. The police force in the United Kingdom has been reviewing their mental health services’ response to demonstrate their commitment and determination to understand and address the issues affecting staff and to provide appropriate investment in the key areas they have identified: prevention, early detection of illness, and rehabilitation. Since its initial launch in 2017, the “Oscar Kilo” program has grown rapidly and is now employed by police forces and fire and rescue services across the United Kingdom. Support is provided through an online platform that gives access to evidence-based research and resources that can be used to help shape well-being provision and encourage collaboration and innovation across all emergency services. The College of Policing have also developed the Blue Light Wellbeing Framework. This framework presents a more holistic approach to the risk management of well-being and mental health, recognizing the role of management as well as the responsibility of individuals to manage their mental health.

Mine action also has positive examples of addressing mental health issues in the sector. Within the framework of victim assistance, there is a body of work in psychological support for the family and community. In recent years, countries such as Cambodia have looked to increase resources to support mental health in conflict-affected communities, although challenges remain. Moreover, Humanity & Inclusion provide structured support in community-based MHPSS interventions, aiming to “increase collaboration and coordination among actors to reduce mental health risk factors.” This practice can benefit risk-management frameworks, supporting mine action staff working in affected communities.

MAG have had positive reactions to investing in dialogue and support on mental health issues within the organization.

~Darren Cormack, CEO, MAG
Looking Forward

There is a standard that individuals, managers, and agencies have to the duty of care, which is not just physical wellbeing, but also mental wellbeing. Given that so many people are experiencing mental health problems, we are clearly not meeting this standard, so what can we do to analyse, reflect and adjust to ensure we do better? ~Melissa Pitotti, CHS Alliance

Mine action strives for a world in which communities thrive, free from risks from EO. However, there is a clear need to engage in dialogue about how, in addition to supporting beneficiaries, mine action organizations can better support the mental well-being of their own staff. Indeed, while demining is an especially hazardous profession if safety and security protocols are not followed, evidence from the humanitarian sector more broadly highlights that all staff can be at risk of negative mental health outcomes.

To fulfill the duty of care to staff, it is critical that mine action organizations take steps to adopt a more consistent risk-management approach to mental health. Further work and coordination is required to this end, which can build upon lessons learned from other sectors as well as the work already carried out under the mine action pillar of victim assistance. One potential entry point would be to integrate requirements related to the mental health of staff by updating the IMAS 10.10 Safety & Occupational Health General Requirements, subject to the agreement of the IMAS Review Board. That said, it is evident that more research is required to understand the risk factors and challenges to the integration of mental health considerations into risk management frameworks.

Ultimately, the promotion of mental health in mine action will require a commitment to not only deal with adverse mental health outcomes as they arise but also to contribute to their prevention, based on the understanding that mental health, organizational culture, and people’s management are closely interconnected. Furthermore, in order to be truly effective and respond to the differentiated needs of a varied workforce in culturally appropriate ways, it is vital that any future discussion and initiative on mental health that the sector engages in is undertaken through an intersectional lens.

See endnotes page 149

BIographies

Laura Biscaglia
Programme Officer
Geneva International Centre for Humanitarian Demining

Laura Biscaglia (she/her) is a Programme Officer working on gender equality and inclusion at the GICHID. In her role, she contributes to the provision of capacity development, research, and outreach on gender equality and inclusion in mine action. Biscaglia also acts as the GICHID’s focal point to the International Gender Champions. Biscaglia holds a master’s degree in International Affairs with a specialization in conflict and peacebuilding from the Graduate Institute of International and Development Studies, and a bachelor’s degree in Politics, Philosophy and Economics from Luigi University in Rome, Italy.

Abigail Jones
Advisor on Gender and Diversity
Geneva International Centre for Humanitarian Demining

Abigail Jones (she/her) is an Advisor on Gender and Diversity at the GICHID. Jones previously worked for the Gender and Mine Action Programme (GMAP), the Danish Refugee Council as a global technical advisor on EORE, and as a community liaison manager for the MAG. She holds a master’s degree in Development Studies from the School of Oriental and African Studies, a bachelor’s degree in International Relations from the University of Birmingham, as well as qualified teacher status in the United Kingdom.

Rob White
Deputy Head of Division, Standards and Operations
Geneva International Centre for Humanitarian Demining

Rob White is Deputy Head of Division for Standards and Operations at the GICHID, a division that provides services and technical expertise on developing standards and increasing operational efficiency and effectiveness in mine action. The Division focuses on strengthening national capacities to enable greater ownership of mine action operations, in line with national and global strategic priorities. Prior to joining the GICHID, White worked as Director of Development at a UK NGO. He is a past Trustee and later CEO of the UK mine action research NGO Find A Better Way (now Sir Bobby Charlton Foundation) and Chief Operating Officer of the Iraqi NGO, Iraq Mine UXO and Clearance Organization (IMCO). The majority of his mine action career was spent with the Mines Advisory Group (MAG) in various positions including Director of Operations/Deputy Director with responsibility for managing MAG’s global operations. He has a master’s degree with merit in International Development: Poverty, Conflict and Reconstruction from the University of Manchester, United Kingdom.
AN INNOVATIVE APPROACH TO THE MENTAL HEALTH NEEDS OF Humanitarian Mine Action Personnel

By Ken Falke, Bret A. Moore, Psy.D., ABPP, and Richard Tedeschi, Ph.D.
[ Boulder Crest Institute for Posttraumatic Growth ]

In the fields of humanitarian demining and explosive ordnance disposal (EOD), physical traumas related to blast and fragmentation injuries receive a great deal of research attention. In contrast, focus on the psychological health and wellness of humanitarian mine action personnel (HMAP) is lacking. Although research on the incidence of mental health disorders among HMAP is extremely limited, compared with the general population, this group likely suffers more from psychiatric conditions such as posttraumatic stress disorder (PTSD), depression, and anxiety. HMAP work in a high state of hypervigilance because at any given moment in a demining operation, there is risk of death and/or severe maiming. In addition to the inherent risk associated with searching for and working with live unexploded ordnance, deminers are exposed to the constant stress of conflict, which can include shouldering the psychological burden of responsibility for the physical well-being of innocent civilians exposed to explosive devices and witnessing the death and injury of others. Because of the multiple and unique stressors associated with this inherently dangerous work, HMAP likely experience trauma-related mental health conditions at a rate equal to, if not greater than, other high-risk professionals such as military personnel and first-responders (e.g., firefighters, law enforcement, emergency medical technicians). Although estimates vary, rates of PTSD for the latter groups range from 10 percent to over 30 percent depending on the study cited. Therefore, it is critical to identify effective strategies for mitigating the effects of psychological trauma in this high-risk group.

Conventional Approaches to Addressing Psychological Trauma

Although there are a number of psychiatric conditions that can manifest following exposure to a traumatic event, PTSD is the most notable. Symptoms of PTSD vary among individuals, but most experience some combination of problems related to intrusions (e.g., nightmares, flashbacks), avoidance (e.g., avoid thinking or talking about past traumatic events), mood (e.g., depression, negative thoughts), and arousal/reactivity (e.g., insomnia, being easily startled, irritability). The primary approach to the treatment of PTSD is psychotherapy. The overarching goal of psychotherapy is symptom reduction. In fact, if treatment is successful and enough symptoms are eliminated, the person no longer technically meets the diagnostic criteria for the disorder and is considered “cured” from a medical model perspective.

There are several psychotherapies commonly employed in the treatment of PTSD. Two have gained considerable popularity in recent years—Prolonged Exposure (PE) and Cognitive Processing Therapy (CPT). PE and CPT are trauma-focused, manualized therapies, which are stepwise, scripted interventions that require the person to confront the trauma through talking or thinking about the traumatic event.
Research shows that psychotherapy is beneficial for some individuals who develop PTSD as a result of working in high-risk occupations (see Moore and Penk, 2019 for a review of PTSD interventions for active-duty military members and veterans). However, trauma-focused therapies like PE and CPT have high dropout rates due to the increased distress that often arises when a person actively confronts past traumatic events. There is also concern about the overall effectiveness of these psychotherapeutic interventions. Studies show that up to two thirds of individuals who receive treatment with trauma-focused psychotherapies show only modest improvements and continue to meet the diagnostic threshold for PTSD.4,5,6 Limited access to psychotherapy services must also be taken into consideration when addressing the psychological needs of HMAP. Moreover, the availability of psychiatric mental health professionals is significantly limited in countries where demining operations occur.

Alternative to Traditional Interventions: Posttraumatic Growth and Expert Companionship

Considering the significant limitations and availability of psychotherapy treatments for PTSD, examining other interventions for mitigating the negative effects of this relatively common and chronic psychiatric condition is imperative. One such approach is applying the principles of posttraumatic growth (PTG) as a means to assist people who are managing the negative effects of trauma yet also trying to thrive and grow in the aftermath of trauma.

PTG is defined as positive psychological changes that occur as a result of the struggle with traumatic events. Instead of thinking of trauma as a specific type of event and subsequent dysfunction, the concept of PTG considers trauma as life experience that can produce transformative change due to reconsideration of previous held beliefs. Research identifies five domains of growth following trauma: appreciation of life, new possibilities, personal strength, relationships, and spiritual/existential change.8

The facilitation of PTG is accomplished through the process of Expert Companionship, which is a novel approach based on sound psychological principles and includes education, distress management, emotional disclosure, creation of a new life narrative, and mission/service (see Tedeschi & Moore, 2020 for a detailed review of Expert Companionship).9 An application of this approach is found at Boulder Crest Foundation, a community-based, nonprofit, multisite
organization that focuses on improving the psychological health of veterans and first responders, including active and former EOD personnel. Boulder Crest’s flagship program is a seven-day residential program called Warrior PATHH (Progressive and Alternative Training for Healing Heroes) and utilizes a variety of complementary and alternative interventions (e.g., mindfulness/meditation, yoga, equine therapy) and traditional psychotherapeutic techniques (e.g., psychoeducation, distress management, relationship building, goal setting). This initial part of the program has a follow-up component that lasts eighteen months through online resources and interpersonal connections. As part of an evaluation of the program, forty-nine combat veterans who completed Warrior PATHH were followed for eighteen months. Results showed reductions in psychiatric symptoms associated with PTSD, depression, and anxiety as well as increases in the ability to manage stress and psychological growth.\textsuperscript{10}

A unique aspect of Warrior PATHH is that it is peer-delivered and is not run or managed by mental health professionals. This is an important component of the program as those working within Warrior PATHH are veterans and first responders who understand the unique needs and professional culture of those who attend the program. This peer-delivered, expert companion approach would be serviceable within mine action, as HMAP engage in work and function within a professional and organizational culture that few people truly understand. Moreover, attending a program provided by people who can speak directly to the everyday work experiences and shared psychological challenges of demining work can rapidly produce trust and open disclosure, facilitating the healing process. Although participants in Warrior PATHH point to specific program elements as impactful, they commonly refer to the way they are treated with respect and understanding by all the staff as a crucial element in allowing them to engage in the learning that takes place during the program.

HMAP, whether they are local individuals within their respective communities or former EOD professionals, would benefit from an interventional approach that focuses on education about common responses to trauma, strategies for managing distress, and methods for integrating traumatic experiences into a future-oriented framework that promotes psychological growth.

Conclusions

It is incumbent upon those within leadership positions in humanitarian mine action to identify novel and effective strategies for addressing the mental health needs of their staff, especially those working in high-stress environments. For mental health professionals, our experience with combat veterans and first responders can be a source of ideas about how to help traumatized HMAP. Not only do these groups have similar traumatic work experiences, but many individuals involved in demining also have engaged in their work as a way to be of service to others, and to act as protectors. One of the reasons why the PTG intervention model of Expert Companionship resonates with people in these professions is because there is an emphasis on developing a mission of service as part of the healing.

Logistically, implementation of mental health programs within organizations involved in demining work will need to be championed by those within leadership positions. However, the delivery of novel psychological interventions similar to the ones noted in this article can be peer-managed for reasons already noted. This will likely resonate within the HMA community as peer-support programs have historically been a critical part of addressing the varied needs of HMA personnel.\textsuperscript{53}

See endnotes page 150
It is incumbent upon those within leadership positions in humanitarian mine action to identify novel and effective strategies for addressing the mental health needs of their staff, especially those working in high-stress environments.

**Biographies**

**Ken Falke**  
Founder & Chairman  
Boulder Crest Institute for Posttraumatic Growth

Mr. Ken Falke is a twenty-one-year veteran of the U.S. Navy Explosive Ordnance Disposal (EOD) community and retired Master Chief Petty Officer. During his career, he made over 1,000 parachute jumps and the same number of underwater military dives. He led thousands of high-risk operations to include rendering safe unexploded ordnance, landmines, and improvised explosive devices (IEDs) and is highly respected around the world as an innovative and forward thinking thought leader on the subjects of counterterrorism, military training, innovative technology development, wounded warrior care, and military to veteran transition.

Falke’s passion is taking care of his fellow combat veterans and their family members and is chairman and founder of Boulder Crest, an organization focused on the teachings of posttraumatic growth. He spends the majority of his time educating the public and private sectors on the issues surrounding the long-term care of our returning military personnel and their families from the last twenty years of war.

Falke is a serial entrepreneur. He founded two for profit and two nonprofit companies. As the Founder and CEO of his first company, A-T Solutions, the company is a recognized international expert and valuable global asset in combating the war on terrorism. At the forefront of providing training and consulting services in the Counter-Terrorism industry. A-T Solutions was named four consecutive years to the Annual Inc. 500 fastest growing privately held companies in the United States. Also recognized in Entrepreneur Magazine’s Hot 500 List, the Washington Technology “Fast 50”, Smart CEO’s “Future 50”, and the winner of the Greater Washington Area Government Contractor Award in the category of companies $75M–$100M. In 2010, Falke was named as the Entrepreneur of the Year for the Fredericksburg, Virginia Regional Chamber of Commerce and selected as a finalist in the prestigious Ernst and Young Entrepreneur of the Year program.

**Bret A. Moore, Psy.D., ABPP**  
Vice Chair  
Boulder Crest Institute for Posttraumatic Growth

Bret A. Moore, is Vice Chair of the Boulder Crest Institute for Posttraumatic Growth and a clinical and prescribing psychologist based in San Antonio, Texas. He is a former active-duty Army psychologist and completed two tours (twenty-seven months) in Iraq as a Clinical Psychologist and held the positions of Chief of Clinical Operations and Officer in Charge of Preventative services while deployed. He is the author and editor of twenty-two books, including Handbook of Clinical Psychopharmacology for Psychologists, Handbook of Clinical Psychopharmacology for Therapists, Child and Adolescent Clinical Psychopharmacology Made Simple, Treating PTSD in Military Personnel: A Clinical Handbook, The Posttraumatic Growth Workbook, Wheels Down: Adjusting to Life after Deployment, and Taking Control of Anxiety: Small Steps for Overcoming Worry, Stress, and Fear. In addition to writing dozens of book chapters and journal articles, Dr. Moore has written feature articles for a number of popular press publications to include Scientific American Mind, The New Republic, Psychology Today, and Military Times. Dr. Moore is a Fellow of the American Psychological Association and recipient of the Charles S. Gersoni Military Psychology Award and the Arthur W. Melton Award for Early Career Achievement in Military Psychology from Division 19 and the Early Career Achievement Award in Public Service Psychology and the Peter J. N. Linenrooth National Service Award from Division 18 of APA. His views on clinical and military psychology have been quoted in USA Today, The New York Times, and The Boston Globe, and on CNN and Fox News. He has appeared on NPR, the BBC, and CBC.

**Richard Tedeschi, Ph.D.**  
Distinguished Chair  
Boulder Crest Institute for Posttraumatic Growth

Richard Tedeschi, Ph.D., is Professor Emeritus in the Department of Psychological Science at the University of North Carolina at Charlotte, and Distinguished Chair of the Boulder Crest Institute for Posttraumatic Growth, in Bluemont, Virginia, where he has been one of the developers of programs based on PTG principles to help combat veterans and first responders. He has published several books and numerous professional articles on PTG, an area of research that he developed while at UNC Charlotte. Dr. Tedeschi serves as a consultant to the American Psychological Association on trauma and resilience, is a Fellow of the Division of Trauma Psychology and the Division of Psychotherapy, and is Past President of the North Carolina Psychological Association.
Automated management information systems to enhance decision-making abilities are becoming more important today. Funding and resources are scarce, but technological developments are making it possible to conduct sophisticated analyses that will enhance planning and prioritization: doing more with less. Centered around optimization and efficiency, the geographic information system (GIS) tools provided by Esri have been crucial in providing MAG (Mines Advisory Group) with decision-making software.

MAG has assisted affected communities in Southeast Asia (SEA) for more than twenty years. In Cambodia, Laos, and Vietnam (SEA), MAG employs more than 2,000 national staff—more than 30 percent of whom are women. Between 1965 and 1975, more than 7.5 million tons of bombs were dropped over Cambodia, Laos, and Vietnam, which is double the amount dropped on Europe and Asia during World War II. Despite the conflicts ending more than forty years ago, cluster munition and landmine contamination continue to kill, injure, and hinder development in the region.

To be able to make better operational decisions in SEA, MAG incorporated information from the Theater History of Operations Reports (THOR) database, which overlays bombing locations and related data over satellite images. THOR contains declassified records of the aerial bombing missions conducted by the United States from World War I to the present. In what remains the largest aerial bombardment in human history, more than 182,000 bombing missions were conducted during the Vietnam War using cluster munitions in Cambodia, Laos, and Vietnam. As a result, according to data from THOR, almost 1.6 billion submunitions were dispersed. The cluster munition contamination tool developed by MAG aims to accelerate the process of survey and clearance by informing stakeholders in advance to determine where there is a need for non-technical survey (NTS), technical survey (TS), or if an area should be cleared directly.
"Without data, you are just another person with an opinion."

- W. Edwards Deming

The first concept of a simple geospatial analysis was conducted in 1832 by geographer Charles Picquet, who created a map that showed cholera outbreaks across forty-eight Paris districts. His cholera outbreak map was an early version of a heat map represented by color gradient according to the percentage of deaths from cholera per 1,000 inhabitants. In 1854, a similar geospatial analysis model was used by Dr. John Snow who also mapped data from a cholera outbreak in London. His map allowed him to see a clear pattern that no one had noticed and to ultimately discover the source of the outbreak. His findings led to changes in the water and waste management systems of London and other cities resulting in improvements in general public health. The term GIS did not exist in the 19th century, but it allowed Picquet and Snow to ask questions based on data and helped them to solve problems, just like we do today with GIS.

Problem Statement

In 2005, the Geneva International Centre for Humanitarian Demining (GICHID) released its publication, A Study of Manual Mine Clearance. Many of the conclusions and recommendations in this publication are worth revisiting. The publication urged the mine action community and its stakeholders to urgently consider moving to a more explicit risk management approach. Systematically recording, e.g., the depth at which mines are located, would provide valuable information to support development of a professional risk management system. Furthermore, if confidence in the mine clearance industry is to be maintained, the study recommended that performance must be reported accurately and honestly to reinforce the principle that exaggerated clearance statistics are unacceptable. It also recommended that data collection should be standardized and improved to allow clearer oversight of cost-benefit issues related to mine clearance. This data should enable detailed analysis of the costs for the land that had been cleared. In short, this publication outlined the key elements for land release, which almost a decade later was acknowledged when the major amendment of land release was approved for the International Mine Action Standards (IMAS) in 2013. Land release was further strengthened by a new version of the IMAS covering quality management in 2016 and complemented by the new IMAS on risk management in 2019, and an updated IMAS on information management in 2020.

Moreover, in 2018, the Mine Action Review’s publication Clearing the Mines repeated some of the key issues identified in 2005:

For sure, mistakes in survey in the early days cost us all dearly, exaggerating hugely the extent of the problem and asserting the presence of contamination where it did not, in fact, exist. And, despite the best of intentions, poor survey and inadequate information management continues to plague our profession, sometimes leading to clearance resources being wasted on uncontaminated areas. Today, however, old surveys can no longer be an excuse for slow progress. The re-surveys conducted in several countries over the last few years, as well as those underway or planned, clearly evidence that high-quality survey can be achieved without excessive expenditure. An accurate baseline is, or should be, the starting point for all successful national mine action programmes.

Managing Big Data

Many sectors moved more quickly than others to embrace technological developments at the turn of the 21st century, including a broad range of new technical breakthroughs such as information technology and telecommunications. Yesterday’s powerful desktops are being transformed to sensory input and output devices, combining intelligent software and extensive connectivity. We become used to networks connecting to everything and we are adapting to "smart environments” that are changing how we work, what we consume, and how we interact with other people. In the past decade organizations have been increasingly storing, processing, and extracting value from data of all forms and sizes. Systems that support large volumes of structured and unstructured data will continue to rise. Organizations will continue to explore technology that fulfills the demand on platforms that help data custodians govern and secure big data while empowering end users to analyze that data. These systems will mature to operate well inside of enterprise IT systems and standards.
GIS is an extension of cartography, which can be summarized as the art and science of making maps that enable organizations and individuals to visualize, analyze, question, and interpret data. Realistically, there is no limit to the amount of data that can be added to an ArcGIS system for an organization working in mine action. Esri was founded as the Environmental Systems Research Institute in 1969 as a land-use consulting firm and is today a leading international supplier of GIS software, web-based GIS, and geodatabase management applications. Over the past decade, Esri has transformed its GIS into the platform it is today—easy to set up and use “out of the box.”

Since 2013, MAG has explored and developed various information systems for mapping and reporting of survey and clearance activities. In 2015, MAG started exploring Esri tools in Cambodia. Research and development activities were conducted under an Operational Field Evaluation (OFE) project in Ratanakiri Province in northeast Cambodia. MAG’s OFE projects in Cambodia have been funded and supported by the U.S. Humanitarian Demining Research and Development (HD R&D) Program for almost two decades, and have expanded to other global MAG programs in the Middle East, Europe, and SEA for mechanical and detection OFEs. HD R&D focuses on the rapid development, testing, demonstration, and validation of technologies that increase the efficiency and enhance the safety of humanitarian demining operations. In this mission, HD R&D may adapt commercial-off-the-shelf technologies, use mature technologies, or leverage existing military countermine technologies.

In 2018, MAG decided that it was of strategic importance to replace the paper-based system in use at the time with a “one time input” of data method via tablets used by field operators that would improve analysis and decision-making. The information system also needed to be compatible with IMSMA Core that was being developed and rolled out to national mine action authorities by the GICHD in 2016. The strength of MAG’s information system is that
it has taken full advantage of the tools made available by Esri, especially when it comes to geospatial analysis and predictive analysis to inform and assist operational decision-making.

MAG's information system was named the Operations Management Information System (OMIS) to separate it from other information systems being developed in MAG at the same time. In late 2018, funded by HD R&D, MAG purchased a license for Esri systems, and began setting up and implementing OMIS. HD R&D has continued to provide support for the development and rollout of OMIS. In 2020, the Dutch government also contributed toward the rollout of OMIS.

**Development of a geospatial analytical tool.** During the global pandemic in 2020, MAG's Global OMIS team started work on exploring U.S. bombing data from the Vietnam War using datasets from THOR. MAG's aim in developing the tool was to improve planning, prioritization, and evidence-based operational decisions in SEA.

**Cluster munition contamination tool.** The cluster munition contamination tool runs within MAG's Esri Enterprise environment and OMIS, where it classifies priority areas for survey and clearance of cluster munition contaminated areas across SEA. To predict cluster munition contamination risk, the tool compares extracted data from bombing missions that only contain cluster munitions with recorded submunition evidence found during explosive ordnance disposal (EOD) response, survey, and clearance operations for MAG in SEA. Mapping relative risk of ground contamination provides insight for prioritizing survey and clearance operations. In certain cases where predictive risk is very high, the tool will identify areas where battle area clearance (BAC) teams can move directly to clearance operations without the need for TS.

**U.S. bombing data.** The U.S. bombing analysis uses target location data for Cambodia, Laos, and Vietnam from the THOR database that are mapped as points representing cluster munition target locations. Not all cluster munitions were successfully dropped on target, as indicated by battle damage assessment within the dataset. Despite spatial uncertainty, clear distribution patterns are detectable and useful for analysis, such as bombing missions along roads.

**Evidence data.** Submunition evidence was compiled from MAG's survey and clearance operations in SEA. Norwegian People's Aid (NPA) shared some of its data from Vietnam for comparative analysis. Maps of suspected hazardous areas (SHAs) and confirmed hazardous areas (CHAs), released land, and areas known to have no cluster munition contamination were used in the analysis for validation and refinement.

**Elevation data.** Thirty-meter grid elevation data from the United States Geological Survey (USGS) Shuttle Radar Topography Mission (SRTM) was used to create a 30-m slope grid. Terrain type, such as steep slope, gentle slope, and flat slope, provides further results segmentation to assist prioritization of contaminated areas.

**Tool development.** Using the Python programming language, Esri ArcPy, and numerical analysis libraries, the geospatial analytical tool runs locally on Esri ArcGIS Pro and is deployed over server side geoprocessing services into web applications via Esri Enterprise ArcGIS Server. As data analysis takes place on a 30-m grid covering SEA, the tool creates a map of bomb risk by dispersing point-based cluster munition data onto this grid and creates a second grid for evidence-based risk using the density of items found on the ground. The two grids are weighted based on patterns within the data and summed to create an overall risk map. This is classified by priority for survey and clearance, using further ancillary datasets such as slope type. The tool enables selection of evidence data for model training and prediction. Countries and provinces are selected for iterative 30-m grid processing, and the results are converted back to seamless vector polygon mapping for reporting and visualization in Esri desktop and online products. Analysis is performed using Esri spatial grids and running mathematical functions on the same data converted into Python programming language data structures.

<table>
<thead>
<tr>
<th>CLASSIFICATION</th>
<th>REASONING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical survey-low</td>
<td>Nearby cluster munition targets; no nearby submunition evidence recorded</td>
</tr>
<tr>
<td>Technical survey-high</td>
<td>High levels of nearby cluster munition targets; no nearby submunition evidence recorded</td>
</tr>
<tr>
<td>Clearance-low</td>
<td>Nearby submunition evidence recorded; no nearby cluster munition targets</td>
</tr>
<tr>
<td>Clearance-medium</td>
<td>Evidence of nearby cluster munition targets and nearby submunition evidence recorded, where either cluster munition targets are high with low submunition evidence recorded, or submunition evidence recorded is high with low cluster munition targets, or both cluster munition targets and submunition evidence recorded are both medium intensity</td>
</tr>
<tr>
<td>Clearance-high</td>
<td>Evidence of high levels of nearby cluster munition targets and high levels of submunition evidence recorded</td>
</tr>
</tbody>
</table>

Table 1. Weighted scoring table for classification.
Model Parameters

Several model-run parameters were set using a configuration file containing:
- Evidence data to be used for training and prediction
- Percentage evidence data covered by bombing dispersion zone
- Relative weighting applied to bombing and evidence risk
- Granularity of output classifications, i.e., number of output risk in the final risk map (high, medium, or low)
- Slope classification
- Countries and provinces to process

Determine dispersion distance from cluster munition drop target location.
An incremental distance search is performed from all cluster munition target point locations until a required percentage of “training” evidence is found. The spatial relationship between bombing target locations data and evidence data is used to define a distance that ensures submunition data is dispersed to cover all areas of known evidence, with the exception of outliers.

Disperse submunition data into dispersion zones. Estimates of submunition data at each cluster munition target location is calculated using the following formula: submunition count = number of aircraft x load x 650 as a starting point. Submunition counts are dispersed into a circular zone on the 30-m grid, defined by the dispersion distance and using distance weighting. Grid cells closer to the target location will receive a greater proportion of submunition count than those cells at the edge of the circular dispersion zone. The full submunition count at a target point is dispersed into the surrounding 30-m grid. In areas where cluster munition target points cluster, a grid cell may receive partial submunition counts from more than one nearby cluster munition target, which will accumulate. This process creates a submunition density map across SEA, where the sum of all submunition counts in 30-m grid cells equals the total amount of submunitions dropped.

Obtain submunition density profile for evidence locations and create a submunition risk grid. Evidence points are overlayed onto the submunition density grid to calculate a density profile for known evidence. This is converted to percentile-based density ranges, where ranges are ordered from high to low density. The default analysis classifies each grid cell in the submunition density grid with a weighted score from eleven (low) to twenty (high) based on the low-to-high-density ranges overlapping known evidence. The specific number of ranges and weighted scores allocated to each is defined in tool configuration settings.

Create evidence-based risk grid. Point locations of submunitions evidence are interpolated onto a 30-m grid using kernel density routines with a 1-km dispersion distance. Routines convert this grid to numerical Python arrays, and percentile density ranges are calculated based on cells with evidence densities greater than 0. Percentile ranges are classified with a weighted score from twenty-one (low) to thirty (high) based on the low-to-high-density ranges. Presence/absence evidence data is used to create the evidence-based risk grid.

Create cumulative risk map. Submunition and evidence risk grids are relative rather than absolute. They are summed to create a grid cell range (i.e., low-medium-high). Evidence has higher relative weight. The cumulative grid result is re-classified into priority levels as indicated in Table 1 (previous page).

Output generation. Quality control processes are included in the tool to resolve potential misalignment issues between different polygon datasets. For example, CHA extents are dropped using extents of clearance polygons to prevent overlap. Processes also resolve NTS issues. NTS field survey areas indicating no evidence of cluster munitions are subsequently removed from areas defined for TS or clearance priority.

To add reporting value to outputs, priority classifications are further refined by slope type (flat, gentle, or steep) and overlap status with CHA/clearance areas by combining with maps of slope classification and CHA/clearance polygon extents. Outputs are supplied as Esri raster grids and Esri file geodatabase feature classes ready for ingestion into Esri desktop and online products/services.
Conclusion

Easy access to interactive global networks together with machine learning (ML) can improve how we gather, analyze, monitor, and evaluate information. Mine action in particular benefits immensely, enabling the sector to move away from a traditional tiered command and control structure to horizontal networks and co-operative teams that continually enhance decision-making, monitoring, and evaluation abilities.

The cluster munition contamination tool will not be truly effective on its own. The more data that is entered, the better the system becomes. It requires stakeholder and operator feedback, sharing of data, and most importantly, use of the tool. Equipped with ML capabilities, this tool can assume control of manual and repetitive tasks to increase the speed of data analytics. This helps to eliminate manual data entry errors and data duplication, ensuring higher quality of work. Moreover, organizations do not need a developer to reprogram the system every time organizational workflows change inside the system. By learning from data continuously, the platform will be able to improve its performance and adjust work processes in the system with minimum human assistance.

Conclusively, access to information is key to inform decisions and actions determined by methods applied, to manage risk supported by a quality management system to ensure that acceptable risk is monitored and kept as low as possible. This should be a process driven by evidence and systematically sequenced for the control and continuous improvement of processes and products well known to many of us as the Deming Cycle: Plan, Do, Check and Act (PDCA). Consequently, location intelligence and data driven decision-making are key attributes for “doing the right things” and “doing things right.”

See endnotes page 150

Mikael Bold
MAG (Mines Advisory Group)
Technical Director

Mikael Bold joined MAG in March 2018 as the Technical Director to contribute to the delivery of MAG’s Strategic Plan through effective leadership of the Operations Development Team with the aim of ensuring high levels of safety, quality, innovation and continual improvement for MAG’s global operational implementation, and promoting the sharing of expertise, learning, and development inside MAG and within the mine action sector as a whole.

Before joining MAG, Bold worked for the Geneva International Centre for Humanitarian Demining (GICHD) from 2013 to 2018 as an advisor on mechanical and animal detection systems, standards, compliance, and legal efficiency. He also served briefly as the Secretary of the IMAS Review Board.

David Avenell
MAG (Mines Advisory Group)
Regional Information Systems Manager, SE Asia

David Avenell provided GIS consultancy to MAG in 2019, working on situational awareness mapping of the Syria conflict and techniques to increase efficiency of spatial data flows between online operational systems. He joined MAG in 2020 as Regional Information Systems Manager, SE Asia. He is responsible for management of MAG’s cloud-based Enterprise GIS platform and spatial analytics, with particular focus on automation and development of analytical tools.

Before joining MAG, Avenell worked in the United Kingdom implementing Esri Enterprise GIS capabilities and development of spatial tools across government, commercial, and military sectors.
KEY PERFORMANCE INDICATORS (KPIs) FOR LAND RELEASE AND STOCKPILE DESTRUCTION OPERATIONS

Notes on a New Technical Note for Mine Action

By Roly Evans [Geneva International Centre for Humanitarian Demining] and David Hewitson [Fenix Insight Ltd.]

In March 2021 the International Mine Action Standards Review Board (IMAS RB) adopted by consensus a new Technical Note for Mine Action (TNMA): Key Performance Indicators (KPIs) for Land Release and Stockpile Destruction Operations. The TNMA detailed new Common Counting Rules for land release outputs, identified elements of Context Capture at points of data entry and underlined the need for operational staff to prioritize the collection of relevant good quality data. The purpose of this article is to set out why the TNMA was developed and explain certain aspects of its content, particularly those where prolonged debate was necessary in order to achieve agreement.

In its most basic form, the TNMA is a list of thirteen suggested operational KPIs that organizations may wish to consider when designing the dashboards they use for operational oversight and management. They may also be considered by donors when developing their reporting requirements. However, the KPIs are in no way obligatory; they are there to be used if considered helpful. The KPIs are disaggregated in broad headings, such as Land Release, Planning and Progress, Open Burning and Detonation, Safety, Reporting, and Compliance.

The TNMA was subject to prolonged discussion by a Technical Working Group (TWG) of the IMAS RB over the course of 2020. The TWG included representatives from DCA, DDG, FSD, HALO, MAG, Mine Action Review, NPA, HI, and UNMAS. It debated at length the key issues of Common Counting Rules for Land Release outputs and Context Capture at the Point of Data Entry.

One example of how individual KPIs are detailed in the TNMA is meter squared per explosive ordnance item (m²/EO item). This KPI is a useful metric when assessing land release operations but, like all KPIs, may be subject to misrepresentation. The TNMA tries to present this KPI in a way that, while acknowledging how it may be misused, demonstrates how it can be used well. Firstly, the importance of situating the KPI in context is emphasized. For a typical m²/EO item KPI such as meter square per anti-personnel mine (m²/AP mine), the meters squared might very well be quite low when clearing dense minefields in a country like Sri Lanka, and quite high when clearing nuisance/low density minefields in a country like Bosnia and Herzegovina. The KPI could tell us equally about the nature of the contamination in a country as about the operations there.

Also, this KPI can be used to discern different factors about a given land release activity. For example, m²/AP mine can help us understand the efficiency of a clearance plan for a pattern minefield. If for a comparable site this figure is 20 m²/AP mine, but on the site in question it is 200 m²/AP mine, this may imply inefficiency. However, in the same scenario, it might also be an indicator of the effectiveness of survey and operational planning that targeted the clearance. As with all KPIs, m²/EO item does not necessarily lead to hard conclusions, at least not immediately. The TNMA emphasizes that analysis of KPIs should invariably lead to more questions being asked to understand why a given KPI apparently indicates what it does. There might be a number of explanations as to why we could see 200 m²/AP mine instead of 20 m²/AP mine in the clearance of seemingly comparable minefields. It could be inefficient clearance or ineffective survey, or another explanation to do with a particular context. The key point is that indicators based on “data of a higher quality”? induce managers to find out why and allow us to know and understand our operations better.

The comparative use of the m²/AP mine KPI for a set of tasks is also demonstrated. For example, the dataset in Figure 1 shows a comparison of results in one country over different timescales (before 2009 in blue, between 2009 and 2012 in red). The red line sits below the blue line suggesting that later operations are more “efficient” than earlier ones. A range of influences could be significant: later operations could have benefited from initiatives such as the adoption of improved concepts and methods of land release that took place around then. Additionally, improvements could reflect a general learning curve over time as a result of managers repeatedly encountering similar sites and
circumstances. Other factors could also explain apparent differences in performance. For those conducting operational analysis, drawing on skills similar to those used in the root causes analysis or those found in quality and safety management systems may be necessary to understand why differences in performance occur and to identify appropriate management responses.

One theme that is emphasized throughout the TNMA is the need for good quality data. Unless the data that any KPI is based on is true and accurate, the KPI may not only be useless, it can also be misleading. Good quality data requires two things initially: well-designed forms and operational staff who understand that appropriate data collection is an essential part of their job. Forms that capture data, while not overburdening field operators, are not as common as we may like to imagine in mine action. Typically, it is only feasible to collect a finite amount of data about operations. Overambitious levels of data collection can result in lower quality data collected. What data is prioritized for collection is a choice. Operations managers should be clear about exactly what they want to measure and ensure that no superfluous data is collected when designing their operational forms. For this reason, design of data forms for operations should be led by operations managers. Moreover, all field personnel should not only be actively trained in data collection, they should use KPIs daily so that analysis becomes a norm and they appreciate the value of the data they collect. In short, if KPIs are relevant and help field staff perform better, and if operations managers closely quality control data collection, field staff will take more care in collecting the all-important data that feeds the KPIs in the first place.

The need to try to reflect the context of a given KPI, not least to assist in an explanation as detailed in the hypothetical 20 m²/AP mine and 200 m²/AP mine example discussed previously, is also covered in the TNMA. Capturing even basic context will allow those examining data with no connection to the operations on the ground—and thus no

**Figure 1.** Analysis of m²/AP mine by number of mines at a site, including “best fit” curves, Afghanistan pre-2009 in blue, 2009–2012 in red. Survey Action Center (SAC) Afghanistan Database Project 2012; the fact that the red line is lower than the blue line implies an increase in average land release targeting efficiency within the pre- and post-2009 figures (base data provided by the MACCA).

*Figure courtesy of David Hewitson.*

Agreement on this proved elusive. The imperfect compromise that resulted was just to capture as much context as practical with simple Yes or No questions. The TNMA details seventeen context capture questions that may be used by operators. The unit of measurement is the site or polygon as recorded in a task order or clearance plan. Where conditions vary significantly within a given site, the operator may consider splitting the site for reporting purposes. Given that conditions change as a site is processed, the point of context capture should be the first day of Technical Survey (TS) or Clearance.

**Figure 2.** Demining in saturated ground in the Falkland Islands. Capturing Context at the Point of Data Entry is difficult to do effectively. This TNMA suggests 17 basic context capture questions with the demining site/polygon being the unit for which context is recorded.

*Image courtesy of David Hewitson.*
Like-for-Like Principle

Analysis of performance invariably entails some form of comparison. In order for any comparison to be valid, data is required to be collected and reported in the same way: the application of the like-for-like principle. For example, for KPIs involving time, the unit of time must be standardized. The length of a working day can differ between organizations and countries, but an hour can be compared on a like-for-like basis. The same principle is true for teams, the size of which can vary. Thus, it is better to adopt a comparable “unit” such as a deminer. As a rule, the lowest common denominator unit should be chosen for a given KPI. For these reasons, KPIs such as m²/deminer/hour are preferred.

The like-for-like principle becomes more challenging for land release outputs. While the key terms “Cancelled,” “Reduced,” and “Cleared” were last defined in the most recent editions of IMAS 07.11 Land Release, those definitions were still open to a significant degree of interpretation. For example, clearance might entail full excavation in a demining lane on one site but be interpreted as only a visual check on another. This TNMA aimed to at least try to sharpen the definitions of key land release outputs. While some progress was made, it would be wrong to suggest that definitions are now fully clarified.

Cancelled land is now defined as “Areas designated as a SHA/CHA,” or part thereof, which have not been physically processed in any way, and meet set cancellation criteria. This includes areas re-designated as either SHA/CHA as the task progresses. Cancellation may be done at any stage of the LR process.” The key for such a definition is the cancellation criteria, which we are yet to develop in many National Mine Action Standards (NMAS) or International Mine Action Standards (IMAS). Cleared is now defined as an “area where the organisation has applied a process, or processes, to ensure the removal and/or destruction of all EO hazards from the specified area to the specified depth. Where multiple processes are applied to the same area to achieve the clearance standard, the area shall only be reported once, although the processes that achieved clearance may be recorded in order to reflect the accumulated effort applied.” What those processes should be remains undefined.

Cleared versus Reduced Land

The TWG spent a long time debating what constitutes Reduced land. A significant sticking point was whether land processed to a clearance standard during the course of technical survey could be counted as Cleared rather than Reduced. Some operators were adamant that it should be, emphasizing the need to record the effort that goes into releasing a site. However, this is not necessarily straightforward. For example, a grid of lanes is not easy to disaggregate as processed to a clearance standard from the areas they encompass that are not processed to the same standard. This is especially true for those demining operators who don’t employ Differential GPS when surveying progress on their sites. Some pointed out that it would be simpler to try to maintain these areas as one coterminous unit, bounded as a polygon. This view prevailed. Of course, if EO is found on-site, inevitably what on one day might have been recorded as Reduced, by default becomes Cleared. For this reason, land release outputs should typically reflect the respective totals on the last day on site.

The new definition also emphasizes the need to capture exactly what was done to land counted as Reduced and where it was done: “Within an area reported as reduced, organizations shall record clearly where is processed and where is not. Area processed shall be further disaggregated into those subject to manual, mechanical and ADS processing, with multiple processing of the same area by different assets recorded in detail.” The Reduced figure is not counted multiple times, but the processing, possibly the repeated processing, that

Figure 3. The edge of a minefield marked by the Iraqi Mine Clearance Organisation (IMCO), Iraq. The new TNMA has attempted to add more definition on what is Cancelled, Reduced, and Cleared land, albeit full definitions will depend on the development of agreed criteria, most likely at a national level. Image courtesy of Roly Evans.
produces the figure is different and is captured (most likely in daily reporting). In this way it is hoped the effort that goes into releasing a site is recognized, but pitfalls such as multiple counting of the same meters squared as released is avoided. Ultimately, at the point of handover, the combined meters squared of Cancelled, Reduced, and Cleared should equal the surface area of the polygon, with reasonable margins allowed for topography.

Another issue of significant discussion was how to define clearance; specifically whether the actual removal of an item of EO was a requirement for clearance to have taken place. The discussion was based on the need to try to reduce instances where many meters squared are reported as cleared without any EO removed. A number of operators were adamant that there will always be instances of sites that were cleared in good faith based on a reasonable level of evidence providing sufficient justification at the time. These operators believed such instances should still count as clearance even if no EO is actually removed. This was the viewpoint that prevailed in the TWG despite some concerns about the need to minimize clearance of uncontaminated sites. One of the benefits of standardizing KPIs such as m²/EO item is that such instances will be more easily identifiable as they occur. There may be a reasonable explanation as to why no EO was found during the clearance of a site. The important thing is to find, document, and learn from that explanation. Hopefully instances of clearance where nothing is found will become increasingly rare.

The Common Counting Rules outlined in this TNMA are not mandated by a shall statement as might be found in a full IMAS. However, they have been approved by the IMAS RB. When IMAS 07.11.13, 08.10.14, and 08.20.18 are reviewed, these terms will possibly be incorporated into that revision, along with the standard updating of IMAS 04.10.16 The definitions may be seen as a step on the road to a clearer explanation of the key land release outputs, but they are certainly not the final word. There remains a degree of ambiguity with definitions still open to interpretation. How land release outputs are reported and counted in the coming years will need to be closely monitored to see how well these revised definitions are serving the sector. Ultimately definitions for each land release output and activity will require criteria, at least at a national level, in order to be fully transparent. It might be said that until clear criteria are developed for land release outputs and activities, they will not be sufficiently defined. The development of criteria is an important and overdue task for the future.
Determining Cost

Noticeably absent from the TNMA are any KPIs dealing with cost, specifically cost per meter square (cost/m²). Historically this is a difficult KPI to calculate since there is no Common Counting Rule for the cost element of this KPI. It could be that only “operational” costs are counted, or that all costs including overhead support costs are calculated. Fixed price contracts tend to give a clearer view concerning the real cost/m², but even in this context figures can be misleading. It could be that organizations with a significant existing footprint in a given country, where equipment is already procured and imported under a previous contract, might be able to artificially reduce their operational costs. Some estimate initial deployment costs at 30 percent of a first-year budget. While many donors would welcome a clear common counting rule for cost, or maybe a defined disaggregation for different cost categories (e.g., operational cost, operational cost minus equipment, overall cost, etc.), it was not possible to agree on a cost/m² during the development of this initial TNMA. It is hoped that if this TNMA is revised in the future, development of a cost/m² KPI will be possible.

It should be stated clearly that operational KPIs are just a number, or a metric, that inform us about our own operations. They are not necessarily targets. If KPIs are used to set targets, that may well be positive, but it should be done with a degree of care. Many in mine action are aware of targets such as mines destroyed being prioritized in the past. In certain circumstances this incentivized clearance of sites where there were high volumes of contamination rather than those where a higher socioeconomic impact was possible. Scenarios such as this are not a reason for not using KPIs, they are a reason for using them well.

Figure 5. A BLU-97 submunition, Iraq. Correctly identifying the ordnance model is an example of basic data collection required to enable meaningful KPIs to analyze field operations. Reporting items simply as “UXOs” into databases is so general as to be meaningless or worse misleading. Image courtesy of Roly Evans.

Figure 6. Inspection of BETAB-500 concrete-piercing aerial bombs. It is important such items are reported into databases in detail and not just as abandoned unexploded ordnance (AXO) or worse, misidentified as unexploded ordnance (UXO). Image courtesy of Roly Evans.
This TNMA should be seen as a starting point. As with all TNMAs, it is intended to complement the broader issues and principles addressed in IMAS. It also supports a key element of the 2019 Oslo Action Plan that made multiple references to the importance of analyzing good quality data. Until now, IMAS have had no agreed standard definition of performance or standard way of measuring performance. This has had an impact on how well we can analyze and subsequently improve our operations. This TNMA should at least start to address this issue. It is in no way a final word on how we collect operational data and analyze it. In its simplest form the TNMA can be seen as a list of suggested KPIs that mine action operators, national mine action authorities, and donors can consider when analyzing operations. However, in many ways its main focus is improving the quality of data on which KPIs are based, enabling a real analysis of that data by operations staff. Doing so while recognizing the context, even in a limited way, is key. For without good quality data counted in a standardized way, KPIs can actually be misleading. Hopefully this TNMA will contribute towards development and use of suitable KPIs that are not misleading and that actively support mine action operations.

See endnotes page 150
A VIRTUAL REALITY APPLICATION FOR THE TRAINING OF DEMINERS

By Lynn Al Khansa,* Elias Bou Saada,* Rachid Maalouf,* Mohammed Al-Husseini, Ph.D.,** Ali El-Hajj, Ph.D.,* Mohammed Baydoun, Ph.D.,**, and Hassan Ghaziri, Ph.D.**
[*Electrical and Computer Engineering Department, American University of Beirut ] and
[**Beirut Research and Innovation Center, Lebanese Center for Studies and Research ]

As virtual reality (VR) tools continue to improve, more fields are finding ways of implementing the technology to take advantage of training opportunities that reduce costs, alleviate logistical challenges, and more. Where humanitarian deminers must prepare for dangerous work, VR facilitates training that minimizes the danger while giving trainers a level of control over the different conditions of the training and the ability to easily monitor and instruct the user. For this purpose, the American University of Beirut (AUB) and the Beirut Research and Innovation Center (BRIC) developed a VR application for the basic training of deminers, which is called the VR Demining Trainer (VRDT). The first version of the VRDT, presented herein, teaches trainees how to turn on a metal detector, test the detector, conduct soil compensation, and start searching in a virtual minefield. These activities can be done in a closed room, regardless of time of day or weather conditions. Different training scenario attributes—including soil properties, landmine types, and locations—can be easily selected beforehand via software. The VRDT, which is a lab-ready prototype being developed using the Unreal Engine software and the Oculus Quest VR device, is not meant to replace but supplement field training, cutting down on training time and logistics by performing basic training phases in a VR-controlled environment.

Benefits of Virtual Reality in Training Deminers

In the case of demining, VR eliminates many requirements such as the need for ideal weather conditions, logistics, physical training objects, or location setup. When using VR, trainees can practice anytime and anywhere, as all requirements can be controlled in a virtual environment. Terrain can be changed (e.g., from flat to mountainous), vegetation type can also be controlled, and the location of landmines can be altered by the software. With VR, the demining process becomes more cost-effective, modular, less time-consuming, and easy to monitor.

VR in Different Applications

VR is continually being used in training programs ranging from military to medical applications. One example of an existing application is the “Officer of the Deck (OOD)” VR simulation in which a naval officer is trained to navigate a submarine safely into port. Using OOD was found to improve the performance of trainees, proving its effectiveness. Another example is the “Firefighting Trainer” application used by the US Navy for training personnel to utilize optimal procedures to fight fires on ships. A comparison between two different groups, in which only one took the VR training, showed measurable improvements in the group with VR training. Moreover, medical applications are another utility for VR and are used to provide medical students with adequate training for real-life situations. This is the case at Dallas’ Southern Methodist University (SMU), where their VR-developed program allows for numerous medical students to practice the steps for performing a radical abdominal hysterectomy within a specified time and degree of accuracy. Another medical application, Virti—which is a medical training platform focused on building soft skills in augmented and virtual reality simulations—utilizes artificial intelligence (AI) and natural language processing (NLP) to analyze decision-making, leadership, communication, and other capabilities that are not typically a focus of medical school training. Hence, VR systems are time-efficient ways of providing basic training for these surgeons.¹
VR Demining Training System

In the case of demining, VR eliminates many requirements such as the need for ideal weather conditions, logistics, physical training objects, or location setup.

The system is expected to train deminers faster and at a lower cost. The VRDT version presented in this article can be thought of as a precursor for trainees before going to demining schools and before ever stepping onto a training field.

The VRDT system is based on two key components: hardware and software. Hardware includes the headset used by the trainees and the hand controllers that simulate a handheld metal detector (MD). The headset is an Oculus Quest (priced below $300) used to render the environment and provide mobility through sensors and controllers, which are provided with the Oculus Quest (see Figure 1). Software creates the virtual demining environment and its associated objects, and translates the movements, actions, and feedback between real-life and virtual environments.

The VRDT system was developed over the course of nine months. It is important to note that the main requirement has been for the VRDT to be practical for use, and to offer the real-life expertise that deminers possess in the field. This means that the VRDT should provide distinguishable responses to the different types of targets faced in the field, and be able to give the user information about the class of the target, e.g., whether it is a landmine or clutter, and possibly the type of the landmine. While a preliminary lab-ready prototype has been made, more work is under way to produce a more practical and complete prototype that can be easily deployed.

The work has faced several challenges: the main one being the ability to exactly replicate the MD responses for different target types and in different terrain and soil conditions. For example, the MD produces a certain response for an anti-personnel No. 4 landmine and a different response for a buried metal pin. These two responses themselves change when the soil has more or less metal content, and when the terrain changes. The main challenge has been for the VRDT to be able to produce all these different responses and associate them with their respective targets. Other challenges involve configuring the Oculus Quest controllers, which are lighter and have a different form factor than an actual MD, to more accurately simulate the real thing. The system will be updated with additional functionality to make it suitable for all demining stages and embed the controllers in an MD-like device that would provide additional realism to the system.

It is worth noting that obtaining a suitable interaction in addition to a high frame rate were the main challenges regarding the software part of the system.
Hardware Component of the System

The VRDT application requires a powerful VR device to efficiently render the virtual demining environment. Moreover, trainee mobility is an essential application requirement since deminers must move in order to sweep a field and locate landmines. The Oculus Quest was chosen to support the VRDT system because of its performance and its ability to integrate user mobility into the system through its sensors, enabling it to be used indoors without any wiring or space limitations. The VRDT supports casting to other devices such as Google Chromecast, a feature that enables instructors to view the stream on a separate monitor. This function, in addition to video recording, allows instructors to monitor the actions of the trainees in real time, and feedback can be relayed to the trainees at any time during the VR training. The controllers are used to simulate the hands of the trainee during demining, and each button on the controllers controls a specific function such as resetting the view or changing the settings of the currently simulated environment (e.g., soil properties).

Software Component of the System

The Blender software is used to create the environmental objects (e.g., the MD model, the vegetation, etc.). The interactions with the environment are coded using Unreal Engine, which utilizes blueprints or pre-designed blocks of code that provide all functions needed within the system. In addition, the Unreal Engine offers several graphics rendering options compared to other platforms and a relative ease of implementation. The simulated MD is a CEIA MIL-D1, which is implemented with all its functionalities, including an on/off switch, a sensitivity knob, and a volume knob. All interactions happen when the virtual hands, controlled by the Oculus Quest’s controllers, come into collision with the virtual objects (MD and its different parts and controls). A frame rate of sixty-eight frames per second (FPS) is achieved, which minimizes the latency time between user action (i.e., pressing a button) and the simulated counteraction within the VR environment, making for a smoother user experience. Gravity is also implemented in order to make the simulation as close to reality as possible, meaning an object in the scenario can be picked up, handled, and dropped, and is interactive—especially in regards to the MD. Moreover, the software enables the environment to be easily adapted to account for different terrain, vegetation types, and landmine types and locations. Other MD types can also be designed in Blender or other 3D software and added to the Unreal Engine environment.

Implemented Demining Stages

![Figure 2](image1.png) **Figure 2.** VR model of CEIA MIL-D1 MD metal detector.

![Figure 3](image2.png) **Figure 3.** Sample of an Unreal Engine blueprint.

The VRDT focuses on emulating the three stages of the demining process as described in CEIA’s tutorial videos.°

**Startup phase.** The first phase teaches the trainee how to start the MD and operate it. The trainee begins by turning the sensitivity control to the red dot and the volume knob to maximum. These actions all occur in the VR environment. Then, while virtually holding the MD at about 1 m above the ground, the trainee pulls the on/off switch to the on position, which generates a series of beeps followed by the confidence click. In order to ensure that the MD is operating according to factory specifications, the trainee inverts the MD and places the arm rest on the ground, and then passes a reference metal sample across the search head, from side to side, and in two different directions in order to hear the target tones in both directions. This confirms that the MD is operating properly. Finally, the trainee adjusts the search head to make it parallel to the ground in preparation for the next phase, which is soil compensation. All details in this phase are provided by the VRDT system using various blueprints in Unreal Engine.

**Soil compensation phase.** In this phase, the trainee accounts for the metal composition of the soil apart from the metal content of any target landmine. It should be performed every time the detector is turned on. For this purpose, a 1 m by 1 m metal-free box is designed for use in the VR environment, and the trainee starts by holding the MD
above this box (Figure 5) and then holds the switch in the reset position until a series of fast clicks is generated followed by a series of double clicks. At this point, the trainee returns the search head to the ground inside the metal-free box, and sweeps side to side close to the ground in order for the MD to acquire the soil characteristics. If the process is successful, the double clicks change into a fast series of clicks. In this case, the trainee lifts the MD up into the air until a single beep is produced, where the MD returns to the regular confidence clicks. The trainee sets the sensitivity, gradually lowering the maximum setting until no alarm is generated when the metal-free box is swept. Every detail of this phase is also implemented in the VRDT system using Unreal Engine blueprints.

Detection and Pin-pointing Phase. After the soil compensation is done, the trainee starts looking for landmines. The trainee holds the detector so that the search head is parallel and as close as possible to the ground. The trainee then learns to properly sweep the MD and advance forward over the search area (Figure 6). If no target is found, only the confidence click is heard. When the MD detects a target, the center of the target is located where the alarm tone changes from high to low or from low to high.
Comments and Conclusions

The VRDT aims to accelerate and reduce the cost of the training of deminers while removing weather and some logistical constraints. Other advantages include the ability to change the terrain, vegetation, landmine types, and landmine locations in software. As an example, Figure 7 shows two different terrain and vegetation types in the VR environment. This first version of the VRDT covers the demining training phases of MD startup, soil compensation, and basic detection. Mistakes and errors made by the trainees as well as unsuccessful training phases are reported using messages that appear on the headsets screen. Future versions of the VRDT can include more MD brands and types and could focus more on the detection phase.

See endnotes page 151

Acknowledgements. The authors would like to thank Mr. Stuart Henley and the Lebanon Mine Action Center for their ideas, feedback, and support.

Lynn Al Khansa
American University of Beirut

Lynn Al Khansa is a computer and communications engineering graduate from the American University of Beirut (AUB). She has always been passionate about technology, which drove her to work at a couple of tech startups in Lebanon. She received the "Dean's Award for Creative Achievement" and "Murex Best Innovative Software Development Project" award as a result of working on the project titled, "A Virtual Reality Application for the Training of Deminers."

Elias Bou Saada
American University of Beirut

Elias Bou Saada is a computer and communications engineering graduate from AUB. He is a recipient of the "Dean's Award for Creative Achievement" and "Murex Best Innovative Software Development Project" award following his participation in the development of the project, "A Virtual Reality Application for the Training of Deminers." Currently, he is a software engineer with Murex Systems.

Rachid Maalouf
American University of Beirut

Rachid Maalouf's journey as a tech enthusiast led him to major in computer and communications engineering (CCE) at AUB. He holds a degree in engineering, and is currently working as a software developer with Capital Banking Solutions. He is very proud to have been able to work on the project "A Virtual Reality Application for the Training of Deminers" as it has allowed him to explore the world of VR, and to receive the "Dean's Award for Creative Achievement" and the "Murex Best Innovative Software Development Project" award. His plan is to pursue an MBA and further explore the VR world.

Mohammed Al-Husseini, Ph.D.
Director of Humanitarian Demining Research Program
Beirut Research and Innovation Center

Mohammed Al-Husseini, Ph.D., is a Senior Researcher and the Director of the Humanitarian Demining Research Program with the Beirut Research and Innovation Center (BRIC), Beirut, Lebanon. He received his doctorate in electrical and computer engineering in 2012 from AUB, where he was a recipient of the Kamal Shair Ph.D. Fellowship. In 2012, he was a Visiting Researcher with the University of New Mexico in Albuquerque, NM. Al-Husseini’s current research focuses on material characterization and on the use of machine learning for the detection of underground targets.

Ali El-Hajj, Ph.D.
Professor of electrical and computer engineering
American University of Beirut

Ali El-Hajj, Ph.D., is a Professor of electrical and computer engineering at AUB. El-Hajj has thirty-five years of academic experience, and he assumed leadership positions at AUB in General Education, Academic Program Review, Assessment of Program Learning Outcomes (PLOs), Assessment of Units Outcomes, and Strategic Planning. El-Hajj received an engineering degree from L’Ecole Superieure d’Electricite, France, and a doctorate in engineering from the University of Rennes I, France.

Mohammed Baydoun, Ph.D.
Senior Researcher
Beirut Research and Innovation Center

Mohammed Baydoun, Ph.D., is a Senior Researcher with BRIC working on the Humanitarian Demining and the Medical Research Programs. He received his bachelor of engineering and master of engineering degrees in mechanical engineering from the Lebanese University and AUB, in 2005 and 2007, respectively. Baydoun earned his doctorate in electrical and computer engineering from AUB in 2014.

Hassan Ghaziri, Ph.D.
General Director
Beirut Research and Innovation Center

Hassan Ghaziri, Ph.D., is the Director of BRIC and a scientific consultant with the Swiss Federal Institute of Technology (EPFL-LRSE). He conducted his academic activities at AUB, Kyoto University, INSEAD (Fontainebleau-France), and the Swiss Federal Institute of Technology in the areas of machine learning, knowledge management, and decision systems. His research is focused on developing machine learning techniques to improve the decision-making process and the performance of anomaly detection systems in the health, financial, and humanitarian demining fields. Ghaziri has authored or co-authored more than fifty scientific papers and the book, Knowledge Management, published by Pearson.
RECOGNIZING AND REDUCING RISKS From Ammunition and Explosives

By Martina Salini and Samuel Paunila [Geneva International Centre for Humanitarian Demining]

The Geneva International Centre for Humanitarian Demining (GICHD) first engaged in the stockpile management of conventional ammunition in 2013 and has since developed in-house technical, operational, and strategic capabilities for ammunition through-life management. The GICHD is an active supporter of the ammunition management community of practice, and has authored and contributed to articles on this topic, including raising awareness of ammunition safety and security concepts. The GICHD also collaborates with the Center for International Stabilization and Recovery (CISR) at James Madison University by jointly managing the Collaborative Ordnance Database Repository (CORD). This article discusses ammunition and explosives management from global to state levels and examines risk reduction in this setting, building on the experience of the Ammunition Management Advisory Team (AMAT) response mechanism—a joint initiative of the GICHD and the UN Office of Disarmament Affairs (UNODA) since 2019.

In the past decade, states around the world have become aware of the safety and security risks associated with explosive ordnance (EO) and the consequences associated with poor management practices. Today, an increasing number of states are ready to discuss the sensitive topic of risks associated with their stockpiled EO and seek technical assistance toward reducing those risks.

Implementing a risk management system is vital for any state holding EO, from the early stages of procurement through to the stockpiling, use, and disposal of those munitions. As such, a good risk management system extends to the entire life cycle of EO and is integrated within the framework of national regulations and procedures. It is comprehensive and effective but not necessarily resource-intensive nor technically difficult to implement.

The global frame of reference for managing ammunition, the International Ammunition Technical Guidelines (IATG), was developed and made publicly available in 2011 to assist states in addressing inherent risks stemming from stockpiling ammunition according to their capacity and available material, financial, and technical resources. The IATG contain an integrated risk management system, providing concrete guidance to technical and policy practitioners on risk-management principles and processes, as well as procedures to guide risk-based decision-making in ammunition management.

Alongside these guidelines, states and organizations specializing in ammunition through-life management are also known as the “ammunition management community of practice.” This article builds on the experience of the AMAT, a joint initiative established in 2019 by the GICHD and UNODA, to assist states in enhancing ammunition safety and security by managing risks from EO as per the IATG.

Global Attention to Ammunition and Explosives Risks

The safety and security risks pertinent to conventional ammunition management have captured the attention of states’ arms-control bodies as well as humanitarian and development circles. Connecting dots between these risks and sustainable development goals (SDGs) at the policy level, this topic has taken center stage in international, regional, and, less visibly, national debates. Direct testimony of this are the two Groups of Governmental Experts (GGE) on Ammunition established by the United Nations General Assembly. Established in 2008, the first group looked at technical aspects of ammunition stockpile management. The work of the GGE resulted in the development of the IATG,
and gave birth to the United Nations SaferGuard Programme to maintain, update, and disseminate the guidelines. The second ammunition GGE commenced its work in 2020 and is scheduled to hold its third and final session in September 2021. The second GGE’s recommendations, which will address challenges pertaining to through-life management and security issues across the ammunition supply chain, will be presented to the UN General Assembly for consideration later in the fall of 2021.

As discussions continue towards safer and more secure ammunition stockpiles, states’ demands for technical and financial assistance have been on the rise. In the past, a small group of states provided assistance that was largely a bilateral affair between the donor and recipient states’ militaries, comprising training of personnel in ammunition depots, and technical advice in physical security and stockpile management (PSSM). Over the past decade, a handful of international, regional, and nongovernmental organizations further developed their capabilities and became heavily invested in direct assistance to states in ammunition management.

In addition to bilateral assistance, states in need of assistance are also submitting their requests through sub-regional, regional, and international channels. In 2020 alone, ten states submitted requests for assistance with ammunition management to the United Nations in their national reports on their implementation of the UN Programme of Action (PoA) on Small Arms and Light Weapons. Meanwhile, in the midst of the global COVID-19 pandemic and associated, competing national priorities, five states requested assistance from AMAT with their stockpiled ammunition.

Lessons Learned

Whenever inherent risks are not properly addressed, stockpiled EO pose two distinct threats to local communities, armed forces, the economy, and society at large: the risk of accidental explosions and the risk of diversion. Mass explosions can result in people killed, injured, or displaced, and have significant socioeconomic consequences. Additionally, diversion of EO from stockpiles—in-transit and during transfer—leads to unchecked proliferation, which has proven to be a catalyst for conflict and a contributing factor to the escalation of armed violence in several regions of the world. Diverted EO has further been systematically used to assemble improvised explosive devices (IEDs).

The latest available data confirms the gravity and persistence of safety and security risks arising from ineffective stockpile management: the Small Arms Survey (SAS) recorded 242 unplanned explosions at munition sites (UEMS) over the 2010–2019 period, of which 39 took place in Africa, 16 in the Americas, 116 in Asia, 70 in Europe, and 1 in Oceania. Similarly since 2011, Conflict Armament Research (CAR) has documented approximately 7,500 cases of ammunition diversion. Furthermore, in 2018 alone, IEDs used by non-state actors were responsible for 9,366 civilian casualties in forty-nine countries.

Too often, post-explosion investigations report how an accident could have been easily avoided and its impact minimized, if risks inherent to EO had been better understood, appreciated, and managed. Hence, risk management should be perceived by states as a fundamental measure to prevent accidental explosions, unauthorized access, and diversion.

Effective risk management within this context is a joint undertaking by technical and policy practitioners: a process initiated with a state understanding the nature of the risks involved, appreciating their magnitude in the surrounding environment and communities, and anticipating their consequences if materialized. Sound technical knowledge of EO as well as good management practices should be required from the outset. In the long run, for a state to maintain safe and secure ammunition and explosives stockpiles, the risk management process must guide the development and implementation of a national strategy and standards, as well as advise the competent authority and dedicated work force.

Managing Risks, Mitigating Threats

While risks inherent from stockpiling EO cannot be entirely eliminated, the likelihood of an accident can be reduced to as low as reasonably practical, and its effects can be mitigated. Similarly, the likelihood of diversion can be reduced to near zero. Across its modules, the IATG are strong in practical risk management and structured around gradual improvements considering the diversity of states’ capacities and available material, financial, and technical resources. Modules use three levels of gradual ascending compliance, also known as
risk reduction process levels (RRPLs): basic (RRPL1), intermediate (RRPL2), and advanced (RRPL3). All states, regardless of their risk baseline and financial and technical capacities, can assess and improve management processes based on the IATG, using the RRPLs as benchmarks to work toward.

At a minimum, states should aim to maintain processes related to stockpiles at RRPL1. This implies the adoption of low-cost actions that do not often require extensive technical and material capabilities, and can be easily implemented to improve the safety and security of EO. For example, the guidance to achieving RRPL1 entails storing weapons and ammunition separately, segregating certain ammunition types from others in storage and transport, regularly ventilating explosives store houses, and removing vegetation around them.

Forward-planning is important. When more resources become available, a state can upgrade its storage facilities, transport infrastructure and surveillance processes, and fill the deficit in qualified ammunition personnel—gradually advancing to RRPL2 and RRPL3. Acquiring knowledge (e.g., through staff training) and applying the IATG (i.e., risk management principles and processes) will enable a state to identify specific challenges, capabilities, and gaps. Moreover, communicating these in appropriate national, sub-regional, and regional forums may bring expert advice and services to the state from other states and specialized actors. By using the IATG and services made available, a state can establish realistic and sustainable action plans and/or a strategy toward closing the gaps and commencing its implementation.

*Image 1.* Iterative risk-reduction process in the IATG. *All graphics courtesy of GICHD.*

**Risk Reduction in Select States**

Significant differences in states' subject knowledge and management practices continue to be observed; however, a growing number of countries seek international assistance, communicating challenges and capability gaps. Some also prioritize risks with aging, unstable, and obsolete ammunition stockpiles—proactively planning for risk reduction.

**Peru.** Peru was the first country to approach UNODA for assistance from AMAT. As part of the process for their Institutional Transformation (2020–2034) plan, Peru is taking its first steps in aligning its policies and practices with the IATG. After delays caused by the COVID-19 pandemic travel restrictions and lockdowns, AMAT is now able to assist Peru with its ongoing efforts. Currently, nearly seventy war materiel army officers have been trained on the IATG, and deployed in-country in various management and regulatory functions. With technical assistance from AMAT, Peru plans to update and streamline the regulatory framework between branches of the military into a set of national standards for ammunition management, as stipulated by national legislation. These multi-year activities with key ministries and armed forces will be accompanied by further training. Additionally, Peru, in partnership with the Spanish Ministry of Defence and AMAT, will conduct risk assessments of ammunition storage facilities.

**Mauritania.** In response to a request from the Republic of Mauritania for technical assistance in late 2020, AMAT carried out a preliminary assessment mission in support of the *Programme National de Déminage Humanitaire et de Développement* (PNDHD). Through this assessment, AMAT visited eleven storage areas, identifying capabilities, risks, and needs in weapons and ammunition management. The assessments were conducted against the baselines from the IATG and the Modular Small Arms Control Implementation Compendium (MOSAIC). Following the mission, short- and longer-term recommendations were submitted to the PNDHD, aimed at gradually improving safety and security management. Pending relaxation of COVID-19 travel restrictions, AMAT’s plans with Mauritania include a follow-up mission to implement recommendations.

**Moldova.** For nearly two decades, the Ministry of Defense of Moldova, with support from the international community, has implemented a program to secure and make safe its ammunition stockpiles largely inherited...
following the fall of the Soviet Union. Significant steps have been taken to make the management more systems-based, effective, and responsive to risks. This has included bringing ammunition-related policies and practices in line with IATG practices. For example, Moldova has gradually reduced the number of ammunition storage locations from eighteen to five, involving surveillance, transport, and disposal of dysfunctional, unsafe, and surplus ammunition. Yet, aware of the magnitude of the remaining challenge, the Ministry of Defense requested in 2020 that AMAT review the PSSM program’s progress as well as Moldova’s National Army Action Plan 2020–2024. In response, AMAT visited Moldova’s ammunition facilities in October 2020 and, in May 2021, convened a technical workshop for Moldovan experts in Geneva in July 2021, raising government awareness on ammunition through-life management and effective safety and security risk reduction measures.

Equatorial Guinea. In March 2021, a series of explosions rocked the city of Bata, Equatorial Guinea, resulting in more than 100 deaths and 600 injured. The explosions annihilated the military camp belonging to the storage facilities in which the explosions originated and destroyed more than 200 buildings in the surrounding areas. Following the explosion, Equatorial Guinea requested technical assistance from UNODA’s Regional Centre for Peace and Disarmament in Africa, which resulted in UNODA activating the quick response mechanism of the UN SaferGuard Programme. Within three days of the request, AMAT deployed an expert team to Bata to assist in determining the cause of the incident; identifying further explosion risks through a rapid risk assessment on the ground; assisting in reducing the risk of further explosion incidents through technical advice on risk mitigation measures; and providing technical support recommendations to the United Nations in light of the coordinated bilateral offers of assistance from other states and organizations. During and after the mission, the team made next-step recommendations, which the government of Equatorial Guinea approved. These included a training program in EOD safety and security; a new design and relocation of storage areas away from populations; and development of national standards and legislation for EOD management.

Of these examples, Peru, Mauritania, and Moldova manifest a proactive approach to risk reduction. While each country has differing capabilities, the challenges, baselines, and inherent risks from EOD are the same across countries. Such proactive approaches to reducing risks in states are important, especially when comparing the costs of maintaining an effective ammunition through-life management system. This is exemplified by the devastating series of explosions in Equatorial Guinea where, besides the tragic loss of life, the estimated cost for recovery runs into the hundreds of millions USD.

**Difficult but Passable Road Ahead**

In contrast to earlier observations of positive change vis-à-vis states’ efforts to reduce risks, and despite the availability of the IATG, the root causes of the recent, avoidable humanitarian disasters bear witness to the under-appreciation of the safety risks associated with EOD—both military ammunition and commercial explosives. Lack of action by authorities is often explained as an absence of advanced technical knowledge and insufficient financial resources. However, all states have access to the IATG and may seek assistance from the community of practice, e.g., UN SaferGuard Programme, regional organizations, other states, or through a dedicated response mechanism such as AMAT. Additionally, states may take advantage of financial assistance mechanisms and trust funds through which technical assistance can also be channeled. For many states, the road to progressive and sustained risk reduction is long and winding but passable.
Conclusion

The importance of recognizing the inherent risks posed by stockpiled EO and the potential consequences stemming from inadequate reduction of such risks cannot be understated, marking a state’s first step in questioning the adequacy of its policies and standards for conduct. The IATG’s RRPLs offer milestones to work toward, gradually bringing the different components of EO management in line with international good practice. When performed well, through-life management of EO is a costly affair; yet implementing a system for risk reduction is not overly technical or resource intensive. Integrated into a state authority’s logistics management processes, proactive risk reduction prevents UEMS and diversion—saving lives and property. It instills security, accountability, and even slows degradation of stock while lessening the impact of risks materialized—human, material, financial, political, environmental, or reputational. Among other mechanisms for assistance, AMAT and its partners stand ready to support states with their stocks of EO, ensuring that they are safe, secure, and fit-for-purpose.

See endnotes page 151

Martina Salini
Programme Officer AMAT
Geneva International Centre for Humanitarian Demining

Martina Salini is a Programme Officer in the AMAT. Before joining the GICHD in 2019, Salini completed several internships with the Kofi Annan Foundation, Global Migration Centre, Italian Mission to the United Nations, and the Territorial Commission for the Recognition of International Protection in Milan. Salini is fluent in Italian, English, French, and Spanish. She holds a master’s degree in Law from the Bocconi University of Milan, and a Master of Law in International Humanitarian Law and Human Rights from the Geneva Academy.

Samuel Paunila
Head of AMAT
Geneva International Centre for Humanitarian Demining

Samuel Paunila leads AMAT, a global mechanism to assist states in the safe, secure, and effective ammunition management as per the IATG. Established in 2019, AMAT is a joint initiative of the GICHD and the UNODA. Paunila has worked with explosive weapons and armed violence reduction in humanitarian, peace-keeping, and military contexts for twenty years in Africa, Asia, the Americas, Europe, and the Middle East. Initially an ammunition and weapon systems officer with the Finnish Defence Force, he holds a master’s degree in Resilience from Cranfield University, Defence Academy of the UK.
ALTERNATIVES TO OPEN BURNING AND OPEN DETONATION: The Disparity Between HMA and Commercial Best Practices

By Linsey Cottrell [Conflict and Environment Observatory] and Kendra Dupuy [Norwegian People's Aid]

Military and explosive residues have the potential to cause long-term harm when released into the environment. Common explosives, such as TNT and RDX are toxic, with both classed as possible carcinogens.\(^1\)\(^2\) The environmental fate of explosives is complex and varied. TNT absorbs onto soil, slowly leaches, and degrades to form degradation products such as DNT, which has a higher toxicity than TNT itself.\(^3\) RDX leaches from soil more readily, degrades slowly, and can persist in the environment. The residual soil and water contamination at military ranges caused by the firing, detonation, and disposal of munitions by open burning and open detonation (OBOD) is well documented, and there has been increased attention on finding more environmentally acceptable options.\(^4\) This is reflected in the draft Lausanne Action Plan from the Second Review Conference for the Convention on Cluster Munitions, which sets out the need for stockpile survey, clearance, and destruction to be carried out with minimal environmental impacts.

Residual energetic material can accumulate and persist in soil. Contaminants may migrate to underlying groundwater or nearby surface water, leading to the risk of significant environmental impacts. This risk can be reduced by the careful positioning of OBOD sites away from any water resources. The level of risk will depend on the sensitivity of the environmental setting, nature of contaminants, and the likelihood of a viable exposure pathway. In addition to residual explosives, there are contaminants from other toxic components of munitions (for example, antimony, cadmium, chromium, lead, and mercury) and combustion of by-products such as noxious gases, dioxins, and carcinogenic polycyclic aromatic hydrocarbons (PAHs), which are produced from incomplete combustion.

OBOD remains a primary disposal method across humanitarian mine action (HMA) programs since it is cost-effective, can be used across a diverse range of munitions, and does not require sophisticated infrastructure and equipment. It also remains in common use across the military, including in the United States.

Use of OBOD, however, is under increased pressure due to environmental regulation, better understanding of the environmental contamination risks, land remediation costs, and access to OBOD alternatives. In 2016, the United States Congress instructed the Department of Defense to arrange for the review of technologies available as alternatives to OBOD.\(^5\) The National Academies of Sciences, Engineering, and Medicine (NASEM) review findings, published in 2019, provide a useful update and comparison of a broad range of technologies, in spite of its focus on conventional munition stockpiles for the US military.\(^6\)

Some countries already ban the use of OBOD, unless there is no alternative and it is justified on safety grounds. NATO also prohibits the use of OBOD under the contract framework for munition disposal.\(^7\) NATO does not prescribe specific technologies to be used in place of OBOD but does require contractors to adhere to environmental management protocols. This includes requiring contractors to provide independent test reports to demonstrate that any pollution abatement systems for closed incineration or detonation meet the appropriate environmental emission standards.

**OBOD: Open Burning and Open Detonation**

OBOD remains a primary disposal method across humanitarian mine action (HMA) programs since it is cost effective, can be used across a diverse range of munitions, and does not require sophisticated infrastructure and equipment.
Land and Marine Environments

The need for the wider adoption of alternative approaches is not just restricted to land-based disposals. For underwater munitions, blow-in-place detonation is regarded by International Mine Action Standard (IMAS) 09.60 as the safest option but potentially harmful to the marine environment. For detonation, bubble curtains can be used to attenuate the explosive shock wave, and with monitoring put in place, operations can be delayed if marine mammals are detected. Bubble curtains however can be expensive to deploy and ineffective in deep water or strong water currents.

Capabilities of killing adult and juvenile sea creatures, blast detonations also risk physical trauma or permanent auditory injury to marine mammals up to 15 km away (for an explosive charge of more than 700 kilograms). Although estimates of these distances do differ, the OSPAR Commission reported harbor porpoises being killed within 4 km of explosions and suffering permanent hearing damage as far as 30 km away. This evidence indicates that a focus on alternatives to detonation is similarly required to reduce environmental harm in the marine environment.

Constraints to Change

Armed forces worldwide have been late and slow to adopt environmental policies and practices, playing catch-up with the commercial and private sector. This has historically been underpinned by how military activities are exempt from the regulations, including environmental legislation, which govern the civilian sector.

Humanitarian programs are also prone to late adoption of environmental practices. For the HMA sector, there are obvious financial and logistical constraints that restrict adoption of alternatives to OBOD: Funding remains a key barrier to deployment. The environmental impacts from OBOD have been known for some time, but where there are safety and cost constraints, environmental mitigation will often be regarded as a lower priority. In line with other sectors, these barriers may also be psychological and due to individual behaviors, mindsets, and attitudes toward the environment. Perceptions, old habits, and lack of awareness may prevent and slow down the take-up of alternative initiatives.

It is also a challenge to increase or promote environmental protection measures when munition disposal is taking place in an area already regarded as contaminated or environmentally degraded. HMA implementers may similarly not be fully aware, or understand the complexities and ecological sensitivity of the area in which munition disposal is taking place. Areas may still have high ecological value, even if they are not designated or regionally recognized as important habitats (see Figure 1).

Existing environmental governance and legislation in the region may already be weak or loosely enforced, in which case there will be limited accountability or incentive to improve environmental performance. The International Ammunition Technical Guideline (IATG) 10.10 notes that national environmental legislation “shall dictate the emission levels to be met which will in turn dictate the type of technology required to meet these emission levels” and that donors may insist on higher standards if national legislation is less than the international norm. For the HMA sector, there appears to be little evidence that this is regularly being required or monitored by donors.

Figure 1. Percentage of key biodiversity areas (KBAs) that are protected. Large areas of KBAs remain unprotected, at-risk, and are not legally recognized as ecologically important. Globally, approximately 20 million square kilometers of KBAs have been identified by the International Union for Conservation of Nature. Less than 20 percent of these critically important KBAs are covered by complete ‘protected status’.

All figures courtesy of the authors.

All of these constraints, together with conflicting priorities and goals, play a role in preventing changes to disposal practices. There is the risk that the HMA community will continue with “business as usual” by comparing itself to others within the sector (such as the military and other contractors) and a belief that changes will make little impact in the wider context. Collective action will be needed to see real change.

There is the risk that the HMA community will continue with “business as usual” by comparing itself to others within the sector (such as the military and other contractors) and a belief that changes will make little impact in the wider context. Collective action will be needed to see real change.
Momentum for Change?

If militaries move away from using OBOD, there is the potential for increased availability and use of alternative technologies within the HMA sector, provided that momentum continues and the military does not revert to its historical reliance on exemptions to circumvent environmental regulation. Increased uptake of alternative technologies by militaries should play a key role in driving down cost, demonstrating reliability and fitness-for-purpose, increasing technical capacity, and addressing any capability gaps.

This is similar to some militaries’ ambitions to transfer to low-carbon technology and renewable energy, which could mean access to cheaper and greener technology options for civilian society. Given countries’ considerable spending on their militaries, there is the opportunity for economies of scale and investment that would create more efficient technological alternatives while lowering costs, incentivizing wider adoption and increased partnerships. Both advances in military technology and potentially lower costs could support and incentivize the transfer of technology to the HMA sector.

As the viability of alternate technologies within HMA evolves, technologies improve and unit costs fall. However, given shifting attitudes and understanding of the environmental implications of OBOD, it is important that these alternatives (discussed in the following section) are evaluated on a regular basis.

The current IATG 10.10 suggests that, for less than 1,000 tons, alternative disposal methods to OBOD are not cost-effective. The basis for this assessment should be challenged and reviewed, because alternative technologies become more cost-efficient as they improve. It is also important to understand what has been considered under any option benefit analysis, especially whether it takes into consideration any environmental remediation that could be required in the future to address residual contamination at sites where munition disposal has taken place.

Alternative Technologies

Safety, cost, and environmental performance must all be considered in parallel to assess the viability of alternatives. There are no disposal procedures that will have zero environmental impacts, but steps can be taken to minimize the impacts to soil, water, and air. This means following the same “as low as reasonably practicable” approach, which is adopted for the management of other non-environmental risks.

As well as good environmental performance, munition disposal options must be practical and economically viable. The type and state of the munition, the amount to be disposed of, local staff training and competencies, consistency with international agreements, and alignment with applicable national safety, security, and environmental regulations are all factors to consider. When selecting an alternative to OBOD, basic considerations will include

- Is the technology safe, reliable, and affordable?
- Does the technology irreversibly destroy the munition and its energetic materials?
- Does the technology guarantee environmental benefits compared to OBOD?
- Are there opportunities to safely recover and recycle munition components to reach near net-zero waste?
- Can its environmental performance be monitored?
- Will the public and local community have confidence in the technology?

An options appraisal process can be used to evaluate and determine the most feasible and appropriate technology (see Figure 2).

As noted in IATG 10.10, alternatives to OBOD can also create revenue-generating opportunities such as recycling recovered materials (e.g., steel, aluminum, and copper). Scrap metal prices have steadily increased in recent years, and the revenue from recovered material could support operational costs. This is provided that ownership of any scrap is not contested, and that suitable infrastructure and management controls are in place, with control measures that certify items are safe and free from explosives.

The United States Environmental Protection Agency’s (USEPA) report on alternative disposal methods gave a perspective from environmental considerations and concluded that a wide range of alternative treatment technologies have been successfully used instead of OBOD techniques. The criteria used to compare technologies included the scale at which the technology has been developed (i.e., to what degree the technology has been successfully piloted or used full-scale); portability of the technology; and the emissions/outputs of the process—all of which are relevant for the HMA sector.

Some technologies have yet to reach full-scale development, including some chemical treatment and chemical neutralization processes that have applicability in the HMA sector given their portability but, at the time of the USEPA report, have not yet proven to successfully treat bulk energetic material for extended periods. Any process requiring the use of chemicals will need the supply, storage, handling, and disposal of all chemicals or waste by-products managed appropriately. Suitable disposal facilities may not be available in countries where the HMA sector operates. The throughput capacity and rate at which munitions and energetic material can be processed by the technology is also a factor. Some chemical treatments can be slow and take several hours to fully react, require treatment tanks, and must be able to treat wastewater. Treatments that convert explosives into non-energetic by-products, such as fertilizers, could also be sold to generate revenue. This would be subject to quality assurance checks, such as checking residual heavy metal content.
Norwegian People’s Aid (NPA) already utilizes techniques including mechanical breakdown (e.g., band saw), the extraction of explosives as developed by Golden West Humanitarian Foundation, and deflagration for programs (e.g., Palau), where there are environmental and logistical constraints. Explosive harvesting can be used to recover and re-purpose high explosives but is not suitable for all explosives. Harvesting can yield small donor charges for disposal efforts or for commercial use as quarry charges. For HMA, this eliminates the need to purchase explosives to use as donor charges, but any extraction must be strictly managed to prevent soil or water contamination from process discharges. Although harvested explosives remain available for use and the demand for purchasable explosives is reduced, their production and use still impacts the environment.

A combination of alternatives to OBOD may prove viable, but their feasibility and adaptability within the HMA sector need to be fully evaluated. Many successful partnerships already operate across the HMA sector and, for technologies to be viable, this may mean extending local partnerships to share expertise and pool resources where possible.

**Figure 2.** Example of an options appraisal process for technology selection.
So What’s Next?

IMAS 07.13 and IATG 10.10

- IMAS 07.13 sets out guidance on mitigation measures needed to prevent pollution
- IATG 10.10 reiterates the need for environmentally-responsible disposal practices

NPA is not yet in a position where a single technology or combination of technologies will be adopted program-wide as an alternative to OBOD. Field trials and comparative analysis of the environmental performance of selective alternatives are still necessary to evaluate operational constraints. This will include learning from the range of techniques that have already been used and better understanding constraints by mapping regional differences in existing knowledge, levels of training, logistics, and infrastructure.

Environmental management obligations in HMA are already given in IMAS 07.13, which sets out guidance on mitigation measures needed to prevent pollution, and IATG 10.10 reiterates the need for environmentally-responsible disposal practices. It is important to ensure that the environmental risks from OBOD are being communicated to EOD operatives and others to increase awareness on the link between chemical pollution and the disposal of explosives. This also means raising awareness about the potential ecological sensitivity of an area, even though the area may not be officially designated or visibly rich in biodiversity. Communicating the risks and educating donors on the need to fund alternative disposal approaches is similarly needed to overcome the financial and operational constraints.

OBOD will still be needed where technical and safety issues prevail and, until technologies advance, where OBOD remains the only option for certain energetic materials. Environmentally, OBOD is the least preferred method; however, measures can be adopted to help reduce the environmental impacts of OBOD practices. While not all listed here, measures can include the choice of location for central demolition sites; the use of platforms, burning pads or trays to limit contact with soils; and clearing other combustible material from the site. Weather conditions should also be carefully considered, including wind direction, wind speed, and rainfall. OBOD should not be carried out in heavy rainfall or high winds, as an optimum wind speed is needed to enable atmospheric mixing and dispersion of smoke plumes.

Without better access to cost-effective, safe, and reliable technologies for the HMA sector, OBOD will remain the primary means of disposal. Funding is needed to pilot a range of alternative technologies, provide staff training, and deliver the commitments to minimize environmental harm, as set out in the Lausanne Action Plan.

By seeking ways to accelerate the adoption of more environmentally acceptable munition disposal techniques, we can hopefully avoid the adage that “if the only tool you have is a hammer, everything looks like a nail.”

See endnotes page 152

BIOGRAPHIES

Linsey Cottrell
Environmental Policy Officer
Conflict and Environment Observatory

Linsey Cottrell is the Environmental Policy Officer at the UK-based charity Conflict and Environment Observatory (CEOBS). Cottrell is a Chartered Environmentalist and registered in the UK as a Specialist in Land Condition. She is also a trustee for the Institute of Environmental Sciences.

Before joining CEOBS in 2019, she worked in the environmental consultancy sector on contaminated land and environmental risk assessment.

Kendra Dupuy, Ph.D.
Senior Environmental Advisor
Norwegian People's Aid

Kendra Dupuy, Ph.D., is Senior Environmental Advisor at Norwegian People’s Aid. Dupuy has a doctorate in political economy and has worked as a policy advisor and researcher on natural resource and environmental management in low- and middle-income countries, including countries experiencing and recovering from armed conflict. She has also worked on gender mainstreaming in mine action and demining.
AWARENESS and concern are growing worldwide regarding pollution resulting from conflicts. In Vietnam, decades of wars have left a legacy of contaminated land and increasingly polluted water. Golden West Humanitarian Foundation (Golden West) believes future success in eliminating explosive remnants of war (ERW) will depend on highly-skilled, dedicated Vietnamese technicians who can apply training, tools, and techniques that mitigate ERW without unnecessarily adding new contaminants to the environment. Open detonations always contribute steel fragments and particles of explosive residue in the ground along with smoke and detonation products in the air. Golden West is helping to develop facilities, technology, and initiatives that reduce pollution from humanitarian mine action (HMA) operations.
Quảng Trị is arguably Vietnam’s province most impacted by ERW, but positive measures are beginning to reduce environmental impacts of HMA operations. The civilian population of Quảng Trị has endured decades of wars and conflict resulting in trauma and slow recovery from widespread ERW contamination. Cooperation between Quảng Trị’s Provincial Military Command (PMC) Engineers and Golden West, is making HMA operations safer and limiting damage to the environment. Golden West believes that building indigenous capacities in enduring institutions that can solve their own ERW challenges without foreign assistance is a long-term key to success for HMA.

A vital element of this partnership has been an effort to nurture and encourage growing Vietnamese environmental awareness, and to develop and enhance techniques that address ERW while incorporating environmental concerns. These include specialized explosive ordnance disposal (EOD) tools such as cartridge-powered dearmers, shaped charges, and mobile cutters that attack fuzes and can prevent unwanted detonations. These tools manage unexploded ordnance (UXO) while mitigating the need for open detonations. By controlling solid waste and upgrading facilities, we pursue the goal of enhancing safety and acknowledging community concerns regarding air and water quality.

The Quảng Trị PMC is an integral part of the People’s Army of Vietnam, tasked with the mission of protecting the people of Quảng Trị Province from a wide range of threats, including exposure to UXO and other ERW. Golden West recognizes that regardless of outside funding or level of international assistance, the PMC Engineers will always be there and will strive to support the population of Quảng Trị. Because we believe in this concept, Golden West is self-funding Quảng Trị PMC training and mentoring programs, building PMC capacity to conduct EOD operations to an international standard of excellence as central Vietnam transitions to a reactive model of residual ERW response.²

In 2019, the Quảng Trị Provincial Peoples Committee provided their PMC with 400 acres of land in Cam Lộ District for use as a dedicated EOD training facility. The PMC partnered with Golden West and the US Army’s Humanitarian Demining Research and Development Program (HDR&D) to develop this site into a world-class EOD testing, training, and demolition range. Access was improved by expanding the range road network, upgrading gravel road surfaces, and increasing drainage. Several existing structures were developed into modern classrooms with new windows, improved lighting, and classroom furnishings. Demolition areas were improved with proper pits for open demolitions and separate pits for white phosphorus projectile disposal, and other areas for open burns of munitions cut by the Mobile Cutting System (MCS). These improvements greatly improved the overall safety of the range.

The Cam Lộ EOD Range is important because it provides a permanent site for both PMC EOD training and application of safe and environmentally conscious demilitarization of UXO. Centrally located in Quảng Trị Province, the range accommodates treatment of recovered UXO from PeaceTrees Vietnam in the western districts and PMC operations in the rest of Quảng Trị. ERW from other HMA organizations in the province can also be processed if requested by the Quảng Trị Mine Action Center (QTMAC).

In early 2020, with generous support from HDR&D, a purpose-built Ordnance Detection Training and Testing Area was constructed by the PMC Engineers and Golden West on the Cam Lộ EOD Range. This training and testing area incorporates three test lanes, consisting of representative soils from the iron-rich west, native Cam Lộ soil, and sandy soil from Quảng Trị’s eastern coastal districts, all seeded with free-from-explosives (FFE) munitions—produced using Golden West’s MCS—that represent commonly-found UXO. These were recovered by the PMC in Quảng Trị Province, made inert, and emplaced by Golden West EOD operators and geophysicists. The site provides PMC EOD operators with outstanding experience locating and characterizing real UXO targets in all soil conditions, and provides opportunities to test and evaluate new detection equipment and technologies in an indigenous environment. Detection equipment used for training included Vallon handheld detectors—provided by a previous U.S. Department of State grant to Golden West—and Ebinger large loop detection tools. Moreover, we hope to obtain the resources to expand the site to include various types of landmines and additional munitions.
Environmental Considerations

In 2020, at the behest of Golden West, initial baseline water quality testing was conducted around the Cam Lộ EOD Range by a commercial environmental company based in Da Nang. The baseline tests characterize the levels of contaminants that exist in ground water, establish acceptable levels of typical range contaminants, and enable control measures if future tests suggest these levels are being exceeded. Golden West has engaged this company to manage the waste lubricants and solid wastes from the MCS training site. A future program of regular water testing is being planned, monitoring the run-off from the range and protecting the water supplies of nearby farmers and communities. We are standardizing this testing and making it a routine training component at the range, with the aim that the PMC will continue the practices when we depart.

In late 2020, multiple tropical typhoons swept across the central region of Vietnam. The Quảng Trị PMC provided immediate assistance, responding to landslides and endemic flooding across much of the province. The Cam Lộ EOD Range was badly damaged by flooding and erosion, with the Ordnance Detection Training and Test Area eroded, demolition pits washed out, and access to the range disrupted. Golden West responded by soliciting additional funds and reallocating funds from training support to the US Army Pacific’s HMA training for Vietnam’s National Mine Action Centre (VNMAC) and HDR&D to assist with urgent repairs to the Cam Lộ EOD Range. With materials from Golden West and equipment and manpower provided by the PMC Engineers, repairs began and access was restored over the next several weeks. Golden West also supported civilian neighbors of the range, providing emergency supplies for forty-six families living in Cam Lộ.

In the early stages of ERW clearance in Quảng Trị Province, blow-in-place open detonations of large UXO were the only safe means of disposal available. Since the war had recently ended, there was no access to reliable EOD publications detailing United States’ munitions and fuze, often making trial and error render safe procedures and blow-in-place detonations necessary. We now know that open detonations generally endanger the public, contaminates areas with metal fragmentation, and deposits explosive residues. Noise from detonations, damage to crops, and disruptions from safety evacuations alienate local farmers and other residents. In many areas of the world, open detonations of residual ERW are no longer authorized except in emergencies when dangerous munitions cannot be safely moved.

Golden West has pioneered use of the MCS to effectively treat bombs and large projectiles. The MCS consists of an electric bandsaw, a generator, and various tools for lifting and positioning munitions, enabling safe separation of fuzes. Through the use of fixed cameras and airborne drones, Golden West uses video supported by high resolution imagery to ensure safety during remote cutting operations. X-ray imagery of suspected white phosphorus filled munitions will soon be incorporated as an additional safety measure, preventing damage to the equipment and a dangerous and messy cleanup. The key to safe and effective operation of the MCS is knowing how to cut, what to cut, and especially what not to cut.

Originally developed in Cambodia as a spinoff of Golden West’s Explosive Harvesting System, the MCS has been used to great effect in the Pacific Islands where open detonations are not feasible due to small island land areas and at-risk populations. With more than fifteen years of experience, Golden West routinely cuts large aerial bombs and projectiles, removing fuzes and enabling munitions to be safely moved. The concept is simple, but the equipment is only a small part of the process. Detailed knowledge of munitions and fuze functioning resulting from IMAS EOD Level 3 training and mentoring combined with specific MCS training is required to safely cut munitions.

Conclusion

Golden West constantly strives to develop training, tools, and techniques that make HMA operations faster, safer, and more cost-effective and environmentally conscious. In central Vietnam, Golden West will continue working with our Vietnamese partners to improve safety and eliminate ERW while improving techniques that protect the environment. We plan to continue working with the Provincial Government and PMC to further develop the Cam Lộ EOD Range, making it a model facility for training and destruction of ERW. By incorporating environmental considerations into the establishment of range operation procedures, Golden West aims to ensure the long-term viability of the range as a permanent PMC asset for management of residual ERW in the region. 

See endnotes page 152

Allan Vosburgh
Chief Executive Officer
Golden West Humanitarian Foundation
www.goldenwesthf.org

Allan Vosburgh has served as Chief Executive Officer of the Golden West Humanitarian Foundation since 2016. Vosburgh served thirty-six years in munitions and EOD in the U.S. military forces and an additional seven years as Chief of Munitions for the U.S. Army Pacific G-4. Since 2005, he has supported humanitarian mine action and physical security and stockpile management worldwide, and created Swim for Life Vietnam, a drowning prevention program for children in central Vietnam.
MEASURING EXPLOSIVE MUNITIONS USE WITH OPEN-SOURCE DATA:
A New Tool for Enhancing Humanitarian Mine Action

By Jonathan Robinson [Humanitarian Researcher] and Christoph Baade [United Nations Office for the Coordination of Humanitarian Affairs]

Since 2011, there has been widespread use of explosive weapons—including conventional weapons, improvised explosive devices (IEDs), and landmines—by all sides in the Syrian conflict. As is known from other contexts, a proportion of these either fail to detonate, becoming unexploded ordnance (UXO), or are abandoned by combatants to become abandoned explosive ordnance (AXO). Long after conflicts have ended, these explosive remnants of war (ERW) endure as multi-generational threats to a community’s population and future development.

One of the first major challenges of dealing with the physical threat of ERW is assessing levels of explosive contamination in a given area. A vital aspect of this is conducting physical visits to field locations for a variety of activities, such as interviews and surveys. However, in places like Syria, this is not always possible due to insufficient access and other security, political, and financial constraints. Adapting to these challenges, many humanitarian mine action (HMA) organizations turn to desk-based, data-driven activities, such as non-technical surveys (NTS) or impact surveys, as a means to prepare for when conditions become available for conducting operations on the ground.

In 2019, The Carter Center found an opportunity to engage productively via the Explosive Munitions Use in Syria Project. Using its unique, open-source conflict dataset and an innovative method that counts the number and general category of explosive munitions mentioned within a conflict event, it began analyzing and mapping information about explosive weapons use in Syrian communities. So far, The Carter Center has published four reports on southern Syria, areas around Damascus, northwest Syria, and northeast Syria. It has extrapolated 267,267 uses of explosive munitions in 2,485 communities from 63,344 reported conflict events. A final report summarizing the whole of the country, including central Syria, will be released by the summer of 2021.

Not only does this desk assessment contribute to the existing body of information on explosive weapons used in the Syrian conflict, it also provides a new tool at the operational level to assist with initial planning and prioritizing actions on the ground. For example, the findings can infer the likely location and general category of potential explosive hazards. This can act as a basic risk assessment tool for anyone seeking to travel to an area, especially HMA personnel. The study could also be used as a roadmap to help prioritize various tasks within HMA, including risk education (RE) activities and NTS, especially if other verified data is unavailable or verified data is slow to materialize.

The study aims to complement existing data, data-management tools, and software, such as ArcGIS, Google Earth, the Information Management System for Mine Action (IMSMA), or Power BI. The study will be readily available in Excel/CVS file format for HMA actors to utilize for their own purposes, compare with their own datasets, and temporarily fill gaps in understanding. The study would effectively augment verified data until this type of data can be collected or released, or until an on-the-ground assessment can be conducted.

At the strategic level, the granularity provided by this type of study can give political and donor entities a better understanding of the scale and complexity of the issue of explosive weapons contamination in Syria. This is especially true if the data from Syria is compared to other environments where explosive hazards clearance has taken place. The aims of the project firmly align it within key frameworks used in the HMA sector, namely the five pillars of mine action and the UN’s Sustainable Development Goals.
The Data and Method

One dataset that is particularly insightful for HMA organizations conducting desk-based assessments is verified conflict data, which is typically person-confirmed, known-to-be-true information that details the type of conflict an area has experienced, the ammunition used, and the intensity of the fighting there.

While useful, verified conflict data has limitations if used exclusively. A sizable amount of other types of data may be discounted at times, especially open-source datasets and social media that have perceived accuracy or trust limitations, as the source of the information is not always clear or verified. Moreover, the process of verifying or confirming data is time-consuming and sensitive to release in situations where conflict persists. In addition, the way current conflict data is recorded and visualized is limited; often focusing on the events themselves, rather than the information contained within them, which can show key details about the number of explosive munitions in an event. This approach can lead to significant discrepancies in how explosive weapons use in an area is understood.

Taking two real examples from The Carter Center’s Explosive Munitions Use in Syria Project, Conflict Event A records “three airstrikes” in Hobit town, while Conflict Event B records “ten artillery bombardments” in Maraand town (Figure 1). In the current system used by many HMA actors, the two conflict events would be visualized in the same way: as two single-conflict events. However, there is obviously a significant difference in the number of explosive munitions mentioned in these two conflict events. Over time, and with a dataset of thousands of conflict events, the gulf between the number of events and the number of explosive munitions used in those conflict events grows considerably. The result is a significant discrepancy in the understanding of explosive munitions used in a given context.

The Carter Center’s project aims to rectify this limitation. Between 2013 and the present day, it has collected over 200,000 corroborated conflict events from a variety of open-source outlets, including Syrian Observatory for Human Rights (SOHR), Syria Live Map, and the Armed Conflict and Location & Event Data Project (ACLED) data, as well as a small number of verified reports from the ground. To the authors’ knowledge, this data had not been systematically analyzed for use in the HMA sector until now.

Using this data, one of the authors developed and applied a simple method to extrapolate the number of explosive munitions mentioned within a conflict event. In cases where numbers of explosive munitions were mentioned, these were counted (e.g., an airstrike, two barrel bombs, three airstrikes). However, in cases where the number of explosive munitions were not explicitly mentioned (e.g., shelling, several airstrikes, etc.), they were given a minimum count of three. This is because single and double uses of explosive munitions were typically mentioned in the data, and so the most accurate but conservative guess for plural explosive munitions uses after this is three. This rule was used even if adjectives such as “intense” or “heavy” preceded the explosive munitions type in the conflict event (e.g., heavy shelling or intense airstrikes).

Despite its limitations, the study nonetheless provides a useful starting point, identifying a minimum count of explosive munitions used in a given area, from a dataset not typically employed in HMA. The data is divided into four groupings of air-launched munitions (excluding cluster munitions), ground-launched munitions (excluding cluster munitions), air and ground cluster munitions, and landmine/IED/UXO. Within each of these groupings, more details of the explosive munitions used are given, such as barrel bombing, artillery shelling, or mortar shelling, and thus can highlight the general type of hazards potentially in an area. Rather than being viewed as an exact type or number of explosive munitions used in an area, this baseline count should be seen as providing a more detailed picture about the distribution of explosive munitions over an area (Figure 2). The method does not attempt to replace verified datasets or HMA activities, but rather seeks to augment those efforts until conditions become conducive to such activities or receive such data.
The Technical Tool

The potential of the project is wide-ranging and is already supported by some in the HMA community. At the operational level, the project functions as a basic risk assessment tool for initial planning stages and prioritizing HMA activities for actors traveling to a potentially contaminated area. Another use could be to help initially plan NTS and RE activities in a more systematic way, given that the findings cover the distribution of explosive munitions across Syria (Figure 3).

Wider Applications and Future Outlook

Looking to the future, while the current study is applied to Syria, its methodology easily lends itself to other environments where HMA activity is needed or conducted, given that this type of project only requires open-source conflict data as an input. Not only this, other information could supplement the open-source data to strengthen the inference of explosive weapons use and potential contamination, including other open-source conflict datasets, open-source data on explosive munitions clearance, satellite imagery detailing explosive munitions damage, weather conditions during the events, information on how long communities remained under the control of an armed group, or the time a community spent close to a frontline to name a few (Figure 4).

Artificial intelligence (AI) and machine learning (ML) could also be used to extract information about explosive munition uses...
from visual (video and photo) or text media from a wide range of sources, including social media tools like Twitter or Facebook. AI and ML would also improve the speed and efficiency of the project; instead of manually extrapolating the explosive munition counts from each conflict event, it could be done automatically.

The additional layers of information mentioned previously are by no means exhaustive, but could result in unprecedented findings on the validity and utility of open-source data and its usefulness in the HMA sector. As mentioned previously, rather than replace existing methods and systems in the HMA sector, the study would seek to augment these in cases where conditions are not available for HMA actors to obtain firsthand verified data from the ground and act as an initial phase of the desk assessment.

Used intelligently, open-source data could support different purposes outside of the HMA sector as well. For the peacebuilding sector, HMA and open-source data studies can be used as an entry point for convening and conducting initial practical discussions between sides in a given context, as the topic of dealing with explosive munitions contamination is relatively neutral and is a problem that people often unanimously agree needs solving. If successful, HMA and open-source data studies could then be used to build discussions on wider topics, such as humanitarian access issues, housing, land and property rights, or good governance. Examples of HMA being successfully implemented in peacebuilding initiatives have been seen in Armenia, Azerbaijan, Colombia, Sri Lanka, and Sudan.

Conclusion

By using open-source data and a method that counts explosive munition uses rather than conflict events, a detailed overview can illustrate the distribution of a variety of types of explosive munitions in a given area. This can give actors conducting initial desk-based assessments an advantage if other methods are ineffective or unavailable. This tool can be used to conduct a basic risk assessment for HMA actors, as well as add to HMA actors’ ability to plan and prioritize activities over a large area, such as NTS or RE activities. At the strategic level, the granularity provided by this type of study can give political and donor entities a tool that helps contextualize and appraise the scale and complexity of the issue of explosive weapons contamination in an area, especially if used comparatively with other contexts. Not only limited to Syria, the project has strong potential in a number of other locations around the world, such as Libya, Ukraine, and Yemen as well as in neighboring sectors such as peacebuilding. The authors hope that this article encourages other entities to replicate this study in the future with their own conflict data to supplement their existing methods or datasets.

With the completion of The Carter Center’s project expected by the summer of 2021, the authors are actively seeking collaboration with entities seeking to replicate or widen this scope of the project, especially in other regions in the world. We would also welcome any feedback about the project.

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

See endnotes page 152

---

Jonathan Robinson
Humanitarian Researcher

Jonathan Robinson is a humanitarian researcher specializing in data and its application in humanitarian mine action. He previously led The Carter Center’s Explosive Munitions Use in Syria Project, as well as supported Caritas Switzerland, The HALO Trust, and the International NGO Safety Organisation (INSO) among other organizations in the Middle East over the past ten years. Robinson holds a masters of science from the University of Edinburgh and a bachelor of arts (hons) from Durham University.

Christoph Baade
Consultant
UN OCHA’s Central Emergency Response Fund

Christoph Baade specializes in conflict research and application in humanitarian mine action and peacebuilding. He is currently a consultant at UN OCHA’s Central Emergency Response Fund. He previously supported The Carter Center’s Explosive Munitions Use in Syria Project and worked as a research consultant at ArtEZ Institute of the Arts, The Netherlands. Baade holds a master of arts from King’s College London and a bachelor of arts degree from Leuphana University of Lüneburg.
THE ELUSIVE “JUST ENOUGH”
Re-inventing Explosive Hazard Clearance Management in IRAQ

By Mark Wilkinson, Ph.D. [United Nations Mine Action Service]

The Government of Iraq viewed rehabilitation of infrastructure contaminated with explosives during the conflict with the Islamic State of Iraq and the Levant (ISIL) as a prerequisite to socioeconomic recovery and political stability, which, in turn, established a need for the mine action community to deploy qualified, certified clearance teams as quickly as possible. While these teams could deploy quickly, their reliance on international staff and their associated costs attributable to security and other factors introduced a high overhead business model that became an accepted standard during a first clearance phase from 2015 to 2019, despite the understanding that this model could not be sustained indefinitely. A shift in donor priorities and reduced budgets effectively introduced a second clearance phase beginning in 2020. The challenge to the mine action community became the development of a more cost-effective, time-sensitive approach to clearance so as to reduce costs to levels acceptable to donors without compromising clearance standards.

In response, the United Nations Mine Action Service (UNMAS) Iraq through its (1) evidence-based analysis and measurement of data and (2) effects-based approach to clearance delivery introduced a low cost, high return business model. This model offered a more efficient approach when compared to previous like-for-like models, in addition to providing useful tool sets applicable for other locations and conditions similar to those found in Iraq.

As of December 2017, west Mosul was heavily contaminated not only with explosive remnants of war (ERW) but also with what proved to be thousands of improvised explosive devices (IEDs) left by ISIL. These devices denied access to sites and infrastructure, thereby delaying the complicated task of render safe/removal efforts consistent with international standards.”

Phase 1: The Problem

The urgency and conditions that determined the need to deploy qualified, certified clearance teams quickly also de facto dictated the terms for what became the Phase 1 business model of clearance, lasting roughly from 2015 to 2019.

During Phase 1, UNMAS relied on international commercial companies (ICC) for explosive ordnance disposal (EOD) and improvised explosive device disposal (IEDD) expertise despite their relative high cost attributable (1) to their reliance on foreign experts; and, concomitantly, (2) to their need for protection provided by private security detachments.

Although costly, the model achieved the desired results. From 2016 to 2020, explosive hazard (EH) clearance teams under UNMAS-managed contracts performed 1,823 clearance tasks, rendering safe/removing 67,335 EH while clearing 10.6 million sq m of land and counting.3

Yet, at the end of 2019, an estimated 2,522 sq km in an area formerly occupied by ISIL remained contaminated (see Figure 1) while budgets available to support clearance began to decline, partly because donor priorities and strategies had changed. Nonetheless, for the Government of Iraq, rebuilding and rehabilitating infrastructure remained critical and depended upon EH clearance to proceed despite the ongoing risks posed by ISIL insurgents and related security costs (see Figure 2, ISIL Activity); and therein, lay the crux of the business problem entering Phase 2: do more with less.
Phase 1: The Factors

From the outset, UNMAS realized the high overhead model could not be sustained indefinitely, and several factors drove its change.

Security. UNMAS recognized that, effectively, it was managing a hybrid clearance situation: neither peacekeeping nor humanitarian due to the continuing security threats. After their retreat from Mosul in December 2017, ISIL’s remaining fighters did not leave; they switched from conventional warfare to guerilla tactics in an effort to deny recovery and maintain de facto control in the one-third of Iraq they once occupied. Some disappeared literally underground, while others hid in plain sight among sympathizers, at times targeting clearance teams. According to UN security analysts, 2020 set a new record for ISIL incidents (Figure 2). This hybrid situation remains very much a concern and a factor for a low cost, high return model.

Time. Data analysis by UNMAS since December 2017 has shown time-on-task varies as a function of (1) events leading to contamination; (2) extent of contamination; (3) environment type; (4) exposure of operators based on the device and/or its design; (5) operators’ experience, (i.e., skills and assets appropriate for clearance and safe removal of threats as assessed); and (6) events beyond operational control, (e.g., security and COVID-19 restrictions), which either disrupt or delay clearance operations.

Measurement. UNMAS reasoned that these factors when measured systematically 4 could provide an evidence-based estimate of relative hazardousness for contaminated areas with implications for time required for safe clearance, removal, and disposal of hazards.

---

Figure 1. Explosive hazard contamination in Iraq, UNMAS Information Management Unit, 4 February 2021. All graphics courtesy of UNMAS.

Figure 2. Comparison of open source and Amasq (ISIL News Agency) data as compiled by, and courtesy of Joint Analysis Unit (JAU), United Nations Assistance Mission for Iraq (UNAMI), 27 January 2021.
consistently with IMAS standards; and, importantly, for team composition, training, and deployment (i.e., assigning teams appropriately trained for each task). Accordingly, by mid-2019, UNMAS began development of what became a lethality index, which—for the first time—classified clearance tasks according to environment and technical factors (see **Time**), and assigned values for locations, thereby providing an evidence-based measurement of lethality with implications for skillset, time, and cost. The more lethal the task, and the longer the time required for render safe and removal, the greater the skills required and associated hourly cost.

**Fit-for-purpose.** At the same time, UNMAS began evaluating alternative team compositions and, by mid-2019, introduced on a trial basis a light version based on the decades-old, proven rapid response team (RRT) concept. These highly-mobile, cost-effective teams relied exclusively on fully-trained Iraqi staff for high-risk search (HRS), EOD, IEDD, and geographic information systems (GIS) reporting, equipped with integral medical support, and deployable anywhere in the liberated areas of Iraq within a twenty-four-hour period. The RRTs were backed by a single, on-call international technical advisor who did not deploy. The RRTs relied on local security, eliminating the constraints and costs associated with predominately international staff and less mobile-heavy teams equipped with mechanical assets.

**Repositioning.** UNMAS positioned itself to (1) rewrite the way business was conducted through statements of work based on evidence-based data measuring time-on-task as a function of relative difficulty (the lethality index) and validated operational concepts (e.g., RRT teams) that could provide both flexibility in tune with changing requirements and tasks as received from the Directorate of Mine Action (DMA), Iraq’s national mine action authority; and (2) deliver results meeting IMAS standards at reduced costs and a higher rate of return.

**Expediency.** If the new ideas being developed offered a potential low-cost, high-return business model, UNMAS also would need to change its statements of work, which initially focused on specific requirements for clearance teams and their capability rather than outcomes, thereby introducing an unintended bias into the process that favored ICCs largely for reason of expediency: Given that their accreditation, team composition, and readiness to deploy solved the urgency issue, ICCs became the only viable clearance solution in the short term.

**Double jeopardy.** As of 2018, this safe choice pattern began to repeat. New contracts nearly always specified size, capability, and scope that favored bidders with similar, previous experience. This generic, move-of-the-same approach de facto endorsed the ICC profile as a norm for clearance teams, negating nongovernmental organizations (NGO) cost advantages. Since virtually all ICC teams were dominated by large numbers of international personnel, their statements of work built in higher personnel and security costs as an accepted cost of doing business. NGOs accredited for clearance in Iraq could therefore find themselves responding to statements of work that assumed security costs based on an ICC model despite NGOs’ reliance on less costly local staff as well as associated operational advantages, including a reduced security requirement, thereby negating their competitive advantage while adopting the ICC’s disadvantages. This situation would not begin to change until late 2018 when UNMAS awarded its first commercial contract for EH clearance in Iraq to an NGO.

**Phase 2: The Changes**

**Statements of Work.** The experience of Phase 1 strongly suggested other changes were necessary including re-design of statements of work, the part of each contract that detailed the methodology for delivery of services using an effects-based approach toward delivery of services. By 2019, UNMAS was developing evidence-based measurement useful in assessing time-on-task for appropriate skillsets (the lethality index) and adapting and testing an agile, flexible team concept (the RRTs) which, taken together, promised the low-cost, high-return business model sought for a Phase 2.

**Effects-based.** This inherently fairer approach gave potential clearance partners more freedom and an opportunity to focus on outcomes rather than dictating means of delivery. Thereby, UNMAS not only achieved a desired outcome but also tested potential clearance partners’ existing knowledge while encouraging a just enough approach to resources, thus promoting innovation and cost-effectiveness while meeting IMAS standards.

Accordingly, consistent with its evidence-based measurement and agile, flexible team concepts, future statements of work were framed using an effects-based approach to clearance delivery around the following parameters:

- **Intelligence analysis.** UNMAS includes an initial work package based on lethality index measurements to ensure that clearance partners base their proposals on a thorough and evidence-based assessment of the intended geographical area, the impact of the conflict there, its IED and EH threat characteristics, likely task types, and mobility/travel requirements.
- **Requirements.** Clearance partners use environmental and technical factors derived from UNMAS intelligence analysis as a guide to ensure adequacy of delivery proposals.
- **Capability.** Clearance partners demonstrate their capability to deliver the required clearance outcome(s) through a detailed analysis of tasks, and their working procedures and practices as meeting relevant national/international standards.
- **Enhancement.** Clearance partners include mentoring and development of both individual and team skills in a logical way such that teams can plan, deliver, and report effectively on the task types they have been trained to conduct: capacity enhancement is as important as clearance.
- **Risk management.** Clearance partners demonstrate a dynamic and proactive approach to risk management to predefined levels that are “as low as reasonably practicable.”

**Transition.** By 2019, UNMAS Iraq had worked through details of a two-step approach as agreed with its procurement partners to transition to an effects-based approach and was ready with a first clearance contract, including a statement of work based on three parameters open to both ICCs and NGOs. Accordingly, UNMAS aimed to
• shorten the mobilization phase by providing precise environmental and technical information related to current and potential locations, thereby ensuring ICCs and NGOs could reflect this information in terms of proposed team composition and equipment as cost effectiveness/value for money;
• limit international staff and increase national staff levels and ownership, both of which are consistent with a commitment to mentoring and development of national resources along with cost reduction; and
• ensure proper oversight by linking the operational delivery to a pilot study using an UNMAS risk management tool set dating from contract signature onward, affording a visibility of risk so that UNMAS could comment and/or intervene constructively and developmentally to address concerns at any time.

This first step in the transition to full effects-based clearance activities was delivered with a contract for clearance in Ninewa that commenced in January 2020, followed by the second step in October 2020 when the new grant partnership model was signed and initiated. Statements of work for a two-year time frame included management, programs, operations, support, quality assurance, leadership, risk management, and resource mobilization as parameters in anticipation of fully-qualified, Iraqi-managed clearance capability sustained by international and national NGOs.

## Phase 3: The Transition

Even as UNMAS was developing an evidence-based measurement tool useful in assessing time-on-task for appropriate skillsets (the \textit{lethality index}) and adapting and testing an agile, flexible team concept that, taken together, promised the low-cost, high-return model sought in Phase 2, the experience of Phase 1 strongly suggested other changes were necessary. These included a transition in advance of an UNMAS exit to a stronger leadership role for DMA. During this transition, UNMAS saw itself moving into a consulting role, gradually transferring ownership of the day-to-day management of clearance tasks under contract. By mid-2019, UNMAS Iraq had introduced four management initiatives to guide those making decisions on both sides while managing the expectations of all, namely:

- **Partnership.** UNMAS would approach operational oversight and quality assurance on a cooperative basis, with an emphasis on coaching and mentoring delivery partners so as to build local capacity, confidence, and independence.
- **Sustainability.** Delivery partners should train initially with minimal direct international technical supervision so as to strengthen and sustain national capability to the point that it is self-sustaining and self-supervising.
- **Identity.** National capability should represent the ethnography of the areas it operates within, thus bolstering acceptance of clearance teams and their work.
- **Gender.** UNMAS and the DMA would share a leadership role to assure that all strategic, managerial, and operational decision-making, planning, and participation would reflect both women’s and men’s experiences, needs, and perspectives.

### Table 1.

<table>
<thead>
<tr>
<th>Contract Cost: Simple Rural</th>
<th>Contract Cost: Complex Urban</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cost $</strong></td>
<td>10,232,049</td>
</tr>
<tr>
<td><strong>Sq m</strong></td>
<td>179,472</td>
</tr>
<tr>
<td><strong>Environment</strong></td>
<td>Urban</td>
</tr>
<tr>
<td><strong>Type</strong></td>
<td>Complex</td>
</tr>
<tr>
<td><strong>Contractor</strong></td>
<td>ICC 3 Mosul</td>
</tr>
</tbody>
</table>

### Table 2.

| Cost $ | 7,486,814 | 8,509,911 | 2,548,636 |
| Sq m | 639,450 | 2,089,806 | 639,450 |
| Environment | Rural | Rural | Rural |
| Type | Simple | Simple | Simple |
| Contractor | ICC 3 Sinjar | ICC 3 Kirkuk | ICC 2 Sinjar |

![Figure 3](image1.png)

![Figure 4](image2.png)
Benefits

The benefits of an effects-based approach to clearance delivery are clear, beginning with the most important: a sustainable, fully-national, and non-profit clearance capability. Three additional benefits are worth noting:

- **Value for money.** A reduction in the contracted cost of like-for-like clearance contracts by a factor of five during a two-year period, largely as a result of reduced reliance on international personnel and related security requirements, while maintaining IMAS quality standards.

- **Ownership.** Locally-recruited teams generate both acceptance and sustainability, eliminate accommodation costs, and require only a locally-based office to sustain operations. Any required international staff can work remotely with travel limited to quality assurance, technical oversight, or training purposes until they are no longer required.

- **Redefined role.** Relationship with delivery partners is now based on a clear definition of pragmatic outcomes, when-needed support, and operational and quality oversight.

![Figure 5.](image)

<table>
<thead>
<tr>
<th>Month</th>
<th>Cost $</th>
<th>Sq m</th>
<th>Environment</th>
<th>Type</th>
<th>Contractor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jun-18</td>
<td>6,374,302</td>
<td>183,906</td>
<td>Mixed</td>
<td>ICC 1 RRT</td>
<td></td>
</tr>
<tr>
<td>Sep-18</td>
<td>3,996,182</td>
<td>111,235</td>
<td>Mixed</td>
<td>NGO 1 SAD</td>
<td></td>
</tr>
<tr>
<td>Jun-18</td>
<td>3,782,356</td>
<td>740,146</td>
<td>Mixed</td>
<td>NGO 2 Nineva</td>
<td></td>
</tr>
<tr>
<td>Jul-19</td>
<td>3,691,709</td>
<td></td>
<td>Mixed</td>
<td>NGO 1 Anbar</td>
<td></td>
</tr>
<tr>
<td>Aug-20</td>
<td>2,343,195</td>
<td></td>
<td>Mixed</td>
<td>NGO 1 Fallujah</td>
<td></td>
</tr>
</tbody>
</table>

Table 3.

The Future of “Just Enough”

UNMAS Iraq through its (1) evidence-based analysis and measurement of data and (2) effects-based approach to clearance delivery offers a logical and coherent approach to planning, reduced cost, and performance gains when compared to previous like-for-like projects, and useful tool sets applicable for other locations as well. Most important, the timing of this low cost, high return model coincides with the on-going transfer of UNMAS Iraq's evolving role and transfer of remaining clearance activities and related management to DMA as part of a well-planned exit strategy. 

See endnotes page 153

---

**BIOGRAPHY**

**Mark Wilkinson, Ph.D.**
Senior Operations Manager
United Nations Mine Action Service (Iraq)

Mark Wilkinson, Ph.D., UNMAS (Iraq) Senior Operations Manager, has twenty years of professional experience in military and HMA. As a former British Army Ammunition Technical Officer, he worked as a High Threat IEDD Operator in several operational environments before transitioning to HMA. His HMA experience has developed through time spent as an IEDD operator, then a program manager, before moving to UNMAS. His academic background includes a master’s degree in global security and a doctorate in politics and international studies. His thesis on Arms Control and Intelligence has been published internationally as the book Before Intelligence Failed. He is also a Visiting Fellow at the University of Nottingham Centre for Conflict, Security and Terrorism where he maintains an active research agenda.
MANAGING RISK THROUGH TRANSPARENCY AND COOPERATION:
Improving Lebanon’s PSSM Capacity

By Jamie McGhee [Mines Advisory Group. MAG]

Weapons and ammunition management (WAM) is a global issue in which nations are responsible for the physical security and stockpile management (PSSM) of weapons and ammunition to help mitigate weapons diversion and proliferation, and to prevent against an unplanned explosions at munitions sites (UEMS). Although in most instances preventable, UEMS incidents have increased, leading to significant loss of life, life-changing injuries to innocent civilians, and damage to property.

In ideal circumstances countries would have the money for sufficient equipment and storage facilities; however, this is not always the case. Often the security sector is left to manage its weapons and ammunition stockpiles on an extremely limited budget. This means having to be self-reliant to keep things running as they should, sourcing basic equipment such as wooden pallets to stack ammunition. While this is often seen as a short-term scenario, the reality is that these stop-gaps often turn into a long-term solution or become the “norm” in the absence of sufficient cash or capacity to run technical refresher training for military personnel, replace outdated equipment, and keep existing storage facilities maintained. As a result, ammunition stockpiles can deteriorate rapidly.

The same can be said of the procurement of arms and ammunition. If states do not have a budget to purchase newer ammunition and phase out older stockpiles, ammunition is inevitably kept past its original shelf life, with insufficient technical capacity to conduct routine surveillance and maintenance of the ammunition throughout its lifecycle. Through no fault of the military, ammunition is often housed in less than adequate storage facilities or buildings not originally designed for its storage.

These are the defining factors in global incidents involving ammunition stockpiles, and it’s why the Lebanese Armed Forces (LAF) requested assistance to bolster its national capacity for PSSM, as they fully understood the dangers posed to both the military personnel working at these facilities as well as the civilian population living nearby.

Global Challenges

There are always challenges when discussing WAM with any government, due the sensitive nature of the subject, and general reluctance to allow outside parties to see the true extent of the state’s deficiencies regarding PSSM. Every country ultimately has different needs when looking at both technical capacity of existing security sector personnel, weapons/ammunition storage, accounting practices, and management systems that are at different levels of compliance when looking at the risk reduction process levels (RRPLs) in the International Ammunition Technical Guidelines (IATGs).

International best practices are often associated with costing millions of Lebanese pounds (LBP). However, this is not necessarily the case, particularly at the start of any WAM pilot project. While it does cost money to train and provide adequate equipment for security sector personnel to conduct their duties, first understanding what the problems are and finding the solutions through dialogue with the national authorities can bring an easy resolution to what initially seemed a difficult problem.

Similarly, governments often claim there are insufficient funds to provide better storage, train more personnel, purchase new weapons and ammunition, and destroy older stockpiled ammunition. However, thorough risk assessments of all ammunition stockpiles and existing storage facilities, and estimated financial implications of a potential UEMS can incentivize more governments to better manage their weapons and ammunition stockpiles. In the case of storing explosive munitions, “risk avoidance” is impossible as the state already has ownership. Therefore, identifying all risks and ensuring they are professionally managed is critical.

*The essence of risk management lies in maximizing the areas where we have some control over the outcome while minimizing the areas where we have absolutely no control over the outcome*.

– Peter L. Bernstein
MAG History in Lebanon

Mines Advisory Group (MAG) currently has operations in twenty-six countries globally, and nineteen of those countries have a WAM program. Operational in Lebanon since 2001, MAG began by conducting mine clearance operations and mine risk education (MRE). Lebanon has endured several decades of both civil and external conflicts that have left the country with an extensive legacy of landmine and cluster munition contamination. In total, MAG Lebanon has cleared more than 18 million sq m of contaminated land and removed or destroyed more than 62,000 landmines, cluster munitions, and other unexploded ordinance (UXO). Since 2017, MAG has deployed teams on the Blue Line (the border demarcation between Lebanon and Israel as defined by the United Nations on 7 June 2000). In this time, MAG has cleared and released an area of more than 400,000 sq m and found and destroyed more than 29,000 items including anti-personnel mines, anti-tank mines, and explosive remnants of war (ERW). In October 2018, MAG expanded operations in the northeast of Lebanon and has since conducted non-technical survey (NTS) and clearance activities; releasing over 786,000 sq m of suspected and contaminated hazardous land.

Weapons and Ammunition Management in Lebanon

In 2017, the LAF approached the U.S. Department of State with a request to support PSSM activities at three of their existing ammunition storage facilities. After an initial assessment (21-22 January 2018) of the LAF’s PSSM practices at several locations by a US technical team, MAG was asked to assist LAF improve current WAM practices, and bring them into line with the IATGs. MAG conducted technical site assessments (October and December 2018) at the three locations and made recommendations on how to improve the overall security of the facilities.

With an additional $1.6 million in continuation funding in February 2019, MAG has since conducted PSSM technical site assessments at thirteen locations (three in 2018 and ten in 2020) identified by the LAF as high priority for possible intervention. At each location, MAG assessed and then prioritized storage facilities utilizing a "low cost-high impact" model when looking at WAM interventions, i.e., MAG provided the correct level of intervention to meet the requirements for that specific location. This process often involves finding a simple, cost-effective solution to resolve an issue and mitigate the risks identified, which is just as effective as a more complex high-cost intervention. Whereas all locations are prioritized by risk probability and impact, several key factors must be taken into consideration when conducting a site assessment to ensure the correct level of intervention is identified. These can include the following:

- accessibility (including visibility) of the site
- adequate fire-fighting equipment and personal protective equipment (PPE)
- adequate lightning protection
- compatibility groups of the ammunition
- construction design and blueprint of existing facilities
- costs of potential rehabilitation/construction works
- estimated repair costs if UEMS take place (conducted by the state)
- future expansion plans of facility (if applicable)
- hazard class of the ammunition
- location of facility
- net explosive quantity (NEQ) of ammunition being stored on site for calculating quantity distances (QDs)
- number of personnel living/working at the base
- number of trained ammunition technical staff
- quantity and types/nature of ammunition stored
- secondary hazards or critical infrastructure near storage facilities (fuel stations, gas pipelines, underground services, hospitals, ministries, schools, power stations, religious buildings, etc.)
- security of area in which ammunition depot is situated
- value of ammunition stocks stored

While this list isn't exhaustive, it highlights the need to gather significant data to ascertain the appropriate intervention level required to ensure the safety and security of both the ammunition stockpiles and the civilian population living near the potential explosion site (PES).

In December 2020, MAG completed construction work at three of the thirteen locations previously identified as a priority by the LAF. The level of intervention at each of the storage facilities at the locations varied in scale and complexity, and involved MAG providing technical training—an IATG familiarization workshop to introduce the IATGs and international best practices to forty-seven existing LAF ammunition technical personnel from the Ammunition Directorate who will be managing the ammunition at the three locations where these technical interventions were conducted. Additional refresher training for LAF personnel was planned in 2020, but due to COVID-19 restrictions in Lebanon this was not possible.

Due to land constraints and the encroachment of the civilian population to existing ammunition storage facilities in country, the provision of QD training to the LAF was seen as critical. This training familiarized staff with online tools that (1) can help determine what can safely be stored at all ammunition storage facilities in country and (2) assist them with risk mitigation as part of the long-term planning for the Ammunition Directorate.

As a result of the training, a plan is underway to destroy donor-gifted ammunition that cannot be used by the LAF, which will provide much needed space inside the storage facilities, in turn reducing the risk to both military and civilian personnel living nearby. A joint assessment of the LAF central demolition site was also conducted on 17 September 2020 to check the location’s suitability for future ammunition destruction operations by LAF explosive ordnance disposal (EOD) teams.

This QD training also allowed the Ammunition Directorate to start planning logistical movements of larger caliber ammunition to more suitable locations outside of populated areas. The QD training showed
the LAF the minimum safety distances needed for each site based on the NEQ of explosives being stored. With this knowledge they were able to identify the amount of ammunition that had to be either moved from the location to somewhere more suitable or marked for destruction if it was (1) surplus to operational requirements or (2) if there was a lack of sufficient storage space to house it securely and safely.

MAG completed the full-scale construction of a new purpose-built ammunition storage area (ASA) in December 2020 that has four explosive storehouses to secure the LAF’s more valuable, larger caliber munitions at a strategically important location. The facility meets all requirements within the IATGs.

Image 1 and 2. Storage of projectile propellant before (left) and after (right) Intervention by MAG.
All images courtesy of MAG.

Current Challenges in Lebanon

One of the biggest challenges for the LAF is availability of suitable land for construction of military bases and larger ammunition storage facilities. A large proportion of existing military infrastructure was purpose built by France in the 1950s. Although a lot of this infrastructure remains and is still functional, facilities previously isolated with excellent safety distances are now located in highly populated areas.

At the end of the Lebanese Civil War (1975–1990), plots of land were quickly snapped up by civilians and used to build houses, shops, etc. Building developments continue to expand and now encroach close to existing ammunition depots, meaning they are at risk should an UEMS take place. As the minimum safety distance in the IATGs for storing explosives is 400 m, the LAF has thought innovatively about how to reduce the risk at these sites, while mitigating the threat posed to the civilian population. In light of this, the Ammunition Directorate, who are responsible for all in-country ammunition, has managed significant logistical movements of ammunition stocks throughout the country to reduce the threat to civilians while still maintaining LAF operational effectiveness.

As part of the LAF long-term strategic planning, MAG is in regular contact with the LAF’s G3 Director of Planning Department and G4 Logistics regarding available governmental land, and discussions continue to identify suitable areas pending technical field assessments for the construction of large-scale ammunition depots and sub-unit depots.

LAF Response to the Beirut Port Explosion

On 4 August 2020, a warehouse in the Port of Beirut containing 2,750 metric tonnes of ammonium nitrate (confiscated off a cargo ship in 2013 for failure to pay port fees and stored with commercial fireworks and other chemicals) caught fire, causing the ammonium nitrate to detonate.17 The subsequent explosion caused severe damage to civilian homes, key military and civilian installations, and infrastructure in the vicinity of the port.

The incident itself left at least 218 people dead, 7,000 people injured, 300,000 displaced, and most of the country’s grain supplies destroyed; the overall cost of the blast is estimated at $10–15 billion.15 The political fallout from the explosion was almost immediate, resulting in widespread rioting and significant increases in major security incidents across the country. Through increased pressure by the public, it eventually led to the collapse of the Lebanese government and resulted in several senior members of the port customs and immigration going to jail for their failures leading up to the event.

While this event was not related to either weapons or ammunition, the devastation the blast caused highlighted the need for the LAF higher command to seriously look at existing LAF ammunition storage facilities and start working towards removing all ammunition stockpiles outside of populated areas.

Following the explosion, on 4 August 2020, LAF G4 Logistics requested MAG’s assistance to conduct post-blast assessments of several military facilities near the port that suffered heavy blast damage and resulted in LAF personnel being killed and injured. MAG, supported by LAF military engineers, made emergency security repairs at
these military installations and received additional emergency funds from the US government to conduct this work.

The LAF G4 and the Ammunition Directorate were tasked with moving all unserviceable ammunition identified during the site assessments by MAG and ammunition previously earmarked for destruction by the LAF to various holding locations ready for destruction, pending final approval from LAF higher command.

The General Commander of the LAF ordered the Ammunition Directorate to deploy immediately and conduct risk assessments of all military facilities to ensure all known risks were being managed correctly and report back on any new risks identified or non-conformities.

LAF are the de facto entity when it comes to having the trust of the civilian population, who look to the LAF to maintain security, conduct damage assessments of all buildings impacted by the blast, and deliver food aid packs to all households affected by the blast. Not only did they manage the situation, the LAF has accelerated all planned ammunition destruction operations, and discussions are taking place between LAF and MAG regarding upgrading the existing central demolition site assessed in September 2020 to allow for larger ammunition destruction operations to take place.

*Image 3 and 4. (Left) One of the external roller shutter access doors to the ammunition depot. (Right) A large ammunition depot in Lebanon constructed by MAG.*

**Next Steps**

MAG Lebanon has secured an additional $3.5 million from the U.S. Department of State and will assist the LAF with the development of the strategic plan, which is seen as essential for the LAF to ensure its fit for purpose. Moreover, MAG will continue to foster its relationship with the LAF and assist both in the development of its personnel's technical skills and with improving existing standard operating procedures to ensure compliance with the IATGs.

MAG will also provide additional WAM technical training to a further forty-five LAF personnel and provide munition safety planning (MSP) workshops to higher levels of the Lebanese military to ensure everyone is aware of their roles and responsibilities regarding the safety and security of the national ammunition stockpiles and the citizens of Lebanon. In addition to the capacity development of LAF personnel, technical field assessments will also be conducted at thirty locations identified by the LAF. These locations are still being determined as part of the strategic planning discussions.

Technical interventions at six locations previously assessed by MAG have also been agreed by LAF and approved by the donor. These interventions range in complexity from improving basic security measures to the complete construction of a new purpose-built ammunition storage facility. When completed, this will be a significant improvement to both the LAF’s existing technical capacity and overall capability to securely store their ammunition stockpiles. All planned activities mentioned will be completed by January 2023.

While there is still a long way to go in achieving the required standards, current progress can be attributed to the LAF’s proactive nature and transparency at all levels with MAG. The WAM program in Lebanon has already made significant progress in this regard, and the author would like to personally thank the donor and all members of the LAF with whom MAG is working for, helping these vital PSSM interventions to take place.

*See endnotes page 153*

**Jamie McGhee**

WAM Technical Manager
Mines Advisory Group (MAG)

Jamie McGhee is a former British Armed Forces EOD Specialist who began working in humanitarian mine action in 2009. He has previously held technical roles for The HALO Trust in Afghanistan, Ivory Coast, South Sudan, Angola, Georgia, and Cambodia; and the Danish Demining Group (DDG), where he was responsible for all SALW activities in the Horn of Africa and Yemen. He started working with MAG in 2015 as Technical Operations Manager and then Country Director in Somalia before moving to the Operations Development Team (ODT) at MAG HQ in 2018. He is responsible for technical oversight of WAM activities in Somalia, Ecuador, Peru, Nigeria, Lebanon, Angola, Sierra Leone, Mexico, Gambia, and Sri Lanka.
ASSISTING LANDMINE SURVIVORS IN Yemen

By Elise Becker and Tamara Klingsheim [Marshall Legacy Institute]

Over the past ten years, with funding from the U.S. Department of State, the Marshall Legacy Institute’s (MLI) Mine Victim’s Assistance Program (MVA) has helped over 800 male, female, and child landmine survivors in Yemen. MLI and our in-country program partner have worked to identify survivors and provide them with the assistance they require, including prosthetic services, vocational training, and self-employment opportunities, to improve their lives and increase their prospects for a brighter future.

Abeer Mabkhot is a thirty-year-old Yemeni landmine survivor. Ten years ago, she stepped on a landmine and lost her left leg. Abeer shares “I knew that the area had been contaminated by mines recently as a result of the war between Al Qaeda groups and the army, but because of the shortage of our fuel (gas, electricity, and diesel), I had to collect wood (fuel) for cooking. The mines were planted around a military camp, but the trees were also located in the same contaminated area. I was afraid of the mines, and this was the second time for me to collect wood from this area.” Abeer laughs, saying “the third time didn’t happen because I had my accident the second time.” Soldiers from the military camp heard the explosion and immediately took Abeer to the military hospital, but she lost her left leg.

Qasem Al Surabil is a young man living with his mother, father, wife, and children in Yemen. He works hard to support both his family and his parents. Qasem is also a landmine survivor. “I was going to work as usual in agriculture with my brother when I saw a strange object on the ground and I thought it is a game. My brother told me to ignore it, but I took it and started playing with it, then it exploded. My brother, with some villagers who heard the explosion, took me to the Revolution Hospital in Sana’A, and there my hand was amputated.” After his accident, Qasem searched for a job but employers did not want to hire him due to his disability. He took out a business loan, but still went into debt. “Unfortunately, because of the bad situation of Yemen, which increases every day, my small business failed with no return… I lost everything.”

Program Overview

As of 2017, the Landmine and Cluster Munition Monitor indicates 9,118 known casualties from landmines and other explosive remnants of war (ERW) in Yemen; however, there is no differentiation between those injured or killed. The cumulative figure of landmine survivors is undoubtedly much higher. Ongoing conflicts since March 2015 have likely added additional landmine and ERW contamination, and have hindered data collection of casualties, which has “prevented the operation of a national casualty surveillance mechanism.”

Wanting to help address the physical, vocational, and financial needs of landmine survivors in Yemen, MLI launched the MVA program in Yemen in 2011, with funding from the US Department of State. To date, MLI’s MVA Yemen program has provided prosthetic...
limbs, vocational training, and/or micro-grants to 822 landmine survivors in Yemen. The Yemeni Association of Landmine Survivors (YALS) serves as MLI’s in-country partner, assisting with identifying survivors as well as arranging transportation and accommodation for survivors as needed.

The program has provided real, tangible results for landmine survivors in Yemen. In 2016, five years after her accident, MLI and YALS identified Abeer to receive a prosthetic leg, which allowed her to regain some of her mobility. Abeer says her prosthetic provides her “with a lot of hope for the future.” Through the program, she participated in a vocational sewing training course and, in 2019, applied for and received a micro-grant through MLI’s MVA program, which provided funding for her budding sewing business. Some of Abeer’s handmade items were sold at the Silent Auction during MLI’s 2018 Clearing the Path Gala Event held in Washington, D.C. In 2020, Abeer was selected to receive MLI’s “Survivor of the Year Award” at the annual Gala event, held virtually due to the COVID-19 pandemic. She continues her studies in literacy at the local university, paying for her schooling with money that she earned through her sewing business.

Comparatively, Qasem participated in the carpentry vocational training course offered by MLI through the program. In 2019, he received a micro-grant to open a mini-market in his village, stating “I became happy that I will have work, which will help me and my family and allow me to take care of them.”

The joint MLI-YALS project provides the following:
1. Prosthetic services and other medical care to Yemeni landmine survivors, including both adults and children
2. Vocational training to enhance the employment opportunities and social integration of adult Yemeni landmine survivors
3. Self-employment opportunities for select graduates of the vocational training programs through competitive micro-grants

Medical Assistance: Providing Prosthetic Limbs

To provide medical assistance to Yemeni landmine survivors, MLI and YALS first identify survivors from governorates throughout Yemen that are under elected government control. YALS coordinators living in these governorates and districts collect information on survivors from local authorities, then meet the survivors in person to determine their needs and to create survivor profiles. The YALS coordinators send the profiles to the YALS central office and to MLI for review and the group then creates a plan of care. The survivors selected for medical assistance receive prosthetic limbs and other required rehabilitative care. The majority of survivors receive their support at prosthetic centers in Aden, Taiz, or Al Hudaydah, although there have been special arrangements made for certain survivors to be fitted and receive their new prosthetic limbs at home, as some are unable to travel comfortably and/or safely to the medical facilities. The program

Basher Al Wesaby working in the vocational training carpentry course offered through MLI’s MVA Yemen program.
Vocational Training and Micro-Grants

Vocational training. Similar to medical assistance, the process of identifying landmine survivors desiring and needing vocational training begins in the governorates, where the YALS coordinators collect data, meet the survivors, and share their profiles with the in-country program manager, YALS, and MLI. Once MLI approves the selection of trainees, YALS arranges the vocational training courses, typically one course for women and one course for men each quarter. Coordination with local authorities is often required to ensure that MLI and YALS have permission to conduct the training and, at times, to allow survivors and YALS teams to travel from one governorate to another.

MLI's MVA program has funded a variety of training topics throughout the years. The survivors themselves often suggest the vocational training subject, as they identify the skill they prefer and have the physical capacity to perform. The training topics have included beekeeping, carpentry, computer/typing skills, sewing, and weaving. All courses are offered to enhance employment and income generation opportunities and to assist survivors in their reintegration into society.

The training courses each take place five days a week over the course of one month. Participating survivors are provided transportation from their homes to the vocational facility, as well as accommodation in hotels near the vocational facility and a modest stipend. The training courses vary in size, with sewing classes having ten to fifteen students per class, and weaving classes usually having six to eight students per class. The training courses are segregated by gender due to cultural considerations and norms. Most of the vocational courses are held at rental facilities chosen based on their proximity to the survivor participants as well as the safety of the general area.

The majority of recent female survivors participating in these courses have been from Aden, Al Hudaydah, Lahij, and Taiz Governorates. Each graduate of the sewing course receives a sewing machine, fabric, and items such as thread, scissors, buttons etc., to take home upon course completion to employ their newly learned skills and provide support for their families. A sewing room has been created at the YALS Center to provide successful trainees with materials to produce items for barter or sale in their villages. The sewing room also gives participants the chance to sell their work from the Center.

A computer training lab with high-speed internet connectivity was established in 2011 at the YALS Center and equipped with state-of-the-art computers and software for selected survivors to receive instruction from a certified teacher. This computer training course was suspended in 2013 due to internet instability; however, it provided valuable training to survivor participants who continue to have access to computers. Labibah Abdo Saif is a thirty-one-year-old female landmine survivor who lost her right leg and right eye due to a landmine explosion at the age of nine. In 2013, Labibah received computer training through the MVA program. With her computer training, Labibah acquired a government job and also serves as a team leader in mine risk education (MRE) at YALS.

MLI has offered beekeeping, carpentry, and weaving courses to adult male landmine survivors. The carpentry participants built ramps for wheelchairs at many schools and homes of other survivor amputees, greatly improving access and mobility. Unfortunately, high lumber prices and scarcity of materials have limited the carpentry training course in recent years. Beekeeping also became difficult, as the course
providers and graduates frequently had to move their hives to new locations for security purposes. In recent years, vocational training in weaving has proven the most viable training course for men, and the loom work is a good fit for survivors who have lost a leg, as weaving allows them to work while sitting. Basheer Al Wesaby was injured by an anti-personnel mine while caring for his sheep. Basheer participated in the vocational training carpentry course, graduated, and went on to assist the course instructor in the next course iteration, helping new trainees understand the skills of the trade. He now has a carpentry job and makes an income that allows him to cover expenses for his wife and five children. Basheer also works with YALS’s MRE team.

Micro-grants. For the past three years, MLI and YALS have awarded ten competitive micro-grants annually to vocational training course graduates, enabling them to grow and expand their businesses in the fields of sewing, beekeeping, and mini-markets. Survivors who have previously completed a vocational training course are eligible to apply for a competitive micro-grant. Survivors submit their business plan to YALS, and a selection committee reviews all applicants and determines who is best qualified to receive funds to grow their business. One micro-grant recipient is Qaryah Mohammed Al Amry, a twenty-two-year-old female survivor who lost her right leg to a landmine explosion. Qaryah, who participated in the sewing course and received a micro-grant in 2019, says that “sewing for women is the best vocational job and the best social relationship. I have a lot of women customers. Last month, the income was between $200 and $250, but this month I expect my income will be double that because of the feast season.”

To date (2011–present), 436 adult male and adult female landmine survivors have participated in the MLI vocational training courses, and most participants have gone on to use their skills to earn a living, but there are additional, intangible benefits to the training as well. YALS coordinator Ahmed Alawi says, "the friendships made during training is one of the important things they do. They make good friendships and I know a lot of them stay in touch with one another and also with YALS staff after training."

Program Challenges

Providing medical assistance and vocational training to landmine survivors in rural areas is challenging, particularly at this time in Yemen’s history. The primary challenge is security. The ongoing conflict between government and Houthi forces has limited the geographic scope of the project, and the MLI and YALS team are working only in areas under government control. Nevertheless, security concerns remain, and the movement of landmine survivors to prosthetic centers and training centers requires careful consideration and planning. The program takes special care to not move survivors through dangerous roads or battle areas. When the YALS team and the local authorities determined that there would be a risk to move survivors, which occurred in the previous two quarters, MLI and YALS arranged to provide the prosthetics to survivors in their homes. While there was a risk to the YALS team and prosthetic technician to reach the survivors, the team developed safety procedures to minimize the danger of travelling through perilous areas.

The majority of survivor beneficiaries live in rural, mine-affected areas. MLI and YALS specifically have chosen to reach these survivors because very limited health services are available to this population. Arranging transportation, security aside, is challenging, and logistics can be difficult, but MLI and YALS feel strongly about reaching the populations that may otherwise be missed. Program implementers have found that detailed coordination with local officials is essential to facilitating the logistical and transportation requirements of survivor beneficiaries.

Additionally, the COVID-19 pandemic continues to present challenges in the implementation of programs, such as maintaining social distancing and promoting mask wearing. At the time of this writing, the World Health Organization reports 7,625 confirmed cases of COVID-19 in Yemen, with 1,438 deaths and 311,483 vaccinations administered to date. In 2020, MLI awarded micro-grants to two survivor graduates of the sewing course to create masks for fellow survivors and YALS staff and to distribute the masks throughout their communities. The team is adapting and taking the precautions necessary to limit the spread of COVID-19 while striving to meet program goals.

Vocational training in beekeeping offered Mogbel Ali Hajeeb the opportunity to learn a skill and provide for his family.
Conclusion

With the mountain of challenges present in Yemen today—war, famine, widespread poverty and disease, landmines, and now COVID-19—MLI and YALS have been able to provide prosthetic limbs, vocational training, and/or micro-grants to more than 800 male, female, and child landmine survivors. The overarching goal of the program is to improve the lives of Yemeni landmine survivors, particularly those living in rural, heavily-contaminated areas, and we are humbled to help survivors like Abeer, Qasem, and countless others to have opportunities for a better life. With ongoing support from the U.S. Department of State, MLI, in partnership with YALS, will continue the MVA program for Yemen for the next two years and looks forward to continuing this successful model to provide prosthetic, vocational, and income-generating support to Yemeni landmine survivors. Tamara Klingsheim, who is the MLI Program Manager for Yemen, summarizes the program, saying that: Working with MLI and overseeing the Yemen program for the past ten years has been a wonderful experience as I've seen so many lives being transformed...landmine survivors being given the opportunity to once again become productive citizens within their communities. These individuals, single, as well as, mothers and fathers, have been given hope, the tools, and the training to provide for themselves and their families.

See endnotes page 154

Elise Becker  
Vice President of Operations  
Marshall Legacy Institute

Elise Becker is the Vice President for Operations at the Marshall Legacy Institute, where she manages many of the organization’s major programs, including the Mine Detection Dog Partnership Program and Peacemakers and Problem Solvers Program. She has been in the mine action sector for over fourteen years, and previously served as the Frasure-Kruzel Drew Fellow at the US Department of State. Becker earned her bachelor of arts from James Madison University and her master’s in public administration from the University of Nebraska at Omaha.

Tamara Klingsheim  
Program Manager  
Marshall Legacy Institute

Tamara Klingsheim works out of her home in the Smokey Mountains near the Blue Ridge Parkway in North Carolina. Working with the Marshall Legacy Institute for the past eleven years, Klingsheim has had the opportunity to oversee the CHAMPS Program (Children Against Mines Program) and Mine Victims’ Assistance in several war-torn countries, to include Yemen. She connects school children across the United States and abroad in service-learning opportunities and works with in-country managers of mine-affected countries, helping survivors with both medical and vocational assistance.
REMOTE SENSING AND ARTIFICIAL INTELLIGENCE in the Mine Action Sector

By Martin Jekobs [International Committee of the Red Cross] and Rob White [Geneva International Centre for Humanitarian Demining]

Remote sensing and artificial intelligence (AI) technologies are included in discussions of how technology and innovation can improve humanitarian action and international peacekeeping. These technologies have the potential to improve the capacity to assess needs and to monitor changes on the ground and can be useful for both the mine action (MA) and broader humanitarian sectors. Even though remote sensing and AI are not the silver bullet in MA and come with several challenges (e.g., operational and data protection), the International Committee of the Red Cross (ICRC) and the Geneva International Centre for Humanitarian Demining (GICHD) believe that the integration of remote sensing and AI into the MA sector will enhance evidence-based decision making, aiding in determining priorities for surveying and clearance of contaminated areas and enabling the scarce resources available for MA activities worldwide to be appropriately directed and used as efficiently as possible. On the 20th and 22nd of April, ICRC and GICHD co-hosted a webinar on remote sensing and AI in the mine action sector. The following is a review of the key benefits and challenges discussed during the two days.

In humanitarian mine action (HMA), research and innovation have led to the development and deployment of several alternative methods to identify contaminated areas and for detection. However, these innovations have come with some limitations (cost, training methodologies, limited applicability depending on environmental conditions) and can therefore only be considered as one component of a tool-box approach. The use of high-resolution remote imagery has been tested and evaluated as a valuable supplementary tool for MA teams that require accurate, up-to-date imagery of suspected hazardous areas (SHAs) and confirmed hazardous areas (CHAs); however, past tests and research have been limited. As many countries near the completion of their MA programs, many of the remaining SHAs and CHAs are becoming harder to process and release as they are remote and cover large areas, often with challenging terrain.

Recent papers have shown the potential benefits of using airborne remote sensing to detect explosive ordnance (EO). These tests indicate that even though remote sensing may not be a perfect solution, it may be a valuable addition to the efforts to detect EO in certain environments and improve the pace of non-technical surveys (NTS) and other activities. Some of these findings were also presented at the GICHD mine action technology workshop held in Basel, Switzerland, in 2019.

In addition to remote sensing, AI and machine learning are increasingly prominent technologies that can increase the probability of detection while simultaneously decreasing the false alarm rate. AI has the ability to identify objects, analyze big data at an extremely fast pace, and recognize patterns invisible to the human eye. Coupled with remote sensing, AI can quickly transition an MA operation from time-consuming analysis to decision making and
Although there is a tendency to continually seek better or more data on a range of issues, the wish for better data could be caused by the lack of our ability to cope with big data.

**Key Challenges: Cross-Sectorial Work**

Even though HMA is a niche field with unique resource constraints and highly specific operating requirements, it should not remain siloed in its innovative endeavors, but rather open to technical advancements from other sectors.

The interlinked nature of MA calls for an approach that is holistic, coherent, and includes a diverse set of stakeholders. Remote sensing and AI have been developed and implemented among the private sector, academia, and other parts of the humanitarian sector, including the ICRC—who for several decades have employed AI for damage assessments, crop monitoring, and to analyze satellite images. Therefore, considerable knowledge is already available and can be transferred to the broader MA sector. Whereas the private sector is investing in new start-ups and technology companies that can handle the big data generated from crowd sourcing and is developing AI algorithms so that self-driven cars can detect objects in real time, academia is conducting research on how to improve these techniques. In contrast, the MA sector is in the start-up phase of exploiting the potential of big data to improve decision-making. One of the factors contributing to the slow institutional uptake of these methods within MA is a lack of capacity to apply these methods in operational settings due to lack of funding, cooperation, and support. Nevertheless, partnerships between governments, nongovernmental organizations (NGOs), academia, civil society, and the private sector are critical to obtaining the expertise and resources necessary to integrate remote sensing and AI into survey and clearance activities in a more efficient, cost-effective way that lowers the risk for those involved.

**Key Challenge: Data Needs and Data Protection**

There is a wealth of opportunities to use remote sensing and AI methods when detecting EO or identifying ground contaminant indicators. However, several presenters at the webinar recalled that to benefit from remote sensing data, the sector also needs platforms that can analyze and exploit large amounts of data (e.g., IMSMA® or other GIS-software).

To use the potential of AI effectively, computer algorithms need datasets to train the system. In the future, resources for gathering and training AI should be based on real-world data that might account for EO that has been exposed to the elements for a long time and has aged/decayed. In addition, different types of quantitative and qualitative data from crowd sourcing, baseline studies, and conflict history can provide higher-quality data. Moreover, human experience and expertise should be used for analysis, as well as to train systems and validate results.

While important to obtain different types of images of the environment suspected to be contaminated with EO—including areas not known to be contaminated and SHAs—practitioners note images can also contain information on individuals or communities. Therefore, the MA sector must recognize the potential for harm that can result from misused data and determine general ethical principles and guidelines for data use. Whereas the benefits will depend on the nature of the crisis, so too will potential risks and harms. In 2002, after an unplanned explosion at a munitions site (UEMS) in Lagos, Nigeria, the socioeconomic impact was profound because of the thousands of people who were affected. In such circumstances, where metropolitan areas need to function for the millions of people who live within, the use of remote sensing may outweigh the risks of data being misused. However, data might also be used to target populations and cause more damage than good. If MA is taking place in areas populated by internally displaced persons, compromised data could be misused by nonstate actors, which can occur if drones crash or via data hacking. Nevertheless, each project should be assessed individually.

Furthermore, when using AI, users should note that the results will potentially be biased by the data used to train the machine. Awareness of the data source is crucial as well as the need to use data that best targets region-specific areas, for example, EO will deteriorate differently in different environments, which needs to be reflected in the training of AI.

Although there is a tendency to continually seek better or more data on a range of issues, the wish for better data could be caused by the lack of our ability to cope with big data. Currently, there are plenty of evidence-based datasets that could advance survey techniques when identifying SHAs via airplane or satellite imagery, as well as remote
sensing data from satellites. Moreover, by using machine learning on white papers and reports from the humanitarian sector, these techniques can help validate findings and identify previously unknown contaminated areas and improve desk assessments or NTS in general. AI demonstrates potential in making a valuable contribution to help the MA sector analyze the data that is already available.

**Key Challenge: Region-Specific Contexts**

Different types of remote sensing such as true color/RGB (Red, Green, Blue) images, thermal images, and ground penetrating radar, etc., will produce varying advantages in different environments. The potential benefit for using remote sensing therefore needs to be addressed in each individual case. Whereas some types might work better in deserts, others might work better in snowy or cold conditions, or in areas with vegetation. The consensus among practitioners is that more testing is needed.

The market for remote sensing platforms is increasing, as many of these solutions are cost-effective and sustainable. Modern unmanned aerial vehicles (UAVs) can be easy to repair in the field, are relatively easy to acquire, and do not need to have a huge impact on resources. However, operators must also consider legal aspects of using UAV’s in their respective regions or countries. Being able to communicate the pros and cons of using remote sensing with national authorities and local communities is therefore necessary. In addition to leveraging UAV imagery, mine action can also employ satellite imagery to generate useful remote sensing data, even though satellite imagery tends to have a lower resolution and is more easily impacted by weather (cloud cover) compared to UAV’s.

**Outlook**

The ICRC and GICHD firmly believe that the integration of remote sensing and AI (either used individually or together) into MA activities could enhance evidence-based decision making. This will improve prioritization for surveying and clearance activities in SHAs/CHAs and enable operators to better and more efficiently direct the scarce resources available for MA activities worldwide. Remote sensing and AI will also support the MA sector in articulating the positive impact of the work by identifying the development of rural activities such as farming or urban access to infrastructure and services in released areas. Combining increasingly complex MA datasets (i.e., remote sensing imagery) with socioeconomic data will present opportunities to evaluate the risk for individual contaminated areas, which should be used when prioritizing clearance activities.

Although recent hype can oversimplify what can and cannot be done with remote sensing data and AI, these are fundamentally new additions to the mine action toolbox that can improve survey activities. To ensure that we don’t spend resources duplicating work or take resources away from getting EO out of the ground, the collaboration between the wider humanitarian and MA sector, academia, and the private sector will be crucial in the future. For this reason, the need for information sharing among the organizations working to mainstream these technologies cannot be underestimated. The “Use of Remote Sensing and AI in the Mine Action Sector” webinar was not a standalone event, as the ICRC and the GICHD are currently developing a platform on which ideas and lessons learned can be shared. In addition, the GICHD plan to use the next GICHD technology workshop, scheduled for November 2021, as an opportunity to continue the important dialogue and exchange of information on remote sensing and AI in MA.

*See endnotes page 154*

---

**Martin Jebens**  
*Weapon Contamination Consultant*  
*International Committee of the Red Cross*

Martin Jebens is currently working for the ICRC Weapon Contamination Unit and delegation of Japan, where he is leading a project on how thermal sensing and AI can improve detection of weapons or be used for other humanitarian needs. Previously Jebens worked in the field of disaster risk management. He has a strong focus on innovation, improved coordination, and planning to reduce risks and uses the SDG’s and the Sendai Framework for Disaster Risk Reduction as guiding tools. He has a background in mine action as GIS manager and drafted IMAS 07.13 on environmental management. He has been appointed to participate in several national advisory boards including the Danish national nuclear emergency group and to advise on climate change adaptation. He holds a master’s in disaster risk management and a master’s in volcanology, both from the University of Copenhagen.

**Rob White**  
*Deputy Head of Division, Standards and Operations*  
*Geneva International Centre for Humanitarian Demining*

Rob White is Deputy Head of Division, Standards and Operations at GICHD, a Division that provides services and technical expertise on developing standards and increasing operational efficiency and effectiveness in mine action. The Division focuses on strengthening national capacities to enable greater ownership of mine action operations, in line with national and global strategic priorities. Prior to joining the GICHD, White was working as Director of Development at a UK NGO. He is a past Trustee and later CEO of UK mine action research NGO, Find A Better Way (now Sir Bobby Charlton Foundation) and Chief Operating Officer of Iraqi NGO IMCO. The majority of his mine action career was spent with the Mines Advisory Group (MAG) in various positions including Director of Operations/Deputy Director with responsibility for managing MAG’s global operations. He has a master’s (with merit) in International Development.
How to Implement Drones and Machine Learning to Reduce Time, Costs, and Dangers Associated with Landmine Detection

By Jasper Baur, Gabriel Steinberg, Alex Nikulin, Ph.D.; Kenneth Chiu, Ph.D.; and Timothy S. de Smet, Ph.D. 1
1 [Binghamton University - The State University of New York]  
2 [Columbia University - Lamont-Doherty Earth Observatory]  
* Equal contribution

Two rapidly emerging technologies revolutionizing scientific problem solving are unpiloted aerial systems (UAS), commonly referred to as drones, and deep learning algorithms. 1 Our study combines these two technologies to provide a powerful auxiliary tool for scatterable landmine detection. These munitions are traditionally challenging for clearance operations due to their wide area of impact upon deployment, small size, and random minefield orientation. Our past work focused on developing a reliable UAS capable of detecting and identifying individual elements of PFM-1 minefields to rapidly assess wide areas for landmine contamination, minefield orientation, and possible minefield overlap. In our most recent proof-of-concept study we designed and deployed a machine learning workflow involving a region-based convolutional neural network (R-CNN) to automate the detection and classification process, achieving a 71.5% rate of successful detection. 2 In subsequent trials, we expanded our dataset and improved the accuracy of the CNN to detect PFM-1 anti-personnel mines from visual (RGB) UAS-based imagery to 91.8%. In this paper, we intend to familiarize the demining community with the strengths and limitations of UAS and machine learning and suggest a fit of this technology as a key auxiliary first look area reduction technique in humanitarian demining operations. As part of this effort, we seek to provide detailed guidance on how to implement this technique for non-technical survey (NTS) support and area reduction of confirmed and suspected hazardous areas with minimal resources and funding.

Introduction

Explosive remnants of war (ERW), including unexploded ordnance (UXO) and landmines, resulted in a recorded 5,554 casualties in 2019 with nearly half (43%) of the civilian victims—for whom the age was known—being children. In 2019, an estimated 164,000 emplaced anti-personnel mines were destroyed globally, but completely clearing the world of anti-personnel mines is still decades away as there are tens of millions of mines estimated to reside in place worldwide, assuming no new landmines are deployed. As of 2007, experts estimated that ten to twenty landmines were laid for every mine cleared, considerably exacerbating the landmine crisis. 5 However, since the recent success of the implementation of the Anti-Personnel Mine Ban Convention (APMBC), this number may be less but is unknown. In the last decade, anti-personnel landmines have been used in active conflicts in at least fifteen countries, including but likely not limited to Afghanistan, Colombia, India, Iraq, Israel, Libya, Myanmar, Nigeria, North Korea, Pakistan, Syria, Thailand, Tunisia, Ukraine, and Yemen. 6 The pace of mine clearance is largely driven by operator experience, the technological capacity of mine-detection technology, and environmental difficulty, which can be quantified by survey area and ratio of successful detection relative to false flags. Recent studies demonstrated that preliminary rapid wide-area surveys conducted by unpiloted aerial systems (UAS) may be utilized to initially constrain search areas, ultimately decreasing the time and cost associated with humanitarian mine action (HMA) while reducing the safety risk to clearance operators. 7-12 Terrestrial electromagnetic-induction (EMI) methods are currently one of the main standard approaches to HMA. 13 While hand-held EMI detector surveys have proven themselves as one of the most reliable geophysical techniques for HMA, their implementation
has a number of shortcomings: (1) they have high false-positive alarm rates in the presence of metallic clutter; (2) they are time and labor intensive, especially in difficult terrain; and (3) they entail operator risk. Some of these shortcomings can be mitigated if suspected hazardous areas (SHAs) are constrained by autonomous surveys providing an initial assessment of mine presence and subsequently expanded to classify mine type, mine condition, minefield density and orientation, soil type, and other environmental parameters. Modern uncrewed aerial vehicle (UAV) platforms capable of flying at low altitudes and collecting autonomous surveys, coupled with sensitive and compact visual, thermal, multispectral, and magnetic sensors, often allow operators to rapidly identify small anthropogenic targets previously identifiable only in ground surveys in certain situations.8-14

Over the last decade UAVs have become more reliable, and their push into the consumer market considerably decreased their costs. In parallel with the advancement of UAV technology, modern miniaturized optical and geophysical sensors became smaller, more sensitive, less costly, and mountable on UAV platforms. Advances in UAV and sensor technologies enabled the development of reliable UAS for wide-area, high-resolution remote sensing and geophysical surveys to address some of the most pressing humanitarian challenges.9-12 With recent developments in small autonomous UAVs, advanced sensors have the potential to significantly contribute to the field of HMA, as this allows for rapid low-cost data acquisition over wide areas in a safe and time-efficient manner. However, the emergence of UAS surveying has led to the new problem of analyzing these large (both in terms of area covered and file size) and prohibitively complex datasets, requiring advances in machine learning to aid interpretation. As we have learned firsthand, manual analysis of these large surveys is operationally difficult, subjective, and sometimes inconsistent. The application of deep learning to remotely collect wide-area surveys (greater than 15 m²) improves the reliability of NTS and provides stakeholders with the quantitative data necessary to plan HMA activities. This area reduction methodology may ultimately be used to help guide ground demining activities to reduce search area size and drive down HMA costs while reducing operational risks.

We present a machine learning case study focused on initial detection and identification of the widely-used PFM-1 anti-personnel landmine (also known as the butterfly mine) as an index example of a small, low-metallic scatterable landmine. This type of mine is emblematic of a wide-area aerial-mining strategy responsible for both a legacy landmine concern and a looming threat of future contamination, as variants of these mines and their deployment systems remain in active service. The PFM-1 is composed of polyethylene plastic that presents a particularly difficult challenge to HMA operations.15,16 Other plastic anti-personnel mines have historically been composed of Type IV plastic, differing from the flexible polyethylene used for the PFM-1,15 which was notoriously widely used during the Soviet-Afghan War (1979–1989). Although some of these mines have deteriorated over time, many of the nearly ten million mines remain an active threat today due to cold climate preservation.17 These antipersonnel mines are designed to be ballistically dispersed from aluminum KSF-1S cartridges that contain four dispenser racks of eighteen mines with seventy-two mines in total (Figure 1). Guided by their stabilizing wings, the mines fall gently to the surface where they remain scattered in ellipsoidal minefields of 8-10 m x 18-20 m. While the original PFM-1 design was subsequently updated to include a self-destruction timer, modernized PFM-1S type mines fall short of the self-destruction criteria in Protocol II of the Convention on Prohibitions or Restrictions on the Use of Certain Conventional Weapons,18 as studies show that nearly half of PFM-1S mines fail to self-detonate upon deployment.19 Many of the original PFM-1 stockpiles were destroyed by signatories of the APMBG, but considerable stockpiles of variants of the PFM-1 mines are thought to remain in arsenals of multiple countries.20 Today, Russia hosts the world’s largest stockpile of anti-personnel mines with an estimated 26.5 million.21 Moreover, as recently as 2019, the Russian army introduced the UMZ-G multipurpose tracked vehicle with minelaying capabilities compatible with PFM-1 bearing cassettes capable of dispersing nearly 20,000 PFM-1 type mines per hour.22

Previous drone flights collected over inert PFM-1 mines in proxy environments in New York provided a critical proof of concept on the use of drones to aerially identify small plastic PFM-1 anti-personnel mines from visual, thermal, and multispectral imagery. Baur et al. 2020 presented a case study where a machine learning workflow was developed to automate the detection of these landmines for the first
Background

Object Detection. The branch of machine learning used in this paper—object detection—involves the general goal of detecting and locating predetermined objects in often dynamic and complex environments. We used supervised object detection, which involves training an algorithm (a CNN in our case) to recognize objects by showing it a large number of images containing those objects (landmines in our case). The algorithm uses this set of images, the training set, to learn the distinguishing characteristics of the objects and form a generalized model in order to detect the objects in different images in the future. The algorithm is trained in epochs (rounds), where every image in the training set is analyzed and where the algorithm is tuned to be able to recognize images like it in the future. After the training of the algorithm is complete, a pre-trained model is created with the generalized model of the objects encoded in it. The accuracy of this model is evaluated using the testing set, containing images that were completely withheld from the training set. The lack of overlap in the training and testing sets is designed to ensure that the testing set provides an unbiased evaluation of the model, as it will not be trained to detect the objects as they appear in the testing set; it will have to rely on the generalized model of the objects it obtained from the training set.

The model is evaluated using three relative accuracy scores: precision (positive predictive value), recall (sensitivity), and F1 (harmonic mean). These scores are calculated from our raw evaluation metrics: true positives, false positives, and false negatives. Precision is a measure of the relative amount of positively labeled objects that were correctly labeled and is calculated using the following formula:

\[
\text{Formula 1: } \text{prec} = \frac{\text{true positive}}{\text{true positive + false positive}}
\]

Recall is a measure of the relative number of desired objects that were positively labeled and is calculated using the following formula:

\[
\text{Formula 2: } \text{rec} = \frac{\text{true positive}}{\text{true positive + false negative}}
\]

The F1 score is the harmonic mean of precision and recall; it is calculated using the following formula:

\[
\text{Formula 3: } F1 = 2 \cdot \frac{\text{prec} \cdot \text{rec}}{\text{prec} + \text{rec}}
\]

Algorithm 1. Coordinate computation

For our implementation of object detection, we used an actively-maintained, open-source GitHub repository called Faster region-based convolutional neural network (R-CNN). An important component of the Faster R-CNN architecture, which we modified to achieve a higher accuracy with our dataset, is the anchor box. These make it possible for the network to locate objects of different scales and different aspect ratios quickly and effectively. Instead of scanning an entire image using a sliding window of a set size and aspect ratio, nine anchor boxes are centered around every sixteen pixel in the image. The default anchor boxes consist of all nine combinations of boxes with a 1:2, 1:1, and 2:2 aspect ratio, and boxes with a scale of 8, 16, and 32 multiplied by the default base anchor: 16.

For proof of concept and laying the foundation for other researchers to develop similar deep learning models for detection of other types of landmines, UXO, and ERW. In order to expand the capabilities of this particular CNN for automated detection of landmines or ERW other than the PFM-1, additional datasets of novel minefields would be required. With these data, our CNN has the potential to be generalized for automated detection and coordinate return of small objects in any raster dataset, including geophysical, RGB, thermal, and multispectral orthomosaics. Because of the self-learning capability of the neural network approach to detection and classification, it is important that researchers and field operators work together to develop methods for data sharing of aerial images, so the HMA community can continue to collectively refine and improve the reliability of deep learning methods that are rapidly gaining traction.

Algorithm 1. Pseudocode outlining coordinate computation of object.

1: size = 700 (size of each cropped image)
2: overlap = 70 (overlap of cropped images in pixels)
3: cropped_image_name = 'Grass_RGB_Split1205.tif'
4: split_x, split_y = 370, 360 (pxl position of object in cropped image)
5: ortho_easting, ortho_northing = 420000, 4600000 (UTM coords of ortho)
6: x_res, y_res = 0.00644, -0.00644 (m/pxl of orthophoto)
7: ortho_x = split_x + (col * (size-overlap))
8: ortho_y = split_y + (row * (size-overlap))
9: ortho_casting = ortho_easting + (ortho_x * x_res)
10: ortho_northing = ortho_northing + (ortho_y * y_res)
11: (Get col and row of cropped image in ortho)
12: (Get pxl position of obj in respective orthomosaic)
13: obj_easting = ortho_easting + (ortho_x*ortho_x_res)
14: obj_northing = ortho_northing + (ortho_y*ortho_y_res)
15: (Get easting and northing coords of obj)
16: obj_lat, obj_lon = utm.to_latlon(obj_easting, obj_northing)
17: (Get latitude and longitude coords of obj - python utm package)
18: obj_lat, obj_lon = utm.to_latlon(obj_easting, obj_northing)
Remote sensing methodology. Additional training and testing data were acquired on the Binghamton University campus of an inert grass minefield and an inert sand training minefield. In both instances, the training minefields consisted of fifteen to thirty PFM-1 landmines and their KSF castings scattered throughout a 10 x 20 m region. We collected aerial images of the minefield with the DJI Phantom 4 Pro drone at a 10 m height and 2 m/s speed with an 80% overlap. The flights were planned using the Pix4D capture mission planner. In the grassy terrain, the mines were randomly dispersed so that their orientation was left to chance. In the sandy terrain, however, we specifically placed the mines in six different orientations to increase the robustness of our model: horizontal body up, horizontal body down, vertical cap up, vertical cap down, horizontal body buried (partial occlusion), and horizontal wing buried. We also collected control data over the sandy area with no mines to add negative samples (often called negative templates in remote sensing literature). Additional orthomosaic simulated minefield data from rubble, grass, and snowy environments was used for this project and had previously been collected with the same acquisition methods as presented here. The addition of more data and negative samples greatly improves the accuracy of machine learning algorithms, critically decreasing false positives.

CNN improvements and adjustments. Since the previous implementation of a Faster R-CNN to detect PFM-1 landmines, our methods have changed and improved dramatically. Baur et al. 2020 describes the use of Impy to create non-overlapping crops of our orthomosaics with at least one object in each photo and corresponding XML files containing the bounding boxes around each object. As in Baur et al. 2020, the Faster R-CNN begins the processing by resizing the inputted images to a maximum of 700 px for each axis. Therefore, we continue to employ the method of splitting orthomosaics but employ this method very differently, using a script we created called ImageSplitter. This shift allows for the inclusion of negative samples (images with no objects) in our training and testing sets to improve our accuracy, provide more precise evaluation metrics, and most importantly, easily locate the predicted objects with latitude and longitude coordinates.
Impy, our previous splitting tool, split an image into non-overlapping 1032 x 1032 px crops each containing at least one bounding box. The two major limitations of this tool were the difficulty in labeling our predicted objects with latitude and longitude coordinates and the inability to create negative samples, which were not possible using Impy because of the requirement that there must be at least one object within each split image. It was difficult for us to locate our predicted landmines with coordinates using this tool, because the orthomosaics were split in a non-uniform way without the ability to output the offsets with which the split images relate to the orthomosaic as a whole. The location of the split images was created based on the location of randomly scattered landmines instead of on constant, predetermined offsets.

ImageSplitter solves both of these problems by splitting an image into square crops of a predetermined size (we chose 700 x 700 px, as larger images would be downsampled by the CNN) with a predetermined percent overlap (we chose 10%) and creating corresponding XML annotations. This method allows us to input negative samples as training and testing data to boost our accuracy and to obtain a more precise evaluation of our model. The predetermined crop size and overlap also allows us to determine where each image crop would lie in the larger orthomosaic, and therefore allows us to locate the predicted objects with latitude and longitude as well as easting and northing coordinates. This process is outlined in Algorithm 1 and Figure 2.

After the calculations, the following data are written to a CSV (comma separated values) file, which can be read by Google Earth Pro or other geographic information systems (GIS) via the object name, the corresponding orthomosaic, its predicted confidence score (from 0 to 1; and its corresponding latitude, longitude, easting, and northing coordinates.

All training sessions were conducted over 50 epochs, with the Resnet-101 pre-trained model and an 8 px base anchor size with all other parameters set to the default values. The train-test splits that were used are outlined in the following results section.

## Results

The experiments described in the methodology were done on a Dual Socket Intel® Xeon® Silver 4114 CPU at 2.20 GHz with 128 GB of RAM with a Titan V GPU with 12 GB of RAM. Thirteen experiments were executed by manipulating four variables.

We found that the highest mean F1 scores, regardless of train-test split, were achieved with a 700 x 700 px image size with a 10% overlap, 8 px base anchor size, and negative samples included. With these parameter values, we tested seven different train-test splits. These seven splits can be categorized in two ways: randomized splits and orthomosaic withholdings. The results from the experiments in each categorization give us unique insights. The randomized splits involved randomly selecting a percentage of images for the training set, while the withheld remainder are used for testing. This type of splitting gives us insight into how the model will perform when generating predictions on environments that have been partially included in the training set in the form of simulated minefields or negative samples. The orthomosaic withholdings involve selecting an entire session of drone flights to make up the testing set, while the remainder are used for training. This train-test split gives us a more accurate insight into how the model will perform when generating predictions on an environment that was completely excluded from the training set, but similar environments were present. The best randomized split obtained was an 80/20 train-test split (80% training, 20% testing) yielding a 0.95 F1 score for PFM-1 landmines, a 0.89 F1 score for KSF casings, and a 0.92 mean F1 score. This split is often standard, striking a balance between obtaining a robust model through training and a complete evaluation of the performance of the model during testing. The best orthomosaic withholding was obtained by withholding three orthomosaics we collected from a simulated rubble minefield in Chenango Valley State Park, NY. This split yielded a 0.86 F1 score for PFM-1 landmines, a 0.98 F1 score for KSF casings, and a 0.92 mean F1 score.

## Using the Pre-Trained Model for PFM-1 Detection

**Materials.** Materials needed to detect and map PFM-1 anti-personnel mines using this method include a commercial off-the-shelf (COTS) drone, an RGB visual camera mounted on the drone, orthomosaic generation software, and GIS software to analyze and visually inspect drone imagery.

**Steps.** The first step to implementing our pre-trained model for automated detection of PFM-1 anti-personnel mines is collecting UAS flight data. Optimal data acquisition involves flying a UAS at a 10 m height (the chosen height for optimal resolution and ground coverage) with 80% overlap coverage between consecutive traverses and at
a slow speed (we used 2 m/s) to minimize blur in the images. Our survey size was 10 x 20 m in correspondence with the approximate dimensions of PFM-1 minefields, but this variable is up to the discretion of the operator and is often region specific. As the survey size increases, the processing time for constructing orthomosaics will also increase. The UAV must be equipped with an RGB-capturing camera such as the built-in camera on the DJI Phantom 4 or an external sensor such as the Parrot Sequoia multispectral sensor. Additional wavelengths, such as thermal or multispectral bands, may also be collected and used to cross-reference with visual imagery providing a multiparameter approach to confirm areas of potential surface-laid mines.\textsuperscript{23} A multiparameter sensor system would help reduce false positives and provide additional physical information (such as temperature anomalies for thermal infrared imaging) of suspect mines, adding to the robustness of the technique. At this point, while these additional wavelengths are useful for cross-referencing with visual imagery, they are not suitable for input into the CNN as it is only trained on RGB images and is not currently able to recognize PFM-1 landmines in other types of imagery.

After data acquisition, the collected photos must be uploaded into photogrammetry software for orthogonization generation. We used Pix4DMapper,\textsuperscript{23} but other software such as DroneDeploy, Agisoft Photoscan, and ESRI Drone2Map for ArcGIS are also capable of this task. For our trials, the Phantom 4 Pro camera at a 10 m height produced a resolution of 0.27 cm/pix in the orthomosaic with the internal drone GPS with the use of ground control points to further improve location accuracy.

The resulting orthomosaic will produce a TIFF file and a corresponding TFW file containing important locational metadata. This metadata must include the x and y meters or centimeters per pixel resolutions (ours yielded 0.27 cm/pix) and the easting and northing value of the top-left pixel of the orthomosaic. After the orthomosaics have been created, they must be split in order to be input to the CNN to generate PFM-1 and KSF-casing coordinate predictions. This will be accomplished using the ImageSplitter tool. Once a directory with the split orthomosaic has been created, follow the directions in the Faster R-CNN repository to execute predictions and output CSV files with the predicted coordinates in latitude and longitude, and UTM (Universal Transverse Mercator) formats. Notably, the zone for the outputted easting and northing coordinates will be the same zone present in the TFW files corresponding to the orthomosaics.

After the CNN outputs the coordinates of suspect mines, it is recommended to convert the CSV file to a shapefile (SHP) and overlay the SHP onto the original minefield orthomosaic. This can be accomplished using most GIS software and can be done for free using opensource software like QGIS or Google Earth Pro. An added benefit is that these maps may be downloaded for offline use in the field. Next, the operator can reduce the number of false negatives and false positives by visually inspecting the orthomosaic with the overlaid coordinate predictions to confirm or reject the location of the suspect mines, and to add any additional unidentified mines (Figure 3). More detailed directions on editing the CSV with predicted mines can be found at the Demining Research Community's website (de-mine.com) under the Open Source->Instructional tab.

While this methodology has a 91.8% accuracy for visible PFM-1 mines in sand, grass, and rubble proxy environments, it is important to note the limitations in real world situations that would complicate detection using the CNN and RGB imagery.
How will pairing drones and this CNN improve demining practices?

**Safety.** Detecting PFM-1 mines remotely from drones can reduce the uncertainty associated with finding previously unidentified minefields on the ground. Additionally, orthomosaics with identified suspect PFM-1s (Figure 3) will allow deminers to visualize where these mines may be before stepping onto the minefield and provide them with better situational awareness. This method acts as an NTS for area reduction to assess SHAs or CHAs quickly and safely before investing more time and resources with a technical survey.

**Cost.** One of the major advantages of this method is its ability to reduce costs associated with mine detection by constraining the SHAs. The software required for this method includes our open-source CNN (freely available at de-mine.com), GIS software for making maps (QGIS software and Google Earth Pro software, both free), and orthomosaic generation software. For the orthomosaic generation software applications, we used Pix4D costing US$4,990 for a lifetime license, or $3,500 per year with free trial available, but other software applications available on the market include ArcGIS Drone2Map, costing $1,500 per year (requires ArcGIS). Additionally, open-source (free) orthomosaic generation software options exist including Meshlab, McMac, and VisualSFM. The hardware required includes a COTS drone with an RGB camera (we used the DJI Phantom 4 Pro costing ~$1,600) and a commercial laptop on which to run predictions. We used a Lenovo Yoga C740 with a 10th Generation Intel® Core i5-10210U Processor and 8 GB of RAM, which is sufficient to execute predictions, costing ~$850. The lowest estimated cost for the materials of this method is $2,000 to the highest estimated cost of $20,000. The lowest cost assumes using a COTS drone with a built-in camera, relying on open-source freeware or free software trials, and excluding the cost of purchasing a sufficiently powerful computer on which to run the software. The highest cost assumes the operator is buying a professional specialized drone and camera while purchasing a lifetime license for a photogrammetry software application.

**Time.** Collection of aerial drone footage takes approximately 3.5 minutes for a 200 m² minefield, covering roughly 1,143 m² in 20 minutes before the battery needs to be replaced or recharged for a typical DJI Phantom 3, assuming the drone is flying at a 10 m height, at 2 m/s, with 80% overlap. Orthomosaic generation takes about 1 hour and 17 minutes for a 200 m² area on a 2.7 GHz Dual-Core Intel® Core i5 processor with 8 GB of RAM. Generating predictions using the CNN takes about 0.04 seconds per cropped image on a Dual Socket Intel® Xeon® Silver 4114 CPU at 2.20 GHz with 128 GB of RAM with a Titan V GPU with 12 GB of RAM. Generating predictions takes about 6 seconds per cropped image using the Lenovo® Yoga C740 with a 10th Generation Intel® Core i5-10210U Processor and 8 GB of RAM. Manually verifying the CNN mine predictions and labeling any false negatives in QGIS takes approximately 10 minutes for 30 objects in a 10 x 20 m minefield. In total, the estimated time required for this methodology from start to producing field maps is 2 days. The first day will be used for data acquisition and drone operation, while the second day will be used for orthophoto generation, CNN predictions, and creating field-ready maps.

**Accessibility.** Our method allows for remote assessment in regions that can be physically inaccessible to survey, but we suggest the operator retains line of sight of the UAS at all times. In rugged terrain with large elevation shifts, mission planning software is necessary to preprogram global navigation satellite system (GNSS)-guided autonomous missions where waypoints are used in navigation to maintain constant altitude above ground level (AGL); alternatively, a laser altimeter can be used to maintain constant altitude AGL. Our method will have limited success in highly-vegetated regions and in detecting mines that are occluded in the RGB wavelengths of light, including buried minefields.

**Limitations**

While this methodology has a 91.8% accuracy for visible PFM-1 mines in sand, grass, and rubble proxy environments, it is important to note the limitations in real-world situations that would complicate detection using the CNN and RGB imagery. Firstly, PFM-1 mines that have been buried by earth surface processes or are completely covered in vegetation/obscured from an aerial view are not detectable with this algorithm or optical imagery of any kind. Detecting buried mines is outside the scope of this paper, but recent studies show other UAS-based techniques such as thermal sensing show promise for detecting shallowly buried mines in dry environments. Furthermore, there may be some visible landmines that the CNN fails to detect, as our algorithm is not 100% accurate. Because of this, it is important for an operator to double check the orthomosaic for mines. Additionally, our algorithm was trained on non-deteriorated model PFM-1 mines, so this may introduce a bias in the CNN, and is an avenue for future work to include images of decade-old, in-situ PFM-1 mines. Many of the mines we trained on were exposed to the outdoors or previously buried, being caked with mud or sand as we would expect in nature.
Additionally, over time, as the PFM-1 mines become more deteriorated, the probability that these mines will have either already detonated due to reaching their cumulative triggering pressure or will have experienced a casing breach resulting in neutralization or disarmament increases. However, some PFM-1 mines from the Soviet-Afghan War remain active and present a particularly difficult target to identify, since our algorithm is tailored to identify more recently laid mines. In regard to detecting half-buried or half exposed mines, this CNN was provided minimal training data for these types of images and was only able to detect one of twenty-six half buried mines in the testing orthomosaic. While this number is low, it is also promising in that the CNN was able to successfully extrapolate from the fully exposed mines and is an avenue for future work that will dramatically improve as the training images of partially buried mines increases. Overall, the main limitations of this method are in detecting PFM-1 mines that are not visible on the surface, and lack of training data from real-world minefields which is logistically difficult to obtain and an avenue for future work.

Our methodology is intended to assist and augment current mine detection practices, not replace them. However, employing this methodology can improve the safety of operators, increase the efficiency, speed, and accuracy of detection, and reduce costs for conditions where this method is effective.

This method has potential applications for detecting PFM-1 anti-personnel mines in confirmed hazardous areas (CHAs) and SHAs contributing to a NTS for area reduction and partial detection without deploying personnel on the ground. Using our method in this fashion can be extremely helpful as even detecting a single landmine in a region will provide critical information for mapping areas of contamination and help decision makers prioritize areas based on the contamination density.

**Bigger Picture**

Our methodology is intended to assist and augment current mine detection practices, not replace them. However, employing this methodology can improve the safety of operators, increase the efficiency, speed, and accuracy of detection, and reduce costs for conditions where this method is effective.

This method has potential applications for detecting PFM-1 anti-personnel mines in both confirmed hazardous areas (CHAs) and SHAs contributing to a NTS for area reduction and partial detection without deploying personnel on the ground. Using our method in this fashion can be extremely helpful as even detecting a single landmine in a region will provide critical information for mapping areas of contamination and help decision makers prioritize areas based on the contamination density.

**Conclusion**

Recent advances in machine learning, miniaturization of sensors, and the commercialization of drones are paving the way for the future of automated mine detection. This study couples these powerful technologies by training a CNN on UAV-based minefield data, producing a model that can identify the PFM-1 anti-personnel mine from a drone survey with 91.8% accuracy and can provide deminers field-ready maps with identified mine locations. By following the steps outlined in this paper, deminers can successfully implement this CNN to automate detection of PFM-1 anti-personnel mines. This CNN can be adapted to automate detection of a range of landmines, cluster munitions, and other ERW, given adequate training and testing data. Our future work will involve field testing this method in active minefields to better understand the environmental parameters that may influence this methodology. While this methodology is not meant to replace current demining practices, it is capable of augmenting these practices by providing a safe, low-cost, time-efficient, and accurate detection method to add to the demining toolbox for CHAs and SHAs.

**Data availability statement.** The Demining Research Community is a group of interdisciplinary scientists with backgrounds in remote sensing, geophysics, computer science, and archaeology whose mission is to research, develop, and field test cutting-edge sensors and platforms to improve current demining technologies. We support open access research and data for the betterment of the mine action community. Our minefield datasets (around 160 MB each), source code, and previous publications on mine detection are available at the Demining Research Community’s website and at the Open Repository at Binghamton University.

**Acknowledgments.** Our research team would like to thank the First-year Research Immersion and Harpur Edge for their support of the project. This work was conducted under New York State Parks Unmanned Aircraft and Special Use permits, and we extend our gratitude to park manager Michael Boyle and all staff of the Chenango Valley State Park for their assistance with this project. We would also like to thank the reviewers and editors of this paper for their insightful comments and suggestions that strengthened the manuscript greatly.

See endnotes page 154
Jasper Baur  
**Columbia University - Lenmont-Doherty Earth Observatory**  
Jasper Baur is a Ph.D. student in the Department of Earth and Environmental Sciences at Columbia University studying volcanology with a specialization in remote sensing. He is the founder of the Demining Research Community, which researches, develops, and field tests sensors and platforms to improve demining technologies. Baur received his B.S. in geological sciences at Binghamton University, and double minored in graphic design and geographic information systems.

Gabriel Steinberg  
**Binghamton University - The State University of New York**  
Gabriel Steinberg completed his Computer Science B.S. at Binghamton University and is preparing to begin his M.S. in Computer Science. Steinberg’s main research interest is in object detection with the goal of detecting PFM-1 landmines in post-conflict nations, especially Afghanistan, and he has published that research in Remote Sensing as second author. Steinberg has worked as an Undergraduate Research Assistant at UC San Diego and at the Hamburg University of Applied Sciences.

Alex Nikulin, Ph.D.  
**Binghamton University - The State University of New York**  
Alex Nikulin, Ph.D., is an Associate Professor and Director of the Humanitarian Geophysics Research Program with the Department of Geological Sciences and Environmental Studies. Nikulin is a co-founder of the Geophysics and Remote Sensing Research Laboratory at Binghamton University, a collaborative academic platform that brings together undergraduate and graduate researchers, and faculty, as well as industry, academic, government, and NGO partners, to work on resolving issues facing society through applications of geophysical techniques.

Kenneth Chiu, Ph.D.  
**Binghamton University - The State University of New York**  
Kenneth Chiu, Ph.D., is an Associate Professor in the Department of Computer Science at Binghamton University. His research interests are in the area of high-performance computing, applied machine learning, and cyberinfrastructure. His work has been funded by agencies including DOE, NIH, and NSF. He holds degrees in Computer Science from Princeton University and Indiana University.

Timothy S. de Smet, Ph.D.  
**Binghamton University - The State University of New York**  
Timothy S. de Smet, Ph.D., is a Research Assistant Professor in the Department of Geological Sciences and Environmental Studies, Director of the Geophysics and Remote Sensing Laboratory, and leader of the Environmental Visualization with Drones research stream in the First-year Research Immersion at Binghamton University. His areas of expertise are aerial remote sensing and near-surface applied geophysics. Dr. de Smet’s research utilizing frequency and time-domain electromagnetic-induction, magnetometry, ground-penetrating radar, aerial LiDAR, and thermal infrared remote sensing has been published in Geophysics, Remote Sensing, Near Surface Geophysics, The Journal of Applied Geophysics, Sedimentary Geology, PLOS ONE, The Journal of Conventional Weapons Destruction, Archaeological Prospection, and The Leading Edge, among others. Dr. de Smet is an FAA 107 certified UAS remote pilot.

Watch out for **The CISR Exchange**

Conversations with contributors to *The Journal of Conventional Weapons Destruction*, and experts in humanitarian mine action

Learn more by emailing cisr-journal@jmu.edu
Past, Present, Future: Mine Action in Motion by Ambassador Stefano Toscano [from page 8]

2. In the late 1990s and early 2000s, much of the detection R&D and trials were related to metal detectors. The hopes at that time were that the Ground Compensation and Large Loop detection were going to be the silver bullet, which wasn’t the case. In the 2010s, R&D moved towards the dual and double sensor detection (metal detection and GPR). While this advancement did enhance the efficiency of work, it by no means provided the silver bullet (for many reasons) that the sector was (is) seeking. However, through this R&D work, progress has been made and its undeniable that efficiency and safety of operations has improved as a result.
3. The foundation behind the Humanitarian-Development-Peace-Nexus (HDPN), also known as the triple nexus, is based on the need for stronger collaboration, coherence, and complementarity towards the delivery of collective outcomes. By leveraging the comparative advantages of its three dimensions, the nexus has the potential to reduce vulnerabilities and decrease the number of appeals that remain unanswered, while strengthening risk management capacities and tackling the root causes of conflict. In addition, this approach has been at the center of multilateral efforts to fulfil the commitments made at the 2016 World Humanitarian Summit and accelerate progress towards the 2030 Agenda for Sustainable Development. The triple nexus promotes a change in the way activities are planned, implemented, monitored, reported, and financed in order to more effectively and coherently meet needs, reduce risks, and build resilience in the short, medium, and long term.

Mine Action: The Early Years by lan Mansfield [from page 11]

8. After the Guns Fall Silent; The Enduring Legacy of Landmines, Shawn Roberts and Jody Williams, VVAF, 1995.

Applying “All Reasonable Effort” in the Falkland Islands Mine Clearance Programme: Encouraging Efficient, Confident, and Timely Evidence-Based Land Release Decision Making by David Hewitson and Guy Marot [from page 16]

1. Previous incarnations of the LRC, responsible for work in earlier phases of the programme included Bactec International Ltd and Dynasafe Bactec Ltd.
2. From Phase 5 project contractual documentation, Section 4 – Statement of Service Requirement.
3. IMAS 07.11 Land Release, Edition 1, Amendment 5, February 2019, includes broad guidance on the process elements influencing ARE. The recently released TNMA 07.11/03 All Reasonable Effort (ARE), Version 1.0, March 2021, provides more detailed advice on what constitutes ARE and how to demonstrate its application. Sources such as https://www.hse.gov.uk/managing/theory/alarp.htm explain the concept and practice of ALARP.
5. In some case over 40cm of peat had ‘grown’ over the 1982 mine layer surface level, and on beach areas 11m of sand had accumulated.
6. Suspected hazardous areas (SHAs) in the Falkland Islands were likely to contain other forms of ERW as well as mines. Mine clearance procedures were targeted only on those parts of the SHA where mines were expected until the LRC and DPO were confident that they had all been found and dealt with. At that point the remaining area within the fenced boundary of the SHA could be searched for non-landmine UXO (mortar rounds, grenades, etc.) using the much faster BAC techniques. At some SHAs less than 5 percent of the total SHA area was subject to mine clearance procedures, but the entire area needed to be checked for other UXO hazards.

Linking Mine Action and Development: The Case of Komshuvakha by Nick Vovk [from page 28]

Developing National Landmine Clearance Capacity in Ukraine by Tobias Hewitt and Ronan Shenhav [from page 35]

2. The most heavily contaminated areas are thought to be around Vinnytsia, Ternopil, Zhytomyr, Dnipropetrovsk, Odesa and Kharkiv. The Crimean peninsula contains some of the most affected areas from World War II. Landmine Monitor, Ukraine 1999, http://archives.the-monitor.org/index.php/publications/display?act=submit&pqs_year=1999&pqs_type=lm&pqs_report=ukraine&pqs_section.
3. Until 2012 the called the Ministry of Emergency Situations.
4. Through the SES Department of Pyrotechnic Works and Humanitarian Demining.
7. An inter-ministerial working group was set up for this purpose in 2006. The Cabinet of Ministers Decree No. 131 of 18 February 2009 adopted the State Program for Demining by the Ministry of Emergency Situations for 2009–2014, foreseeing clearance of 15 km² over five years with the destruction of 500,000 items of ERW. In 2010, relevant ministries were tasked to forward proposals to establish a national body for demining and a presidential decree established a NMAMA in 2013. Landmine Monitor, Ukraine 2014, http://www.the-monitor.org/en-gb/reports/2014/ukraine/mine-action.aspx.
Saving Lives in Eastern Ukraine: Alternative EORE Approaches by Olena Kryvova [from page 43]

Explosive Ordnance Risk Education in Ukraine during the COVID-19 Pandemic by Andro Mathewson and Asya Bolotova [from page 49]
6. The official definition of EORE is “activities which seek to reduce the risk of injury from EO by raising awareness of women, girls, boys, and men in accordance with their different vulnerabilities, roles, and needs, and promoting behavioral change. Core activities include public information dissemination, education, and training.”
8. UNICEF has been providing laptops to schools and children across Ukraine during the COVID-19 pandemic to help minimize the negative effects of the pandemic on education.

Landmine Clearance and Socio-economic Development: A Study in Colombia by Oliver Ford, Amasia Zargarian, and Eric Keefer [from page 53]
1. A department is the Colombian equivalent of a state in the United States.
4. A vereda is an administrative division within a municipality. It represents an important geographical demarcation for humanitarian mine action in Colombia.

Impact Caused by the COVID-19 Pandemic on Humanitarian Demining in Colombia by Salomé Valencia Aguirre, Angela De Santis, Ph.D., and Sebastián Tovar Jaramillo [from page 60]
8. Three international organizations (The HALO Trust, Humanity & Inclusion, Danish Demining Group), plus two national organizations.

Moving the Story Forward: Utilizing Deminer Narratives to Increase Women’s Empowerment in Mine Action and Beyond by Brenna Matlock [from page 64]
1. The study utilized the definition provided by John Creswell in Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, “Phenomenological research is a design of inquiry…in which the researcher describes the lived experiences of individuals about a phenomenon as described by participants. This description culminates in the essence of the experiences for several individuals who have all experienced the phenomenon.” In this case, the lived experience of women who are deminers is examined in the study.
2. According to The SAFE Encyclopedia of Communication Research Methods, “Rhetorical theory is fundamentally concerned with composition, forms, functions, means, venues, producers, audiences, effects, and criticism of discourse.” Rhetorical strategies and theories are utilized to examine the texts of both the public-facing documents and the women’s survey responses.
3. The exception being South/Central America due to 1) the lesser number of demining operations in the region and the newness of the current demining programs such as those in Colombia.
4. Handling of all surveys and responses followed James Madison University Internal Review Board approved protocols to protect respondents’ data and anonymity.

Digital Rehabilitation Technologies Deliver Hope for Survivors by Abder Banoune [ from page 68 ]

6. As it is shown by the Landmine and Cluster Munition Reports 2020, over the previous year casualties from cluster munition attacks were reported in Syria and Libya, while casualties due to cluster munition remnants were recorded in ten countries and other areas: Afghanistan, Iraq, Lao PDR, Lebanon, Serbia, South Sudan, Syria, and Yemen, as well as Nagorno-Karabakh and Western Sahara. Similarly, mine casualties in 2019 were identified in fifty-five states and other areas, of which thirty-six are States Parties to the Mine Ban Treaty. Action 38 of the OAP. Available here: https://bit.ly/36TzNML.

Mental Health: Taking a Proactive Approach to Support Staff in Mine Action by Laura Biscaglia, Abigail Jones, and Robert White [ from page 75 ]

1. This article uses the term “staff” to refer to full-time, part-time, national, international, paid, voluntary, professional, technical, non-professional, and clerical staff.
2. Semi-structured interviews were carried out with stakeholders from the mine action sector and experts on occupational health, mental health, and well-being in aid work.
3. Working Well? Aid worker well-being and how to improve it, CHS Alliance, January 2020
4. Mental Health: Strengthening Our Response, World Health Organization, 30 March 2018
5. The authors recognize that the above definition of mental health frames gender identity in binary terms, which suggests the need for an update.
6. Factors associated with common mental health problems of humanitarian workers in South Sudan, H. Stroehmeier et al., 2018; The Mental Health of Expatriate and Kosovar Albanian Humanitarian Aid Workers, B.L. Cardozo et al., 2005; Factors Associated With Adverse Mental Health Outcomes in Locally Recruited Aid Workers Assisting Iraqi Refugees in Jordan, C.B. Eriksson et al., 2013.
8. Men’s Mental Health: Beyond Victim-Blaming, Rob Whitley, 2018
9. Jachens, Liza (Research Associate, Psychology and Counseling Department, Webster University Geneva), interviewed by the authors on 26 April 2021.
10. UNHCR’s Mental Health and Psychosocial Support for Staff, Courtney E. Welton et al., 2013
11. Ibid.
21. Gender-Based Differences in Burnout: Issues Faced by Women Physicians, Kim Templeton et al., 2019
22. Mental Health and Substance Use: Gender and Women’s Mental Health, World Health Organization, 2015
27. A survey conducted by Mines Action Canada in 2019 concluding that approximately 80% of field operations or national staff are men and 19% are women. https://www.minesactioncanada.org/bythenumbers.
31. IMAS 07.14, Risk Management in Mine Action
32. IMAS 10.10 Safety & occupational health - General requirements
33. Ibid.
34. The Impact of Masculinity on Mental Health, Ross, Bozynski, Johnson, Abraham, Human Journals Case Study, January 2020 Vol.:14, Issue:3
35. Humanitarian Aid Workers Mental Health and Duty of Care, Liza Jachens, 2019.
36. Presenteeism refers to the lost productivity that occurs when employees are not fully functioning in the workplace because of an illness, injury, or other condition. Even though the employee may be physically at work, they may not be able to fully perform their duties and are more likely to make mistakes on the job. Although not tracked like absenteeism, the costs of presenteeism have been estimated to be larger in real terms as employees suffering from longer-term conditions see persistent drops in productivity. It is important to note that employees contributing to presenteeism are, by definition, trying to give their best efforts but are physically or mentally unable to do so. Definition taken from ‘Presenteeism: A review of current thinking’, Garrow Valerie, 2016


38. Oscar Kilo, home of the national police wellbeing service. https://oscarkilo.org.uk/

39. Blue Light Wellbeing Framework, College of Policing, 2020


Data Driven Decision Making in Southeast Asia by Mikael Bold and David Avenell [ from page 85 ]


Key Performance Indicators (KPIs) for Land Release and Stockpile Destruction Operations – Notes on a New Technical Note for Mine Action by Roly Evans and David Hewitson [ from page 91 ]


3. Danish Church Aid (DCA), Danish Demining Group (DDG), Swiss Foundation for Mine Action (FSD), The HALO Trust, Mines Advisory Group (MAG), Mine Action Review, Norwegian People's Aid (NPA), Handicap and Inclusion (HI), United Nations Mine Action Service (UNMAS).


Recognizing and Reducing Risks From Ammunition and Explosives by Martina Salini and Samuel Paunila

Mohammed Al-Husseini, Ph.D., Ali El-Hajj, Ph.D., Mohammed Baydoun, Ph.D., and Hassan Ghaziri, Ph.D.

A Virtual Reality Application for the Training of Deminers by Lynn Al Khansa, Elias Bou Saada, Rachid Maalouf, Mohammed Al-Husseini, Ph.D., Ali El-Hajj, Ph.D., Mohammed Baydoun, Ph.D., and Hassan Ghaziri, Ph.D.


17. ECORYS Nederland BV. Advice for Donors on Setting up and Running mine action programmes Lot No 4 - Sectorial and project evaluations – CONTRACT FOR SERVICES No. 2006/128168Version 1. p.31. Available at: https://bit.ly/3yrkI4H.


A Virtual Reality Application for the Training of Deminers by Lynn Al Khansa, Elias Bou Saada, Rachid Maalouf, Mohammed Al-Husseini, Ph.D., Ali El-Hajj, Ph.D., Mohammed Baydoun, Ph.D., and Hassan Ghaziri, Ph.D. [from page 97]


Recognizing and Reducing Risks From Ammunition and Explosives by Martina Salini and Samuel Paunila [from page 102]


2. The International Ammunition Technical Guidelines define explosive ordnance as "all munitions containing explosives, nuclear fission or fusion materials and biological and chemical agents. This includes bombs and warheads; guided and ballistic missiles; artillery, mortar, rocket and small arms ammunition; all mines, torpedoes and depth charges; pyrotechnics; clusters and dispensers; cartridge and propellant actuated devices; electro-explosive devices; clandestine and improvised explosive devices; and all similar or related items or components explosive in nature."


4. https://unsaferguard.org/


8. UNGA (2017), Countering the threat posed by improvised explosive devices, UN Doc. A/RES/72/36, pp. 1-2


17. AMAT advice and services are triggered with a request for assistance from a state or an organization. The analysis of the request often warrants desk research and a risk assessment, resulting in the design of a response package or a programme for the state to reduce risks from ammunition and explosives in the short and long term.
18. The course covered the following modules of the IATG: IATG 01.10 Introduction to the IATG; Ammunition Safety Management – Theory of Explosives and Ammunition Classification, Causes of Explosions; IATG 01.50 UN Hazard Classification System; IATG 02.10 Introduction to Risk Management Principles and Processes; IATG 03.20 Lotting and Batchign; IATG 02.20 NEQ Quantity Distance calculation exercises; IATG 02.30 Explosive Limit Licensing; IATG 09.10 Security of Ammunition Storage Areas; IATG 06.20/30 Storage and Handling; and IATG 05.30 Barricades.
19. As per the feedback compiled to date 27 May 2021, from sixty-two trained army officers ranked from lieutenant to general (fourteen women, forty-eight men).
20. The PNDHD is the national authority responsible for ammunition management in Mauritania.
21. The countries supporting Moldova were organised under the Multinational Small Arms and Ammunition Group (MSAG) and include Austria, Canada, Germany, Sweden, Switzerland, and the United States.
22. Approximately 1,900 metric tons of ammunition have been destroyed since 2004.
23. Chemical, biological, radiological, nuclear, and high-yield explosives (CBRNE).
25. Contact AMAT via amat.gichd.org or UNSaferGuard.org.
26. For example: Arms Trade Treaty Voluntary Trust Fund (ATT VTF), The Saving Lives Entity (SALIENT), UN Trust Facility Supporting Cooperation on Ammunition Regulation (UNSCAR), etc.

**Alternatives to Open Burning and Open Detonation: The Disparity Between HMA and Commercial Best Practices by Linsey Cottrell and Kendra Dupuy [ from page 107 ]**

5. In accordance with Section 1421 of the National Defence Authorisation Act for Fiscal Year 2017, National Academies of Sciences study on conventional munitions demilitarization alternative technologies.
7. Under contract frameworks let through the NATO Support and Procurement Agency (NSPA)

**First Steps to Limiting Conflict Pollution in Central Vietnam by Allan Vosburgh [ from page 112 ]**


**Measuring Explosive Munitions Use with Open Source Data: A New Tool for Enhancing Humanitarian Mine Action by Jonathan Robinson and Christopher Baade [ from page 116 ]**

4. The Carter Center is a nongovernmental organization guided by the principles of Founders Jimmy and Rosalynn Carter. Founded in partnership with Emory University, on a fundamental commitment to human rights and the alleviation of human suffering. The Carter Center has helped to improve the lives of people in more than eighty countries by resolving conflicts, advancing democracy and human rights, preventing diseases, and improving mental health.
5. The Explosive Munitions Use in Syria Project is run by the Syria Conflict Mapping Project, part of The Carter Center’s Conflict Resolution Program on Supporting Peace in Syria.
6. As opposed to the common practice of counting the conflict event itself, which can contain multiple explosive munition uses.
7. The Carter Center, Explosive Weapons Contamination in Syria, Report 1; Southern Syria: As Sweida, Daraa and Quneitra Governorates (Nov 2019),
8. Although it is understood that the data study alone cannot fully predict explosive weapons contamination as a variety of conditions are needed for the formation of this such as firing conditions, weather, ground type and age of munitions (to name some).
9. These weapons types are general such as air launched, ground launched shelling, rather than specific weapons manufacturers. It is also understood that a variety of factors contribute to the formation of explosive weapons contamination, not just where high levels of bombardments have occurred.
10. The advantage of the study being that the distribution of explosive munitions is focused on rather than the exact number of items in it.
11. Given that it takes considerable time and effort to verify or confirm an event or munition use.
12. For example, the data from the project could identify and establish suspected hazardous areas (SHA) polygons which could then later be entered in IMSMA and followed up by non-technical surveys.
13. As the project helps: 1) assist in raising awareness and prioritization of potential high risk areas of UXO contamination in Syria for risk education, 2) assist with prioritizing areas for on the risk mitigation activities and ground surveys as part of the initial stage of mine action, 3) support advocacy efforts in the de-mining sector and donor levels, 4) bring together key decision makers from all sides of a conflict, 5) highlight the need for an effective long term policy response and 6) contribute to reducing the threat posed by explosive munitions and the lasting impact it has to people living in affected areas.
18. Such as with the limited accuracy and trust of open source data, and the method likely under-counting the number of explosive munitions in a given conflict event, especially if no exact number of munitions was given.
19. This is as detailed as the study goes. It does not specify the exact weapon type used or manufacturer. For more information please see the aforementioned Carter Center reports.
20. The study was presented to members of the UNMAS Humanitarian Mine Action Syria Working Group in Amman on 15 September 2019 after being invited to do so. This built on a proof of concept study focused on Eastern Ghouta and in Yemen in 2018 conducted by one of the authors. In addition, at least 8 HMA actors focused on Syria have expressed interest in using the findings and method of the project for their work in Syria. Two HMA actors are currently testing the validity of the findings in their activities on the ground, while one has built in the method outlined in this project to enhance their own desk assessment process.
21. The advantage of the study being that the distribution of explosive munitions is focused on rather than the exact number of items in it.
24. With this count likely much higher given the limitations of the data, methodology and way UXO is formed.
25. Partially available from open sources.
26. This is in addition to various issues such as lack of international appetite for funding in government areas of Syria, sanctions and terrorism laws applied to Syria, and limited access into the country and within for entities that conduct de-mining.
27. Such as Ukraine, Libya or in Yemen, where one of the authors conducted a pilot version of the explosive munitions project with Halo Trust in late 2018.
30. The completed project will span five reports and visualize and analyze a dataset of hundreds of thousands of explosive munitions uses extrapolated from tens of thousands of conflict events. This will cover thousands of communities in the 14 governorates of Syria from July 2013 until the present day. This data will be freely available from The Carter Center Syria Program on request. The Carter Center is expected to regularly update the dataset in the future as part of a routine maintenance of the project to keep it relevant.
31. They are currently seeking to develop a pilot project in Ukraine, develop other information layers to be used in the project as well as its wider use in the peacebuilding sector.

Management in Iraq by Mark Wilkinson, Ph.D. [ from page 120 ]
3. UNMAS data current as of June 7, 2021.
Managing Risk Through Transparency and Cooperation: Improving Lebanon’s PSSM Capacity by Jamie McGhee [from page 125]

4. The term “compatibility group” refers to a grouping identified by a letter which, when referenced to a compatibility table, shows those explosives which may be stored or transported together without significantly increasing the probability of an accident or, for a given quantity, the magnitude of the effects of such an accident. Codes are used to indicate which natures may be safely stored together.
7. The term “hazard class” refers to the UN recommended system of nine classes for identifying dangerous goods. Class 1 identifies explosives.
8. The term “hazard division” refers to the UN classification system that identifies hazardous substances.
11. A PES is any stock of explosives, however or wherever stored (building, stack, vehicle, railway wagon, berth, transit shed etc), the explosion of which will affect an exposed site. "Quantity Distances and Licensing Criteria, JSP 482 Edition 4, Chapter 10," https://bit.ly/3gFueXb.

Assisting Landmine Survivors in Yemen by Elise Becker and Tamara Klingenheim [from page 129]


Remote Sensing and Artificial Intelligence in the Mine Action Sector

by Martin Jebens and Rob White [from page 134]

6. Big data is a concept in computer science that broadly covers the collection, storage, analysis, processing and interpretation of enormous amounts of different data (in MA context this could be data collected during NTS; satellite images, remote sensing data, white papers, positions of different objects). The data-sets are too large or complex to be dealt with by traditional data processing software.

How to Implement Drones and Machine Learning to Reduce Time, Costs, and Dangers Associated with Landmine Detection

By Jasper Baur, Gabriel Steinberg, Alex Nikulin, Ph.D., Kenneth Chiu, Ph.D., and Timothy S. de Smet, Ph.D. [from page 137]

1. Deep learning is a subfield of machine learning based on the use of deep neural networks. Machine learning is a subfield of artificial intelligence wherein a computer uses algorithms to improve at a task on its own only through experience. Artificial intelligence describes any program designed to imitate human perception.
7. UAV refers solely to the aerial platform (drone), whereas UAS refers to the drone along with the attached sensors, the ground control station, and the remote pilot controlling the autonomous flight.
13. EMI occurs when a current applied to a coil induces a magnetic field. This magnetic field will then induce electrical eddy currents when exposed to a metallic object, which then results in the induction of the magnetic field towards the coils, generating an opposite current in the coil. This current from the metallic object is then detected by the instrument.
28. Negative samples (or negative templates) are images collected with no objects of interest present (PFM-1 mines or KSF casings in this case). Including them in the training data can often decrease the number of false positives by allowing the computer to clearly distinguish between background and objects of interest.
36. de Smet, Timothy; Nikulin, Alex; and Baur, Jasper. “Scatterable Landmine Detection Project Dataset 1-7” (2020). *Geological Sciences and Environmental Studies Faculty Scholarship*. 1-7. https://orb.binghamton.edu/geology_fac/4