Issue 28.3 | Fall 2024

THE JOURNAL of Conventional Weapons Destruction

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FOR CIVILIAN CASUALTIES OF EXPLOSIVE INJURY

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INTERVIEWS
WITH LONG-TIME CWD EXPERTS

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THE JOURNAL of Conventional Weapons Destruction

Issue 28.3, Fall 2024
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The Journal of Conventional Weapons Destruction
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Harrisonburg, VA 22807 / USA
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https://www.jmu.edu/cisr

ISSN: 2469-7575
The Journal of Conventional Weapons Destruction
Issue 20.1 ongoing: (print) ISSN 2469-7575; (online) ISSN 2469-7605
For previous ISSN numbers visit:
https://www.jmu.edu/cisr/journal/about.shtml

The Journal of Conventional Weapons Destruction is a professional trade journal for the humanitarian mine action/conventional weapons destruction community, including but not limited to humanitarian mine action, physical security and stockpile management, small arms and light weapons, and other conventional weapons destruction related topics.

The editorial board reviews all submissions for content and accuracy, as well as suitability for *The Journal*. The editorial board reserves the right to reject articles.

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

This publication is funded by grants from the US Department of State. The opinions, findings, and conclusions stated herein are those of the author[s] and do not necessarily reflect those of the US Department of State, the US Department of Defense, James Madison University, or the Center for International Stabilization and Recovery.

ON THE COVER: Transarticular knee amputation with prosthetic leg from the article "The Explosive Weapons Trauma Care Collective (EXTRACCT): A Roadmap for Reducing Preventable Death Among Civilian Casualties of Explosive Injury" on page 28.
Courtesy of Frank Gaillard, Radiopaedia.org, rID: 32534.

TOPICS FOR VOLUME 29 (2025)

- **Innovative Technology**
- **Survey, Clearance, and Land Release**
- **Environmental Considerations**
- **Countries and Regions**
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- **EORE and Survivor Assistance**
- **Humanity and Culture**

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THE JOURNAL

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A MESSAGE FROM THE DIRECTOR

This summer has been a busy time for the CISR team. In August, I traveled to Tajikistan with faculty from the James Madison University College of Business to launch a new partnership with the Regional Explosive Hazards Training Center in collaboration with the Organization for Security and Co-operation in Europe, Programme Office in Dushanbe, with funding support from the US Department of State. More recently, I participated in the Humanitarian Demining Innovation and Technology Summit in the United Kingdom where experienced practitioners and technology specialists engaged in innovative problem-solving and information exchange. Also, CISR program staff, Amy Czajkowski and Adrienne Harman-Griggs, attended PeaceCon 2024 at the United States Institute of Peace in Washington, D.C., and CISR Managing Editor, Jennifer Risser, attended the Geneva International Centre for Humanitarian Demining's (GICHD) Innovation Session on Artificial Intelligence Applications in Mine Action.

In this issue of *The Journal*, we feature:

- John Stevens and Harry "Murf" McCloy, officials from the Office of Weapons Removal and Abatement in the US Department of State Bureau of Political-Military Affairs (PM/WRA), share about their wealth of experience in humanitarian mine action (HMA). You will not want to miss these interviews.
- Christelle Mestre (GICHD) examines current funding practices for the environment in mine action, emphasizing the importance of strategic partnerships, donor awareness, and national mine action strategies, all within a holistic approach to the broader impact of HMA.
- "Innovative Finance for Mine Action: Needs and Potential Solutions" by Danielle Payne (GICHD), Camille Wallen, and Chris Loughran (Symbio Impact Ltd) highlights critical innovative funding needs in mine action amid emerging and protracted conflicts and the increased use of improvised devices by non-state armed groups.
- The Explosive Weapons Trauma Care Collective (EXTRACCT) presents an overview of its approach to reduce death and disability among civilian victims of explosive weapons and ordnance, emphasizing the importance of point-of-injury care for civilians as well as collaboration between mine action and emergency care services in low-resource settings.
- Rory Collins (United Nations Office for Project Services (UNOPS)), Lionel Fragniere (Swiss Armed Forces International Command), and Mateo Dulce Rubio (Carnegie Mellon University) discuss the initiatives taken by UNOPS Peace and Security Cluster in developing a mapping tool in Gaza, the application of Natural Language Processing for improvised explosive device data management globally, and the use of remote sensing and machine learning technologies in Afghanistan and Syria.
- Edward Crowther and Natalia Shepel (United Nations Development Programme Ukraine) present findings from their Phase II testing of unmanned aerial vehicles/sensor systems for mine action in Ukraine. Involving Ukrainian and international organizations, their results demonstrate that integrating technologies to detect explosive remnants of war (ERW) could enhance traditional demining methods.
- Kiengkay Ounmany from the Southeast Asian Ministers of Education Organization Regional Centre for Community Education Development reviews Lao PDR's national unexploded ordnance capacity over the past three decades, identifying potential improvements in the areas of financial and information management, strategic planning, and quality management.
- Senior Lieutenant Perederii (National Police of Ukraine), Tony Salvo, and Drew Prater (Bomb Techs Without Borders) provide an update on Version 6.0 of the Basic Identification of Ammunition in Ukraine.
- Vaghinak Sargsyan from the Center for Humanitarian Demining and Expertise in Armenia evaluates the impact of landmine and ERW contamination on Armenia's pastoral, arable, and forested lands, detailing its effects on civilians, the environment, and development.

We are looking forward to working with contributors on our 29th volume of *The Journal*, and in spending time with our colleagues at various upcoming events. As presented throughout this issue's articles, in this time of uncertainty and ongoing conflict, we acknowledge and reflect on the vital importance of discussion, information sharing, and strategically looking ahead as we navigate the many facets of the evolving sector that is mine action.

Sincerely,

Suzanne Fiederlein, PhD

IN THIS ISSUE

In this issue of The Journal, *we feature interviews with two officials from the Office of Weapons Removal and Abatement in the US Department of State's Bureau of Political-Military Affairs (PM/WRA), who recount their careers and experiences working with conventional weapons destruction (CWD) programs.*

AN INTERVIEW WITH John Stevens

John Stevens is a retired PM/WRA Program Manager with extensive experience running multi-million-dollar conventional weapons destruction (CWD) programs in Vietnam, Sub-Saharan Africa, the Balkans, and Ukraine. Since December 2014, Stevens has been re-employed as a Senior CWD Advisor with PM/WRA. In this capacity, he conducted fresh CWD assessments in Bosnia and Herzegovina, Colombia, Guinea-Bissau, Lao PDR, Senegal, Serbia, and South Korea.

HOW DID YOU BECOME INVOLVED IN HUMANITARIAN MINE ACTION?

The United States Information Agency (USIA), where I served as a Watch Officer in its Operations Center, was consolidated with the US Department of State in 1999. Selected USIA officers were given the opportunity to compete for public diplomacy positions at the Department. For me, the most interesting vacancy was at the Office of the President and Secretary of State for Global Humanitarian Demining. I interviewed, was picked, and plunged immediately into helping publicize US policy on landmines and the accomplishments of the US Humanitarian Demining Program—already the world's largest—and to travel to mine-affected countries to observe and learn. After PM/WRA was established in 2003, consolidating all of the Department's demining, small arms/light weapons (SALW) destruction, and related policymaking, I was asked to manage our explosive remnants of war (ERW) programs in Vietnam in addition to continuing my public diplomacy duties. After several years, I attended the National War College, where I received a master's degree in National Security Strategy. Upon graduating I returned to the State Department, served for six months on the US Horn of Africa counter-piracy program, and then returned to PM/WRA where I took over management of our CWD programs in the Gambia, Guinea-Bissau, Mauritania, Senegal, Sudan (before South Sudan's independence), Somalia, and Mozambique. I was then asked to manage our CWD programs in Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Kosovo, Lithuania, Montenegro, North Macedonia, Serbia, and, beginning in 2013, Ukraine as well. I retired in early 2014. In late 2014, PM/WRA hired me on an intermittent basis to help assess our CWD programs in Colombia, Bosnia and Herzegovina, Guinea-Bissau, Lao PDR, and Senegal, and to assess South Korea's brief resumption of demining in its half of the Demilitarized Zone. I continue to advise PM/WRA as needed.

The author at a HALO Trust humanitarian demining site in Colombia, 2015.
All images courtesy of the author.

When PM/WRA was created in 2003, its mandate also included the destruction of other countries' at-risk SALW, including man-portable air-defense systems (MANPADS) and anti-tank guided missiles (ATGMs), the provision of physical security and munitions stockpile management (PSSM) assistance, and helping other countries safely clear ammunition that polluted communities following catastrophic explosions at some of their "dangerous depots." In addition to the brief executive level introduction to landmine clearance that I and other PM/WRA program managers received from the Department of Defense's Humanitarian Demining Training Center, we also received introductory training on PSSM from such professional military education institutions as the NATO School in Oberammergau, Germany. In summary, PM/WRA's mission confronts all manner of conventional weapons threats, not just landmines and ERW.

DID YOU KNOW ANYTHING ABOUT LANDMINES BEFORE YOU TOOK YOUR FIRST JOB AT THE US DEPARTMENT OF STATE?

When I served in the US Army in the early 1970s, we were taught to use Claymore mines and were given the chance to detonate some during Infantry Advanced Individual Training. I was astounded at how powerful these mines were, far more than the hand grenades we were also taught to use. But it was not until I served for two years as an Observer in the Multinational Force & Observers (MFO) peacekeeping organization in the Sinai Desert that I learned just how dangerous, ubiquitous, and persistent landmines and ERW can be. We were advised that the dangers in the Sinai might still include some wooden anti-personnel "shoe box" mines emplaced by the Ottoman Turkish Army during World War I. I never saw one. But I did recognize that vast numbers of modern anti-vehicle mines and ERW dating back to Israel's War of Independence from 1948–1949, 1956 Suez Crisis, 1967 Six-Day War, 1967–1970 War of Attrition, and 1973 Yom Kippur War (October War) posed the greatest actual threats! Many of the mines visibly littered the desert, where the wind shifted their locations and repeatedly covered and uncovered them with sand.

WHAT ROLE DOES POLICY PLAY IN ADVANCING HUMANITARIAN MINE ACTION AND IN DENYING ARMS AND AMMUNITION TO CRIMINALS AND TERRORISTS, AND HOW HAS THE UNITED STATES CONTRIBUTED TO SHAPING THESE POLICIES?

US policy on the use of landmines and cluster munitions, and in helping other nations rid themselves of these "hidden killers," is in strict adherence to Amended Protocol II to the Convention on Certain Conventional Weapons, *adopted in 1996, making it the first landmine treaty in history, and to which the United States is a party. On the kinetic side, this means US armed forces uphold its requirements during conflicts. On the humanitarian side, the United States leads the way in helping other countries clear landmines and ERW that endanger their populations. This assistance even covers US-origin ERW in the Pacific region dating back to World War II. In addition, our CWD programs help countries safely destroy their stocks of aging, unstable, and excess arms and ammunition to keep them out of the hands of criminals and terrorists, and to prevent catastrophic unexpected explosions at munitions sites whose humanitarian and political impacts often surpass those created by persistent landmines and ERW. In addition to the humanitarian good done by the US CWD program, the national security of the United States and of its allies and friends are also reinforced.*

WHAT DID YOU LEARN DURING YOUR TIME AS PROGRAM MANAGER FOR VIETNAM?

To be humble and leave my assumptions at the door. During my assessment visits to Vietnam, we funded a complex multi-million-dollar pilot Landmine Impact Survey in six of the central provinces in addition to funding battle area clearance (BAC), mine risk education (now called Explosive Ordnance Risk Education (EORE)), and survivor assistance.[1] During this time I discovered that it was ERW—usually cluster munitions—and not landmines that posed the greatest threat in those six provinces. I also believed that some of the EORE we funded was well-intended but probably of little lasting value, and that the sites identified by the provincial authorities to be cleared were not always sites that posed the greatest immediate threat to local inhabitants (and in one case would have necessitated the complete removal of a large cemetery). I learned that a significant number of explosive devices, whether of Soviet, Chinese, or US origin, ranging from hand grenades to rocket propelled grenades, mortar rounds, artillery shells, and aerial bombs—both unitary and cluster—had failed to detonate over the course of the Vietnam War and were still killing Vietnamese people and hindering Vietnam's agriculture sector and infrastructure development in the provinces that needed that development most. This is unfortunately still the case even today, though our programs have successfully reduced the number of accidental deaths and cleared thousands of acres of land for agricultural and infrastructure development, according to the needs of the local communities.

Once, at the end of a long day in the field, I found myself at a beach overlooking the beautiful South China Sea, or, as the Vietnamese call it, the East Sea. It struck me that as an episodic visitor to a country where I could not speak or read the language and therefore could not always perceive where the national and provincial authorities priorities might conflict with each other's, I knew as much about the local context and Vietnam's own deep-seated concerns as I knew about what was going on with the fish in front of me. That beachside revelation remained with me even when I was tasked to manage our CWD programs in Africa and years later in Eastern Europe.

"...I knew as much about the local context and Vietnam's own deep-seated concerns as I knew about what was going on with the fish in the East Sea."

MINE ACTION IS OFTEN LINKED TO DEVELOPMENT. ARE THERE ANY OTHER SPECIALIZED FIELDS THAT YOU WOULD LIKE TO SEE MORE CLOSELY COLLABORATE WITH MINE ACTION (I.E., EMERGENCY RELIEF, ENVIRONMENTAL SCIENCE, AGRICULTURAL DEVELOPMENT, ETC.)?

Years ago, when the idea of integrating mine action with development was first raised, it ran into institutional skepticism. The concern was that humanitarian demining (HD) would get encumbered with all sorts of non-kinetic responsibilities and suffer from a diversion of funds and distractions imposed by other humanitarian and development assistance requirements. In fact, there has always been room for other disciplines to work side by side with HD and BAC, and for the greater good. I cannot imagine a scenario in which the HD/BAC communities would not want to keep medical practitioners, aid workers, emergency responders, public works engineers for municipal water, sewage, and power systems, and farmers apprised of where they have cleared the land from hidden killers or where clearance remains to be done, or to work with other professions to help prioritize clearance tasks, just as a doctor triages patients after a major accident. And I cannot imagine a situation where medical practitioners and others would not immediately alert the HD/BAC specialists when they encounter explosive devices that hinder their essential work. The same goes for environmental protection or remediation, and agricultural development. If The Journal's *readers examine PM/WRA's* To Walk the Earth in Safety's *annual reports (https://bit.ly/3Xd3u68), they will see that years ago the US CWD program initiated a holistic approach in which multiple sectors outside of HD/BAC have been engaged and thereby even more empowered to render all types of assistance to conflict-impacted populations. Encouraged strongly by the Department of State's internal planning processes for foreign assistance, we strive to harmonize our CWD programs with the priorities of the Department's Regional Bureaus, country desks, and US Embassies worldwide.*

Social norms in CWD have matured too. Originally, HD and BAC were almost entirely conducted by men. Women have since been integrated into the HD/BAC labor forces. They have learned and maintained the same high level of diligence and expertise as their male counterparts. There has been no reduction at all in work quality or overall performance. Quite the contrary! Since it was established in 2003, PM/WRA has

The author at a battle area clearance collection pit, Quang Binh Province, Vietnam, 2007.

strongly encouraged its implementing partners to recruit women as well as men. To their credit, our partners have done so and not just because PM/WRA desired it, but because their own institutional ethos called for equal employment opportunity as well. As a result, demining assistance is more effective by ensuring it benefits all segments of society, thereby producing greater positive outcomes for recipient communities, and providing American taxpayers with a better return on their investment. In countries like Tajikistan, Colombia, and Vietnam, mixed-gender demining teams are setting new standards and influencing attitudes in their communities.

WHAT DO YOU CONSIDER TO BE THE MOST SIGNIFICANT ACHIEVEMENTS OR CONTRIBUTIONS TO THE FIELD OF HMA OVER THE COURSE OF YOUR CAREER? WHAT HAVE BEEN THE MOST SIGNIFICANT DEVELOPMENTS?

The Department of Defense's Humanitarian Demining Research and Development's successful creation, testing, and deployment of the HSTAMIDS dual head detector in 2006 (https://bit.ly/3WXsk8V). The HSTAMIDS detector combines metal detecting with ground penetrating radar, and its preset algorithms can determine if a signal designates the presence of specific types of landmines or merely signals a harmless piece of metal shrapnel, belt buckle, or other piece of non-threatening metal debris (false positives). It has been a tremendous labor saver for the demining community. Admittedly, given the sophisticated technology behind these detectors, they are more expensive than conventional metal detectors, and the deminers who use them require additional training to extract the full benefit from these devices. These factors and costs may prevent some smaller demining organizations from adding HSTAMIDS to their tool kits.

Just as armed drones have revolutionized warfare, small quadcopter drones equipped with video cameras and with metal detectors are likely to help further speed mine and ERW detection, and possibly the detection of improvised explosive devices (IEDs).

Looking ahead, drones augmented by artificial intelligence might help to make non-technical survey (NTS) and technical survey even more accurate, and therefore more trustworthy, ultimately freeing up precious funds for clearing confirmed hazard areas (CHA). Of course, the extra cost of acquiring this technology, training deminers to use it efficiently, and the ability to sustain the quadcopters and their sensors in the field with maintenance, may be limiting factors for some demining organizations.

> "Just as armed drones have revolutionized warfare, small quadcopter drones equipped with video cameras and with metal detectors are likely to help further speed mine and ERW detection..."

CONVERSELY, WHAT ARE SOME OF THE MOST SIGNIFICANT CHALLENGES FACING THE US CONVENTIONAL WEAPONS DESTRUCTION PROGRAMS' EFFORTS TODAY?

The first challenge that comes to mind is the use by some non-state actors of landmines, usually improvised, that have little or no metal content. This has been a big problem in Colombia, for example. In the case of minimal metal mines, the deminer and deminer's detection equipment[2] must be properly trained and calibrated, respectively, to pick up a very weak signal. But some metal detectors may not have the sensitivity to be calibrated for these subtle metallic signatures. As for non-metal mines, no, repeat no, metal detection can find them. In this latter case, the employment of mine detection dogs (MDDs) would be helpful, but only if the climate, terrain, and foliage would not constrain the MDDs or their human handlers, and if proper veterinarian care was available.

> "In short, there is still no one 'silver bullet' that will replace all of the currently available, proven devices in the deminer's toolbox."

Also, IEDs with or without booby traps are a threat that will remain as long as warfare exists. Because of their irregular nature and varying metal signatures, they can complicate and add significant risk to demining and BAC.

In short, there is still no one "silver bullet" that will replace all of the currently available, proven devices in the deminer's toolbox.

AS MINE ACTION EVOLVED AND MATURED, WAS THERE ANYTHING THAT SURPRISED YOU, EITHER REGARDING THE SCOPE OF THE WORK CHANGING OR THE FIELD SHIFTING FOCUS TO ADDRESS DIFFERENT CHALLENGES?

I am gratified by the degree to which nongovernmental demining organizations, most of which are PM/WRA implementing partners, have also recognized the threat, and frankly the opportunities, to expand their life-saving services and develop the expertise to safely destroy at-risk SALW, including MANPADS and ATGMs, and provide PSSM or weapons and ammunition management services. These include: renovating or building new munitions storage facilities, ranging from robust arms storerooms in police, gendarmerie, and military facilities, or entirely new, weather-resistant munitions storage depots with proper spacing to reduce the chance of explosions in one building spreading or daisy chaining to other buildings; providing close circuit TV systems in some cases and strong locks; the means and the space to enable fork lifts to stack ammunition more safely than humans alone; and the provision of robust perimeter fencing, electric alarms, lighting, and guard posts, augmented by stricter accessibility protocols. Learning proper storage of various types of ammunition and fuzes, separating them to International Ammunition Technical Guidelines standards, is also included in many PM/WRA's PSSM management initiatives.

One area of HD and BAC that still suffers is from host nation institutional suspicion of NTS, no matter who carries it out, being efficacious enough to enable a suspected mine field or battle area to be accurately and safely declared mine free. There are several reasons for this reluctance to accept NTS. One reason is the understandable suspicion of some local officials and national mine action authorities to sign off on an area being mine free based on NTS alone, without any technical survey. But who can blame them for not wanting to risk their careers, let alone the lives of their fellow citizens by embracing an approach that relies on people's memories and fears even when there has never been an actual casualty in an area that has no confirmed hazards? The other end of the continuum regarding resistance to NTS is what PM/WRA has characterized as the "self-licking ice cream cone" syndrome—meaning some host nation authorities are reluctant to agree that even a CHA, which has undergone full, careful clearance, really is clear, because then the foreign demining assistance, to include salaries for locally-hired deminers, provision of 4x4 vehicles, rent for housing and field offices, and so forth will cease.

This phenomenon in foreign assistance is surely not limited to the mine action and BAC sectors and will probably always exist in some form. It is up to donor governments and private donors to confront these challenges and diplomatically but firmly resist giving in, particularly when funds are so urgently needed to tackle genuine hazards elsewhere.

IS THERE ANY PARTICULAR THREAT OR ISSUE THAT WORRIES YOU?

Yes. The threat posed by criminals and terrorists acquiring MANPADS and ATGMS is number one on my list of CWD concerns. Since PM/WRA was established in 2003, it has led the US Government's interagency MANPADS Task Force (MTF) to destroy these weapons whose powerful lethality is so disproportionate to their compact sizes and ease of portability. Fortunately, the MTF, in concert with governments worldwide, has made real progress in permanently subtracting tens of thousands of these dangerous weapons outside government control or otherwise at risk of illicit diversion from the threat equation, enabling partner governments to better manage their own legitimate stockpiles, and safeguarding global aviation in the process. But as extraordinary as the MTF's work has been year after year, significant dangers remain. MANPADS and ATGM removal are Sisyphean tasks that the MTF continues to shoulder without tiring because the stakes are so high. We must never forget that a MANPADS was used to assassinate the Presidents of Rwanda and Burundi in 1994 as they flew back together to convene in Kigali, Rwanda's capital. Just as surely as the assassin's bullet that killed the Archduke of the Austro-Hungarian Empire in Sarajevo in 1914 was the spark that ignited World War I, so the MANPADS attack that downed the business jet carrying the leaders of Rwanda and Burundi triggered the Rwandan genocide. Terrorist groups that emerged following that genocide continue to murder innocent civilians in the eastern region of the neighboring Democratic Republic of the Congo to this day.

It has been an honor to be involved with the US CWD program that has done and continues to do so much good so that people may walk the earth in safety.

See endnotes page 60

The views expressed in this interview are those of the author and do not necessarily reflect those of the US State Department, US Government, or the Center for International Stabilization and Recovery.

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AN INTERVIEW WITH Harry "Murf" McCloy

Harry "Murf" McCloy, is a retired US Marine Colonel who transitioned from military service to become a pivotal figure in humanitarian demining with PM/WRA in the US Department of State. Heading the US State Department's first demining program in Bosnia and Herzegovina in 1996, McCloy became the State Department's Senior Demining Advisor in 1998, holding this position until his retirement in 2007. He continues to work part-time in the Office of Weapons Removal and Abatement and has played a crucial role in the strategic oversight and execution of mine action programs across forty-six countries, significantly enhancing safety and establishing essential demining programs worldwide.

The author in what is now North Macedonia.
All images courtesy of the author.

HOW DID YOU FIRST BECOME INVOLVED IN HUMANITARIAN MINE ACTION? WHAT WERE SOME OF THE EARLY CHALLENGES YOU FACED WHEN STARTING THE FIRST HUMANITARIAN DEMINING PROGRAM IN BOSNIA AND HERZEGOVINA?

My first involvement in humanitarian demining was in September of 1993, when I was hired by the United Nations to work in Somalia on the staff of the Special Representative of the Secretary General of UNOSOM II. Although I was initially hired as a police official, I was told that I would find out what my real job would be once I got to Somalia. As it turned out, upon arrival I was assigned as the Chief of the Demining, Disarmament, and Demobilization Division, which was just being formed. My Deputy was an Australian Ministry of Defense official seconded to the UN staff. We split the programmatic responsibilities between us along functional lines; I took on the task of setting up a program to demine Somalia, and he took on the task of setting up a program to encourage former combatants to turn in their weapons and learn trades that were needed in the civilian community. Two of my biggest challenges in these pre-International Mine Action Standards (IMAS) days were to: (1) find minefields where local inhabitants from both sides of the conflict could agree that the mines should be taken out, and (2) find local demining groups as well as international demining nongovernmental organizations (NGOs) that were acceptable to both sides to do the work. Needless to say, the demining program that was eventually put into place was much more limited in scope and impact than the lofty initial goal of "demine Somalia," but it did get off the ground and was providing life-saving relief in several locales before the mission was terminated.

The lessons I learned from my exposure to demining in Somalia carried over to my next UN mission with the UN Humanitarian Coordination Unit in Angola during the UN Angola Verification Mission (UNAVEM) II and III. Here I served as the Deputy and subsequently Interim Demining Program Manager. A large part of my efforts involved working with the Director of the nascent Angolan National Institute for Demining to establish a demining school, staffed by military instructors from New Zealand and France, for demobilized soldiers from both the Angolan Army and the National Union for the Total Independence of Angola (UNITA), the former rebel group, and to integrate UNITA members into the National Demining Institute staff to increase the knowledge of the mine threats planted by both sides during the war. To complement these confidence- and capacity-building measures, I also worked with international demining NGOs already in the field to increase the flow of information regarding explosive threats and their impact on the provision of humanitarian assistance to severely impacted communities. This information was extremely useful in the planning and prioritization of future demining efforts in coordination with the National Demining Institute as resources became available.

After cutting my demining teeth with the UN missions in Somalia and Angola, I was offered the opportunity to head the US State Department's first demining program in Bosnia and Herzegovina. As the US Demining Coordinator for Bosnia and Herzegovina, a position I assumed in early 1996, I was essentially the in-country Program Manager for the Department's Office of International Security and Peacekeeping Operations, which was responsible for the Department's demining programs at that time. Our implementing partner for Bosnia and Herzegovina was a commercial contractor with demining experience in Afghanistan and Africa.

The early challenges I faced with the State Department's program were pretty much the same ones I had faced with my previous UN missions: (1) gaining an understanding of the history of the conflict and the political and military entities involved; (2) developing working relationships with appropriate officials (including political and military officials of the former warring parties, donor country representatives, the NATO military command, and the newly established UN Mine Action Center (MAC); (3) establishing an infrastructure to support national demining capacity building and long-term support; and (4) eventually deploying trained demining teams to designated areas to identify and eliminate contaminated areas of threat.

The one new challenge I encountered in Bosnia and Herzegovina revolved around the application of the International Standards for Humanitarian Mine Clearance Operations (the forerunner of IMAS) that were published in early 1997. This was a useful development, but as with any new initiative, there are always areas of ambiguity or possible multiple interpretations that can pose bars to progress if left unresolved. Fortunately, this was not a problem of long-standing, as areas of concern were addressed and resolved as they arose in close coordination with the UN MAC. To be sure, at times strong opinions led to heated discussions, but the end result was always the same: greater clarity of the scope and intent of the standards, better understanding of the roles and missions between the demining coordinating and executing organizations, and increased safety for demining operations and local beneficiaries.

HOW HAVE DEMINING TECHNIQUES AND TECHNOLOGIES EVOLVED SINCE YOU FIRST STARTED IN THIS FIELD?

When I first came into the world of humanitarian demining in 1993 there were no international standards in existence (this wouldn't happen until 1997), and demining was basically conducted according to the standard operating procedures (SOPs) of the demining organizations contracted to do clearance work. These SOPs were based on the equipment they had on hand and the experience of the demining experts they had on staff. These demining experts were, for the most part, former military sappers or explosive ordnance (EO) demolition experts, although there were a few that had learned to deal with explosive threats in the maritime salvage field. The techniques employed in the early days were basically manual demining with some attempts to integrate dogs trained to detect mines, and WWII minefield breeching equipment (such as flails), adapted to humanitarian mine clearance work. Needless to say, the training and techniques varied between implementing partners, and the general rule of the day (before IMAS came onto the scene) seemed to be "do the best you can with what you've got;" sort of a variation of the Hippocratic Oath "Do no harm."

Now that we're twenty-seven years into the IMAS era and counting, things have changed significantly for the better. For example: (1) the IMAS have become the bedrock upon which humanitarian mine action (HMA) is based, which in turn has led to an overall greater accuracy of results, higher productivity, and the realization of economies of scale (i.e., "more bang for your demining buck"); (2) the mechanical assets available have greatly increased since the mine flail days, which has improved the options available to implementing partners to enable them to "work smarter, not harder" when tailoring their operations to meet local requirements; (3) bio-technology has been expanded in HMA from mine detection dogs (MDD) to include mine detection rats (MDR), which gives implementing partners greater operational tailoring choices similar to the mechanical equipment options; and (4) the recent advent of drone technology promises to be another great asset for survey and other HMA work in the future.

"Needless to say, the training and techniques varied between implementing partners, and the general rule of the day (before IMAS came onto the scene) seemed to be 'do the best you can with what you've got;' sort of a variation of the Hippocratic Oath 'Do no harm.'"

HAS THE DEFINITION OF RESIDUAL RISK CHANGED FOR HUMANITARIAN DEMINING OVER THE PAST FEW DECADES?

Absolutely! When I first came into the demining field the word "risk" was not in the deminer's vocabulary. Demining results expected were nothing less than 100 percent. Over time, in the face of the practicalities of the situation, the international HMA community came to realize that nowhere in life is there a 100 percent guarantee (except death and the payment of taxes), and that some degree of acceptance of risk had to be accepted by all concerned, including the beneficiaries of the demining operations. It was a hard but necessary pill to swallow.

WHAT DO YOU CONSIDER TO BE THE MOST SIGNIFICANT ACHIEVEMENTS OR CONTRIBUTIONS TO THE FIELD OF HMA OVER THE COURSE OF YOUR CAREER? WHAT HAVE BEEN THE MOST SIGNIFICANT DEVELOPMENTS?

I think the most significant achievement, or actually combination of significant achievements, that have contributed to the field of HMA during my thirty-one-year career has been the explosion of technological developments to make HMA safer, faster, and more cost-effective and efficient. From the first adaptations of WWII minefield breeching technology (tank-driven mine flails and armored bulldozers), there are now a variety of specialized mechanical and biological technological arrows in the mine action quiver. A few cases in point are: (1) for explosive vapor detection purposes, there are now two different animal species (dogs and rats) that with proper training and accreditation are now included under the IMAS-acceptable umbrella; (2) the sensitivity of metal detectors has been increased and now can be augmented by ground penetrating radar to identify underground EO by size and shape; and (3) there are now a wide variety of both single-purpose and multiple-purpose machines with attachments designed to detect or destroy explosive hazards and to prepare ground for further clearance measures. I think the evolving adaptation of drone technology to HMA is the next wave of the mine action future and will contribute as much to the safety and efficiency of operations as any of the other technological advancements mentioned.

CONVERSELY, WHAT ARE SOME OF THE MOST SIGNIFICANT CHALLENGES FACING HUMANITARIAN DEMINING EFFORTS TODAY?

I see two big challenges ahead: combatting donor funding fatigue and meeting the challenges posed by conducting HMA in a manner that is more attuned to environmental management and climate change considerations.

The donor funding fatigue challenge is not a new problem but an old, persistent, and expensive one. The stark and wearying facts donors must face are: (1) there are no quick fixes in HMA, as national EO contamination clearance programs typically take decades to complete; (2) there is not enough funding to take care of everybody's problems at once; and (3) there is no end in sight of armed conflicts creating new levels of EO contamination in the world before the "old" threats are eliminated, and this puts donors to HMA on a road that goes ever on.

Regarding the second challenge, the new emphasis on environmental management and climate change considerations will usher in a concomitant rise in the costs of HMA operations as current accepted practices such as open detonation/open burning operations and in situ destruction of EO are reduced and/or replaced by more costly but environmentally friendly practices. This will extend the time needed to complete HMA programs as well as elevate operational costs. The result will be increased costs and time to complete programs in exchange for more environmentally friendly land remediation measures.

It remains to be seen if donors will increase HMA funding to compensate for the increased costs of meeting environmental and climate change challenges and what effects their decisions will have on the overall achievement of programmatic goals and objectives.

"I see two big challenges ahead: combatting donor funding fatigue and meeting the challenges posed by conducting HMA in a manner that is more attuned to environmental management and climate change considerations."

AS MINE ACTION EVOLVED AND MATURED, WAS THERE ANYTHING THAT SURPRISED YOU, EITHER REGARDING THE SCOPE OF THE WORK CHANGING OR THE FIELD SHIFTING FOCUS TO ADDRESS DIFFERENT CHALLENGES?

I was quite surprised at how the initial focus on clearing minefields and the destruction of anti-personnel mine stockpiles quickly expanded to include the acquisition and destruction of excess firearms, advanced conventional weapons such as man-portable air-defense systems and anti-tank guided missiles, and large quantities of abandoned ordnance and unexploded ordnance from national authorities, other parties, and armed conflicts in an effort to take these implements of war out of circulation. Although these demilitarization efforts don't eliminate the illicit trafficking of weapons from one area of conflict to another, they do reduce the deadly products available, which in and of itself is a worthy contribution to local and regional peace and security.

"I was quite surprised at how the initial focus on clearing minefields and the destruction of anti-personnel mine stockpiles quickly expanded..."

The author in the HUMMWV in Kosovo.

CAN YOU SHARE A MEMORABLE EXPERIENCE OR STORY FROM YOUR TIME IN HMA THAT HAD A PROFOUND IMPACT ON YOU?

In July 1999, I went to Kosovo to serve as the in-country program manager of the Kosovo Emergency Demining Force, a large and capable demining group that was composed of personnel from Bosnia and Herzegovina and Croatia that we had trained and equipped in earlier years.

After we got on-ground and began operating, Marine Colonel Mark Adams, the Deputy Director of the State Department's Humanitarian Demining Programs Office (PM/HDP), came to Kosovo to check on our progress and to see if there was any further assistance that the Office could provide.

I had inherited a HUMMWV from excess military assets used by the peacekeeping force in Kosovo, and so I used that vehicle to drive the deputy director to the various demining sites, as it was a very robust vehicle, and the site visits involved considerable travel along mountain roads and some off-road travel to reach the demining sites.

We had completed our last visit of the day and were headed back to home base when suddenly there was a terrible screeching sound coming from the rear of the vehicle, which quickly turned into a wobbling of the entire vehicle. I got the wobbling under control and looked out my driver's side window just in time to see my left rear wheel go flying past and down a steep ravine to my left front. Since the vehicle was stable as long as I kept the speed at 30 mph, I was able to drive to a "controlled crash" close to the spot where the rear wheel had disappeared.

Colonel Adams and I immediately jumped out of the vehicle and went racing down the sides of the ravine to try to find the wheel, when all of a sudden, we stopped dead in our tracks and gave each other a look that said, "we're in deep trouble now, what do we do next?"

The problem was that the verges of the roads and the ravines on either side were suspected of being mined, and this section had not yet been checked for any possible EO contamination.

The end result was that Colonel Adams and I had committed a bad "rookie mistake" in jumping to solve a missing wheel problem without taking into account the mine threat factors which should have been foremost in our minds.

The end result was that we slowly retraced the steps we had taken to get to the point of our "explosive threat epiphany," and by slowly, I mean very slowly. Trying to retrace steps through undergrowth by looking for broken twigs, crushed leaves, and disturbed ground is not a fast process, and this is especially so when your life hangs in the balance.

It took us no more than two minutes to push our way down the side of the ravine to start our search. It took thirty minutes to retrace our steps to safety. And those were the longest thirty minutes of my life!

The views expressed in this interview are those of the author and do not necessarily reflect those of the US State Department, US Government, or the Center for International Stabilization and Recovery.

No Silver Bullet:
ENVIRONMENT AND CLIMATE FUNDING IN MINE ACTION

By Christelle Mestre [Geneva International Centre for Humanitarian Demining]

Funding requirements, needs, and models are evolving to reflect the growing focus on environment and climate considerations in the mine action sector. This article examines current funding practices for environmental considerations within the sector and beyond, emphasizing the need for a holistic approach that looks at the broader impact of mine action. It underscores the importance of strategic partnerships, national mine action strategies, and awareness-raising efforts among donors and investors about the environmental and climate-related benefits of mine action. The article argues that while there's no silver bullet, the integration of environmental and climate considerations into mine action can secure additional funding and contribute to global sustainability efforts.

The HALO Trust and its local partner Humanitarian Development Organization have re-planted mangroves destroyed during the civil war in cleared coastal minefields in Sri Lanka. *Courtesy of The HALO Trust.*

INTRODUCTION

The year 2024 marks a pivotal moment in mine action to reflect on environmental and climate funding. While the connections between mine action, the environment, and climate action have always existed, the urgency of the issue has intensified in the face of the triple planetary crisis humanity faces, namely climate change, air pollution, and biodiversity loss.[1] A recent study by the Geneva International Centre for Humanitarian Demining (GICHD) revealed that 60 percent of the twenty countries most vulnerable to climate change are also contaminated by explosive ordnance (EO).[2]

The topic of funding is particularly timely with the release of the second edition of International Mine Action Standards (IMAS) 07.13 on environmental management and climate change in mine action, and the upcoming adoption of a new action plan at the Fifth Review Conference of the *Anti-Personnel Mine Ban Convention* (APMBC), which should address these considerations. Additionally, government donors are increasingly incorporating environment and climate action requirements into their funding tenders.

Acknowledging that the topic of funding is vast and multifaceted, this article provides an initial overview on evolving needs, requirements, and funding models, highlighting experiences and lessons learned from a few select organizations. It emphasizes the need for all actors to converge and enhance the sector's effectiveness in mainstreaming environmental and climate action considerations. Recognizing the absence of a one-size-fits-all solution, this article underscores that progress will result from the collaborative and integrated efforts of all relevant stakeholders, starting now.

STATE OF PLAY

Environment refers to the *surroundings in which an organization operates, while climate action involves efforts to reduce or prevent greenhouse gas emissions and strengthen resilience and adaptive capacity to climate-induced impacts.*[3] In mine action, activities associated with environment and climate action vary widely and are often tailored to specific national contexts. They encompass diverse initiatives such as reducing greenhouse gas emissions from operations through sustainable capital equipment (e.g., solar panels), promoting circularity[4] (e.g., personal protective equipment or rubble recycling), restoring land or ecosystems post-clearance (e.g., mangrove planting), enabling sustainable agricultural or forestry practices (e.g., agroforestry), supporting conservation and eco-tourism in national parks, and more.

These activities frequently begin as side projects initiated by a mine action organization's country programs or headquarters. However, there is a growing trend toward the institutionalization of these efforts, evidenced by the development of organizational environmental strategies or policies and the establishment of dedicated staff positions focused on institutional and programmatic levels.

The second edition of IMAS 07.13 notes that "the most effective way of reducing the direct impact of mine action operations on land is through the application of land release principles."[5] The IMAS also introduces new requirements and clearly defined responsibilities for National Mine Action Authorities (NMAAs), mine action organizations, and donors. IMAS 07.13 is expected to have a profound impact on operations, if adopted through National Mine Action Standards (NMAS) and implemented diligently. Achieving broad stakeholder buy-in from NMAAs, mine action organizations, and donors will be crucial in translating these new requirements into actionable reality.

EVOLVING NEEDS AND REQUIREMENTS

There is a growing trend among government donors to request more information from grantees on efforts to mitigate and monitor greenhouse gas emissions.[6] Mine action donors are also increasingly inclined to support activities related to the environment or climate action, aligning with their own environmental and climate national commitments, as well as regulations on official development assistance.

States affected by EO contamination also have national commitments and regulations on environment and climate action, which all organizations shall comply with.[7] As the sector prepares for the Fifth Review Conference of the APMBC, many mine action stakeholders are calling for the integration of specific actions relating to environment and climate in the new action plan.[8] NMAAs will have an increasing responsibility to integrate environmental and climate action into all aspects of mine action programs.

These new requirements will likely increase funding needs in the sector. In the short term, organizations will need to establish new systems and acquire capital equipment, potentially raising both overhead and operational costs. This includes implementing environmental management systems and acquiring technologies for green organizations and operations (e.g., solar panels in camps or offices). While these investments may involve initial additional costs, they are expected to yield long-term savings and reduce greenhouse gas emissions. However, realizing these benefits depends on securing funding for equipment and systems that often outlast the duration of donor grants, highlighting the importance of sustained donor commitment.

The sector should enhance its capacities to manage and implement mine action activities effectively, as outlined in the revised IMAS. In the short term, this will entail improving environmental and climate literacy across the sector through capacity enhancement. It may also necessitate creating new staff roles such as environmental leads or focal points, which may incur additional costs. Furthermore, this will likely require forging new partnerships with relevant environment or climate action organizations, requiring active engagement, effective management, and initial costs. Despite these costs, such investments should yield returns over time.

In the medium to long term, in alignment with IMAS requirements, organizations should pay more attention to planning and tasking as well as post-clearance land use, ensuring that "the environment is left in a state that is similar to or, where possible, better than before the start of mine action operations."[9] As NMAAs adopt revised NMAS aligned with IMAS 07.13, there will be a growing need to clarify the long-term financial implications of fully mainstreaming environmental and climate change considerations into national mine action programs, including assessing potential delays in achieving clearance targets and effects on time-bound treaty obligations, including APMBC Article Five. An effective approach will be to include environmental and climate action into priority-setting systems, national mine action strategies, and costed work plans.

Finally, the costs of inaction can also be substantial, as land contaminated by EO is often left unused, missing opportunities for sustainable agriculture, environmental protection, or renewable energy infrastructure, such as solar power plants. This unused land results in communities losing out on both monetary benefits, such as agricultural production, and non-monetary benefits, like healthy ecosystems.

… the costs of inaction can also be substantial, as land contaminated by EO is often left unused, missing opportunities for sustainable agriculture, environmental protection, or renewable energy infrastructure …

The HALO Trust has partnered with the Centre for Middle Eastern Plants and local partner, Dryland Solutions, to conduct frankincense surveys in areas impacted by landmines in Somalia.
Courtesy of The HALO Trust.

MAPPING OF FUNDING MODELS

Recent analysis estimates a US$1.69 billion funding gap for seventeen States to meet their land release commitments. This figure would likely be significantly higher if extended to all EO-affected countries and territories.[10] Given this substantial funding shortfall and the increased focus on environment and climate action in mine action, critical questions arise: How will these aspects be funded in the future? Which funds are currently accessible for mine action stakeholders?

Bilateral government funding. The mine action sector relies heavily on government donor funding, predominantly from a small group of dedicated state donors. From 2011 to 2022, the top six donors consistently provided over 70 percent of the annual international funding for mine action. Since 2017, this group has remained unchanged: the United States, Germany, Japan, the United Kingdom, the European Union, and Norway. In parallel, nineteen countries and territories contributed funds to their own national mine action programs during this period, with Angola, Croatia, and Bosnia and Herzegovina being the top national donors in terms of cumulative contributions.[11] No data currently exists on international and national institutional funding for environment and climate action in mine action.[12]

Many government donors and EO-affected countries have national legislation and commitments under international treaties that are increasingly demanding, reflecting the high priority of environmental protection and addressing climate change for national governments. Many donor- and EO-affected States are parties to environment and climate change-related conventions, such as the *Convention on Biological Diversity* (CBD) or the *United National Framework Convention on Climate Change* (UNFCCC). Notably, 84 percent of UNFCCC state parties are parties to the APMBC.[13] The CBD Conference of the Parties (COP) 16 in Colombia and UNFCCC COP29 in Azerbaijan in late 2024 offer key opportunities to include mine action in broader environmental and climate change fora, particularly since both host countries are affected by EO contamination.

Additionally, many donor countries have endorsed national development policies requiring the integration of environment

The Minefields to Ricefields (M2R) initiative links landmine detection with agricultural development in Preah Vihear Province, one of the poorest provinces in Cambodia.
Courtesy of APOPO.

and climate action considerations, including the six primary donors to mine action.[14,15,16,17,18,19] Furthermore, twenty-eight humanitarian donors have committed to supporting the humanitarian system in preventing, preparing for, anticipating, and responding to climate and environmental risks and impacts, as outlined in the *Humanitarian aid donors' declaration on climate and environment*.[20] Countries such as Germany have gone a step further by incorporating environment and climate action into their mine action strategies.[21]

Donors' legal, political, and policy commitments are increasingly well-defined. However, several critical questions remain: How can these commitments effectively translate into actionable initiatives in mine action? Will traditional donors increase their funding to incorporate environmental and climate aspects, or will these donors maintain similar funding envelopes, potentially de-prioritizing other mine action activities in an already challenging funding environment? Can the links between mine action and environment and climate action help preserve or expand funding for mine action? Can international treaties and commitments be leveraged to increase mine action funding and support for environmental and climate action components? Can mine action organizations tap into funding from other ministries or state agencies, with the support of traditional donors, without creating additional administrative burdens? What mechanisms could be established within donor states to facilitate mine action stakeholders' access to official development assistance funds?

Given current funding shortfalls in mine action generally and increasing funding needs for environment and climate, government donors have a critical role to play. They could advocate for integrated funding, leveraging multi-sectoral partnerships, enhancing donor coordination, streamlining access to funds, and demonstrating environment and climate co-benefits of mine action within their governments, supported by relevant stakeholders.

Initiatives like Germany's International Climate Initiative (IKI), a cross-ministerial funding program coordinated by the Federal Ministry for Economic Affairs and Climate Action and implemented in close cooperation with the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and

Consumer Protection, as well as the Federal Foreign Office (under which mine action falls), could offer promising avenues to bridge some of these gaps.[22] Additionally, multi-donor trust funds provide opportunities for government donors to collaborate on shared interests, including on environmental protection and climate action.[23]

Foundations and dedicated funds. Beyond direct government funding, a variety of alternative funds could support environment and climate action efforts in mine action. These include corporate or private foundations, specialized funds (including donor trust funds) dedicated to environment, climate, or conservation efforts, the private sector, and international organizations. These entities derive funding from various sources including individual donations, corporate contributions, or government funding. Such funding can be global in reach or specific to certain regions and can target large programs or small projects.

There is currently no inventory of foundations and funds dedicated to environment and climate, which could benefit the mine action sector. However, specialized resources such as the Climate Funds Update provide comprehensive information on the climate finance architecture,[24] including the financial mechanisms and funds associated with the implementation of the CBD and UNFCCC.[25]

This broad diversity presents numerous opportunities but also requires careful navigation to identify the most suitable sources of funding for interested organizations. Moreover, the accreditation and bidding processes for some large, specialized funds can be resource-intensive, creating barriers for those without significant administrative capacity. Some foundations or funds also often require partnerships with specialized organizations.

International organizations or UN agencies like the United Nations Environment Programme (UNEP) may offer other alternatives by providing direct funding or offering in-kind contributions, such as expertise on environmental or climate-related subjects. Some international organizations may outsource specific aspects of their work and seek mine action partners for survey and clearance purposes.

Access to foundations and dedicated funds can often rely on partnerships with established and experienced organizations working in the fields of sustainability, environment, climate, or conservation. Some mine action organizations like The HALO Trust (HALO) have adopted this model, leveraging their partners' credibility and networks to secure funding. Collaborating with established entities not only enhances funding prospects but also brings additional expertise and resources to mine action projects.

The Minefields to Ricefields (M2R) project was launched in April 2023 and is engaging forty-six small-holder farmer families who have been negatively impacted by landmines. *Courtesy of APOPO.*

Innovative finance mechanisms can help fund mine action by showing investors the tangible and intangible value that safe and cleared land can provide.

Foundations such as The Nature Conservancy[26] (focusing on conservation) and programs like Innovation Norway[27] (with a broader scope) have provided critical funding to HALO and Norwegian People's Aid respectively in support of environment- and climate-related projects. These contributions have been invaluable in piloting new approaches and demonstrating the impact of projects to larger donors.

Innovative finance mechanisms. The potential for innovative finance in mine action is increasingly recognized. Innovative finance mechanisms can help fund mine action by showing investors the *tangible* and *intangible* value that safe and cleared land can provide.[28] Few instances of applying innovative finance models to mine action exist, with two examples presented here:

- The *outcome-based payments* (OBP) scheme has been used by the mine action organization APOPO in Cambodia. OBP is a funding model where payments are made based on the achievement of specific outcomes. In Cambodia, private investors provided upfront funding for initial implementation. APOPO's teams cleared landmines, while the agricultural nongovernmental organization (NGO) Cordaid trained farmers to grow and sell organic rice at a premium. The UK Development Investment Bond repaid the investors (plus interest) once the pre-approved outcomes were achieved, and the outcomes validated by a third-party verifier.
- The *payments for ecosystem services* (PES) scheme has been used by the Government of Croatia to fund mine action activities in Natura 2000 sites. PES involves *users* of ecosystem services making payments to the *providers* of these services.[29] Under Croatia's Forest Act, forest users pay a fee to use the forests, with 30 percent of the collected funds going toward demining activities in forests.[30]

Additional innovative funding models could be further explored:[31]

- *Sustainable bonds* are financial instruments issued to raise capital for projects that have positive environmental and social impacts, alongside financial returns. In mine action, sustainable bonds could fund large-scale mine action projects which include environmental or climate action aspects. Interested entities could issue sustainable bonds (loans), which are sold to investors focusing on Environmental, Social, and Governance criteria. These funds would support mine action projects with environmental and climate aspects. Income generated from the land after clearance (e.g., through placement of renewable energy or regenerative agriculture) could be used to repay the investors. Bond issuers also provide investors with detailed reports on the impacts of the bond-funded projects.
- *Carbon credits* are a market-based mechanism where outputs from climate change projects (reductions in greenhouse gas emissions, increases in carbon sequestration,[32] management of grazing land or renewable energy) can be sold as credits. In mine action, a reforestation project could be initiated on cleared land, where trees planted would sequester carbon dioxide (CO2). Once the pilot project has been verified by a certified party, the project could generate carbon credits (funds from carbon sold on the market) to fund further mine action and reforestation activity.

Establishing such innovative finance mechanisms requires significant institutional commitment and political will. The issue of scale is also crucial: models like OBP may suit smaller organizations, whereas bonds would likely better serve large organizations and programs. Additionally, some models, such as carbon credits, have yet to be trialed due to limited confidence and reputational risks for mine action organizations.

Innovative finance mechanisms, complementary to traditional funding approaches, have proven effective in various humanitarian aid and development assistance contexts.[33] While their implementation in mine action is still in its early stages, these models could help bridge the current funding gap in the mine action sector and address growing funding needs related to environmental and climate action.

Establishing such innovative finance mechanisms requires significant institutional commitment and political will.

KEY LESSONS IDENTIFIED

At the national level, a crucial step is for NMAAs to enhance coordination with environmental and climate change authorities and align mine action policies, strategies, standards, and procedures with national environmental and climate change frameworks. Another key step is for NMAAs to integrate environmental protection and climate resilience in priority-setting and tasking systems.[34] National mine action programs, with the lead of NMAAs, have a critical role to play in establishing the connection between mine action and the environment, actively engaging with actors outside of mine action, and making mine action information accessible to other sectors, as relevant to national contexts. Raising awareness among investors, foundations, and non-mine action institutional donors about the sector's broad impact will be crucial in making this happen.

While funding opportunities exist for integrating environment and climate action into mine action, they come with inherent challenges and limitations. One primary challenge is the need for the sector to adapt its mindset and view mine action through the lens of environmental and climate action. This requires adopting a more holistic approach to mine action, considering post-clearance land use and the wide-ranging co-benefits that mine action enables in terms of environmental conservation, climate adaptation, and climate resilience. This approach positions the sector as a precursor to broader environmental protection efforts.[35]

To attract new funding, the sector can leverage its extensive experience working in fragile or conflict contexts, which environmental or climate-related organizations might struggle to access. Mine action organizations have unique entry points in these difficult contexts, serving communities affected by EO. This privileged access and logistical setup, with organizations often equipped to reach very remote areas, provides opportunities for environmental or conservation NGOs to safely access areas or gain the trust of communities for environmental purposes. This collaboration can create synergies that benefit both mine action and environmental initiatives.

Partnerships present significant opportunities for attracting additional funding sources, both to finance mine action and to mainstream environmental considerations. While some organizations are beginning to invest in this area, the entire sector—including NMAAs and donors—needs to join forces to turn these opportunities into actionable reality for the benefit of communities affected by EO.

Testing and exploring alternative funding models can generate interest in the sector and influence new donors to support mine action. Changing mindsets is crucial—seeing mine action as an investment in climate resilience, whether by strengthening livelihoods, environmental protection, or sustainable infrastructure projects—and can shift the focus toward the impacts of mine action and drivers of sustainable growth.

Mine action is well-placed to participate in the transition to a more sustainable world. There is no silver bullet solution, but there are many opportunities, and the time to act is now. By integrating environmental and climate action considerations into mine action, the sector can not only secure additional funding but also contribute significantly to global sustainability efforts.

See endnotes page 60

The author would like to thank those who have contributed to this article by sharing experiences and lessons learned (in alphabetical order): Emily Chrystie (The HALO Trust), Linsey Cottrell (Conflict and Environment Observatory), Alex Frost (Mine Action Review), Laura Frühwald (Trafigura Foundation), Hesta Groenewald (PeaceNexus), Andreas Luis Hahn (Organization of American States), Camille Wallen (Symbio Impact Ltd), and Rob White (Norwegian People's Aid).

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INNOVATIVE FINANCE FOR MINE ACTION: Needs and Potential Solutions

By Danielle Payne [Geneva International Centre for Humanitarian Demining], Camille Wallen, and Chris Loughran [Symbio Impact Ltd]

Chronic underfunding has significantly impacted the mine action sector, undermining its stability and predictability. This funding shortfall hampers both the efficiency and effectiveness of operations. This trend is further compounded by the nature of today's operating environment in mine action; as new conflicts emerge while others are characterized by their protracted nature, the demands on the sector are multiplying. These conflicts not only prolong the threat of landmines but also introduce new hazards, such as the rising use of improvised explosive devices (IEDs) by non-state armed groups. With the nature of conflicts evolving, the variety of threats grows, necessitating a broader and more adaptive response. Yet, without a significant increase in funding, the sector will continue to struggle to keep pace with these challenges. The mine action community is therefore at a critical point; the sector risks falling irreparably behind unless a holistic commitment to substantial, sustainable support is undertaken.

The recent study "Innovative Finance for Mine Action: Needs and Potential Solutions" published by the Geneva International Centre for Humanitarian Demining (GICHD) assesses the current mine action funding landscape.[1] This analysis not only details the dire financial needs of the sector but also explores how innovative finance mechanisms, already proven successful in other relevant sectors, could be adapted and applied to mine action. The study provides more broadly an overview of potential solutions that could help to revitalize funding and enable more effective responses to the evolving challenges in mine action. The main findings of this study are outlined in this article.

INTRODUCTION

The need for long-term, predictable, stable funding streams has been and will continue to be a recurrent focus for mine action as well as for broader humanitarian aid and development assistance sectors. While the diverse stakeholders in the sector, from traditional donors to those working in mine action recognize the validity of and urgency to fulfill this need, current funding modalities are often limited in their capacity to provide long-term guarantees of support at the fully required funding levels; this is where innovative finance can play a role. Although around for several decades now and initially developed with the aim of accelerating the achievement of the Millennium Development Goals,[2] innovative finance remains nascent in the mine action sector. Innovative finance was referenced in Action 42 of the 2019 Oslo Action Plan, yet so far has seen just a handful of small-scale initiatives implemented in Lebanon and Cambodia.

The context in which the sector currently operates is, however, a game changer, creating the enabling environment needed to accelerate innovative finance for mine action. With new and protracted conflicts creating a greater funding need than ever before, funding to mine action is not keeping pace. The sector is faced with the reality that it needs to adapt the way it is funded. To this effect, this article seeks to provide an overview of the current funding landscape for mine action, a brief overview of innovative finance including concrete examples of two innovative finance mechanisms that could be pursued, and recommended next steps for the sector to urgently pursue.

MINE ACTION FUNDING TRENDS AND NEEDS

Regarding *funding allocations* for mine action, there was an all-time high in 2022 at over US$700 million; approximately 20 percent of this funding, however, was allocated for Ukraine alone, with other affected countries receiving funding that was collectively below the levels for 2017 and 2018.

Mine action funding represents a small portion of overall official development assistance (ODA), with annual international mine action funding representing just 0.4 percent of total ODA funding for the period 2011–2022.[3] Another notable trend is that mine action funding experiences higher volatility regarding its annual changes than ODA, and experiences particularly short-lived (one to two years maximum) peaks in funding.

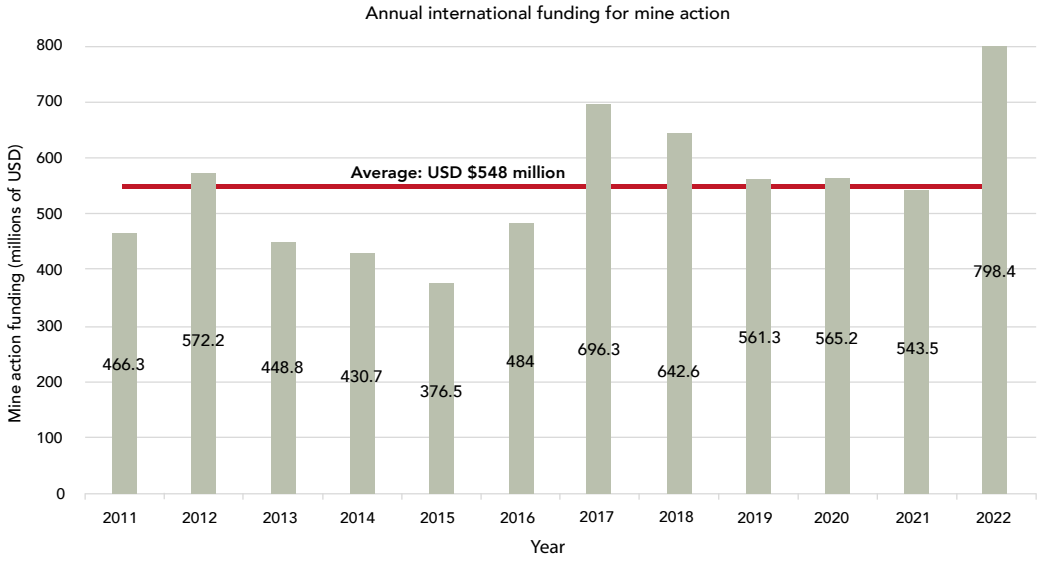

Figure 1. Annual international funding for mine action during the period 2011–2022 (data derived from ***Landmine and Cluster Munition Monitor*** reports).
Courtesy of the Geneva International Centre for Humanitarian Demining.

These short-term funding spikes, often influenced by new crises or significant developments in ongoing conflicts, have been witnessed in Somalia in 2012, Colombia and Iraq in 2017, and currently in Ukraine (see Figure 3). These spikes challenge the sector's sustainability and stability, as countries struggle to effectively absorb and utilize sudden increases in funds. Operations require time to scale up, which means that the intended impact of increased funding may not be achieved during operational adjustment periods. Conversely, abrupt funding cuts, experienced by both those countries from whom funding may have been diverted to respond to a new crisis as well as countries experiencing a new crisis where political interest has waned, force operations to scale down quickly, disrupting

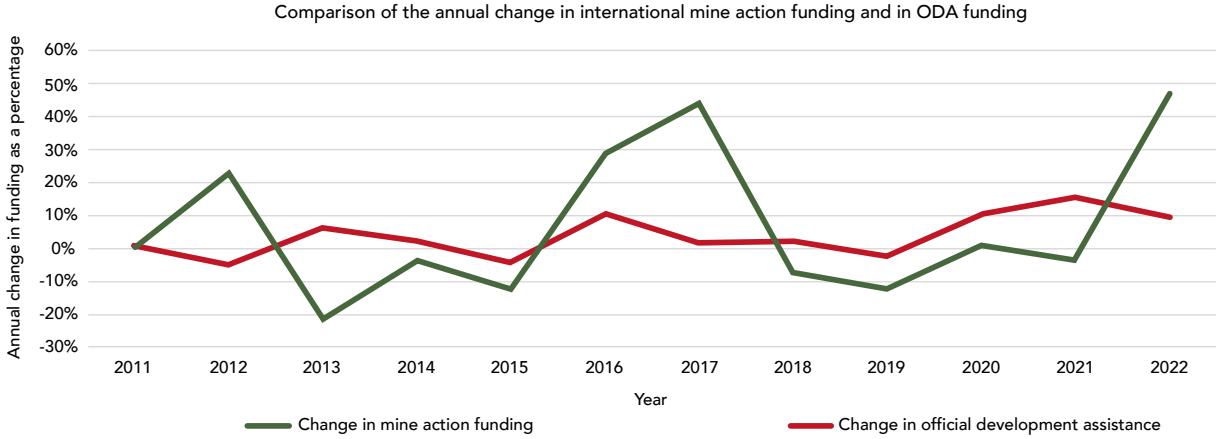

Figure 2. The annual change in international mine action funding (data derived from ***Landmine and Cluster Munition Monitor*** reports) compared with the annual change in official development assistance funding (data derived from OECD Statistics Platform) during the period 2011–2022.
Courtesy of the Geneva International Centre for Humanitarian Demining.

planned activities and reducing overall effectiveness.

In terms of *funding distribution*, while sixty countries and territories are reported to remain contaminated by landmines, between 2011 and 2022, more than 70 percent of the total funding recorded per year went to the top ten recipient countries and territories. Over the same period, each year, the top five recipients—including Iraq, Afghanistan, Lao PDR, Cambodia, and Colombia—received over 50 percent of the total funding.[4]

Regarding funding sources, the main donors to mine action are primarily governmental donors from high-income countries, including the United States, Germany, Japan, and the United Kingdom. While the donors interviewed in the study acknowledged that the current funding system was imperfect, they also explained the challenges they face, including the need to link mine action to a variety of drivers (such as development outcomes, humanitarian aid, or stabilization). This causes the mine action portfolio to fall under different governmental ministries depending on the specific donor country, which can further complicate coordination amongst donors. Other challenges noted were competing funding priorities, including geographical priorities and government procurement cycles, and budget cycles that can limit funding commitments to the short-term.

Figure 3. Annual international mine action funding for Iraq and Ukraine during the period 2011–2022 (data derived from ***Landmine and Cluster Munition Monitor*** reports). *Courtesy of the Geneva International Centre for Humanitarian Demining.*

Funding needs for mine action were assessed across seventeen mine-affected countries,[5] which were selected on the basis that these were the only countries having produced publicly available cost estimates for completing land release commitments under Article 5 of the *Anti-Personnel Mine Ban Convention* (APMBC). The combined reported cost to fulfill land release commitments for these seventeen countries totals US$1.69 billion. Comparing this estimated funding need with the average annual mine action funding from 2018 to 2022 for these same countries, there emerges an annual shortfall of US$115 million if these countries are to meet their land release commitments within five years.

Furthermore, funding received by these seventeen countries and territories accounted for only 40 percent of the total mine action funding during the same period, with the remaining 60 percent going to countries that had not reported their completion costs. This figure of US$115 million is useful in providing an initial indication of the funding gap based on funding needs communicated by affected countries and territories verses how much funding they are actually receiving. The actual funding gap for the sector as a whole is however undoubtedly much higher; this aforementioned funding gap estimate does not include several highly contaminated states like Afghanistan, Ukraine, and Yemen, which lack detailed cost assessments for completion and for which it is thereby impossible to currently calculate the funding gap.

WHY INNOVATIVE FINANCE?

The trends present in the mine action funding landscape demonstrate that while traditional donor funding streams are critical for the sector, they remain insufficient and need to be complemented by other funding sources if the sector hopes to keep pace with the multiplying demands it faces. In addition to addressing the reported funding gap alongside traditional funding mechanisms, innovative finance can create long-term stability and predictability for mine action. This can ultimately help mine action to plan for more efficient and effective interventions that are able to more meaningfully deliver the desired long-term impact.

While no one singular definition exists for innovative finance, the authors of this article have opted to define innovative finance for mine action as *initiatives that make use of financial mechanisms to channel public and private funds to help narrow the funding gap for mine action and complement existing funding arrangements in a way that fosters equity, sustainability, efficiency, and effectiveness.*

Innovative finance is not a synonym for financial innovation. Innovative finance makes use of a broad range of existing financial instruments and assets. The innovation arises from the application of existing financial instruments to new markets or

to involve new investors and mobilize sources of new funding that have not previously been directed to the identified development or humanitarian needs. There are a wide range of potential innovative finance mechanisms used in other sectors that could be applied to mine action, with examples of the main categories provided in Table 1.

The broader study on which this article is based detailed furthermore how two of the categories, as referenced previously, of innovative finance mechanisms that have been successful in other humanitarian aid and development assistance sectors could be applied to mine action: a front-loading mechanism and thematic bonds (a form of impact investing). The application of such mechanisms to mine action will notably require the design and implementation of clear governance structures. These should be developed using an inclusive, cross-sectoral approach, adhere to existing sector principles, and complement existing sector norms, standards, and guidelines.

MECHANISM 1: FRONT-LOADING

The front-loading mechanism allows for public funds to be available earlier than they would be through traditional funding mechanisms. It uses long-term, legally-binding government pledges to issue bonds on the capital markets, directing the proceeds to fund the targeted humanitarian or development issue at hand. The main example of front-loading is derived

Table 1. Key categories of innovative finance mechanisms.
Courtesy of the Geneva International Centre for Humanitarian Demining.

CATEGORY	DESCRIPTION	EXAMPLES
Public-private incentives, guarantees, and insurance	Mechanisms that use public funds to create investment incentives for private sector actors (e.g., by offering advance commitments or subsidies) and new insurance-type facilities to manage (e.g., natural hazard or weather risks).	Index-based insurance; catastrophic risk insurance facilities; State guarantees to repay investors in a development outcome
Front-loading mechanisms	Mechanisms that make public funds available for development earlier than would normally be the case, via the issuance of bonds that are repaid later through committed funding, thereby ensuring the greater availability of up-front funding and more predictability in terms of funding flows.	International Finance Facility for Immunisation (IFFIm)
Other debt-based mechanisms	Mechanisms that convert developing countries' foreign debt at a discount (reducing the cost of repaying the debt) by transferring the debt to another country, on the condition that the developing country contributes a proportion of the debt to the achievement of an agreed development outcome.	Debt swaps, for example Debt2Health (the Global Fund to Fight AIDS, Tuberculosis, and Malaria) and debt-for-education swaps
Results- and outcome-based finance	Mechanisms where funds are made available earlier to achieve a specific measurable outcome. Up-front funds are usually provided by private investors, who are repaid their initial investment, plus interest, by another ("outcome") financer/donor once the pre-agreed outcomes have been achieved and verified by a third party.	Development Impact Bonds (DIBs) *Note: DIBs are not bonds in the conventional sense, as they do not have many of the characteristics of a conventional bond and repayment is contingent upon achievement of specified outcomes.*
Solidarity taxes	Mechanisms that generate funds from new taxes and obligatory charges on expenditure at the point of sale that are subsequently allocated to international development activities and funds.	International airline taxes (used by several initiatives in the public-health sector, like the Global Fund and IFFIm)
Advanced market commitments	Mechanisms involving a binding contract offered by a government or financial entity used to provide financial incentives to manufacturers.	The Pneumococcal Advance Market Commitment and the COVAX Advance Market Commitment by Gavi, the Vaccine Alliance
Impact investing	Investments made to support the achievement of positive, measurable, social, and environmental impacts alongside a financial return, such as thematic bonds that offer investors both financial returns and quantifiable social and environmental outcomes.	Green bonds; social bonds
Market mechanisms	Mechanisms that create a market for trade in the output of an environmental development activity (such as the carbon dioxide sequestered, emissions reduced, or biodiversity protected) between those who wish to offset their negative impact and those who wish to deliver a positive or restorative impact. In greenhouse gas emissions and particulate trading, there is both mandatory and voluntary trading.	Carbon credits; biodiversity credits

from the International Finance Facility for Immunisation (IFFIm) approach for vaccines, as shown in Figure 4.

In terms of structure, the front-loading mechanism of IFFIm uses legally-binding, long-term pledges of funding from eleven donor governments, eight of which also currently fund mine action. The funds pledged by these donor governments originate from a variety of sources, some of which can be considered innovative finance mechanisms themselves. For example, the second largest donor to IFFIm, the Government of France, has committed to funding the mechanism in three installments via its Solidarity Fund for Development, which is financed by the tax imposed on air passenger transport between 2006 and 2021, on the model of a solidarity tax, and its Programme 110 budget program, which provides economic and financial development assistance originating from the French Treasury.[6]

IFFIm uses the World Bank as its treasury manager, which issues bonds based on these long-term binding commitments from donor governments. This means that the World Bank borrows from private investors and uses the donor governments' long-term binding pledges to repay the investors their initial investment (principal repayment), along with interest (coupon payment), once the bonds mature at the end of the pre-agreed investment period. The funds raised by the IFFIm bonds are disbursed to immunization programs implemented by Gavi, itself a public-private partnership that brings together a range of actors, including implementing countries, donor countries, UN-affiliated agencies, the World Bank, and private sector partners, and who is the sole recipient of the funds.

In terms of ***benefits***, the use of a front-loading mechanism would essentially enable quicker achievement of mine action goals by allowing donors to "act now and pay later," crucial for addressing the immediate threats to life and development posed by land contamination. This front-loading approach has accelerated impacts, as seen with IFFIm's role in vaccinating eighty million more children since 2006 compared to traditional funding methods.

Front-loading also promotes economies of scale and would enhance value for money in mine action. For instance, IFFIm's vaccine front-loading results in significant savings in healthcare and productivity losses for each dollar spent on immunization. IFFIm equally operates at a global scale necessary for mine action; IFFIm has secured US$9.5 billion in pledges from 2006 to 2023, issuing US$8.7 billion in bonds over the same period. The front-loaded fund disbursements are overseen through an inclusive governance structure that ensures accountability and transparency to both donors and affected states, while providing stable and predictable funding to be drawn down when it is most needed. If applied to mine action, this setup would benefit and empower mine-affected countries by giving them a significant role in fund allocation, enhancing national ownership efforts within the mine action sector.

Figure 4. International Finance Facility for Immunitisation operating structure and financial flows.
Courtesy of IFFIm Resource Guide 2023.

MECHANISM 2: THEMATIC BONDS

Thematic bonds can come in many different shapes and forms but are also a type of impact investing. This overarching category includes investments made to support the achievement of positive, measurable, social, and environmental impacts alongside financial returns. The establishment of peace bonds[7] in the peacebuilding sector constitutes one such practical example of thematic bonds, however no similar instrument exists for mine action today.

The authors of this article have envisaged the potential development of a mine action agriculture bond as a type of thematic bond that could correspond to the sector's particular needs.

In terms of ***structure***, this approach involves using bonds to fund land clearance activities that prepare the land for farming. The money invested in these bonds can be paid back through the financial gains from the agricultural activities that take place after the land is cleared. This approach also includes different participants: the mine-affected country, a commercial company, a Development Finance Institution (DFI), or a mix of these entities. They all play various roles in a combined structure that can also include safety nets, such as guarantees from a DFI or a government to reduce risks.

Given the diversity in types of land cleared, the funding from the bonds needs to be organized to support land of varying economic value. More profitable projects might support less profitable ones, which, while not financially lucrative, still reap diverse social benefits. It is furthermore critical to establish clear rules and criteria for the projects and those managing

them to make sure that the land clearance does not lead to negative outcomes like land theft, increased conflict, or the exclusion of certain groups.

Having a third party verify the results of the projects funded by the bonds is considered best practice. This ensures accountability and transparency for all parties involved. This verification should enhance and utilize the existing monitoring and evaluation efforts by national authorities responsible for mine action.

In terms of *benefits*, a mine action agriculture bond could strengthen and advance development outcomes. Such outcomes can be further enhanced when additional criteria are set for agriculture projects eligible to be covered under the bond (such as being engaged in sustainable, environmentally friendly agricultural practices). This mechanism can also reinforce national ownership, with the mine-affected country or territory at the center of the mechanism, and ultimately reduce reliance on ODA. Such a mechanism should also be tailored to the country's or territory's specific needs.

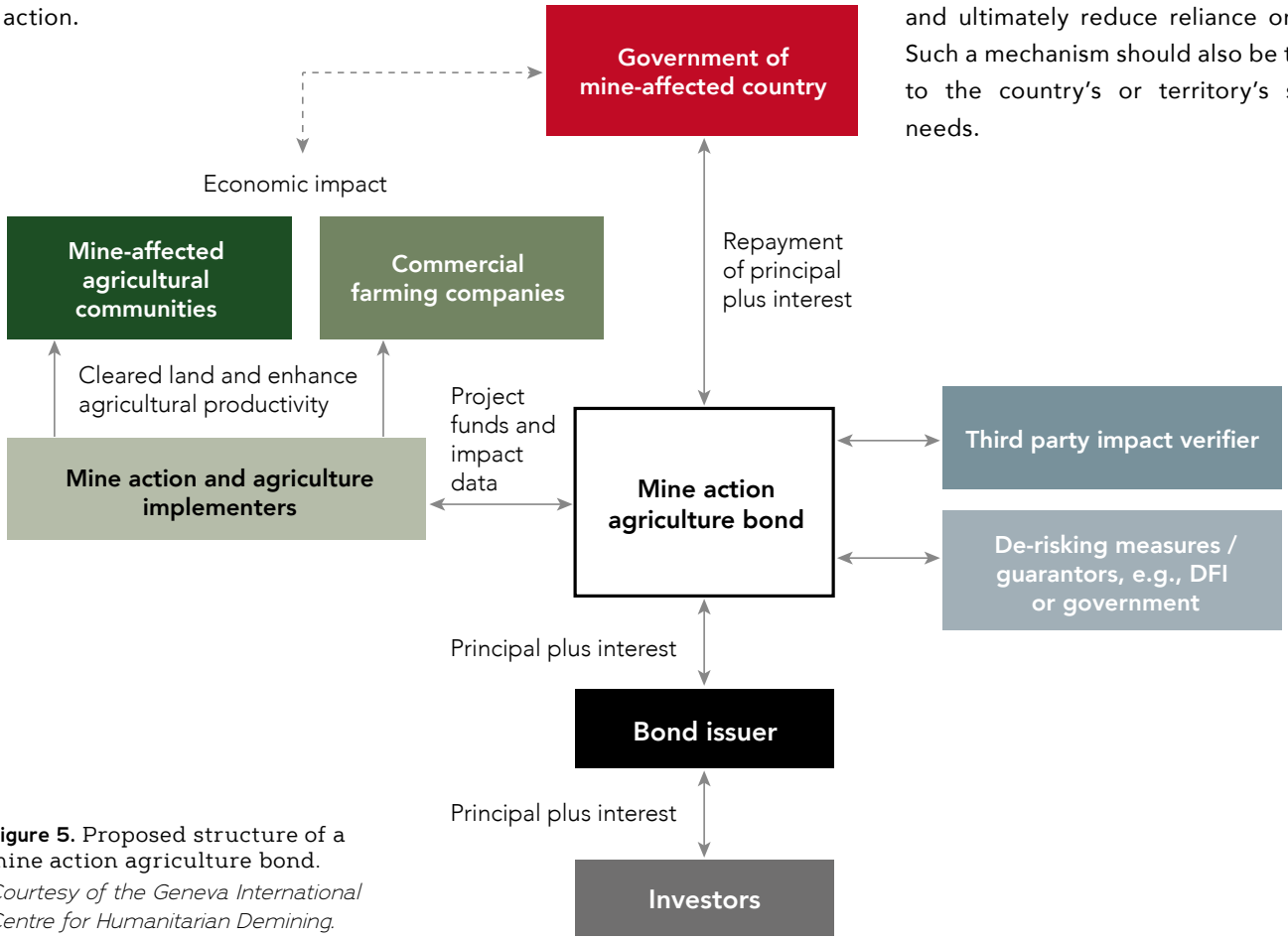

Figure 5. Proposed structure of a mine action agriculture bond.
Courtesy of the Geneva International Centre for Humanitarian Demining.

CONCLUSION

Overall, a range of innovative finance mechanisms that are complementary to traditional funding mechanisms have proved themselves effective when applied in other humanitarian aid and development assistance contexts. Such mechanisms can and should be explored for the mine action sector, particularly the front-loading mechanism, which operates at the scale needed to address the significant funding gap across the sector.

The political will to develop large-scale innovative financial mechanisms has also been identified as a critical requirement. The current context in Ukraine provides the mine action sector with a moment of opportunity; given that funding needs and political interest are so high, they could prompt the exponential increase in awareness of and appetite for the application of innovative finance mechanisms to mine action at the global level. The recent roundtable "Developing a Front-Loading Mechanism for Mine Action"[8] demonstrated interest from both mine action and external actors (including several of those who developed and launched the front-loading mechanism for IFFIm) to harness front-loading's potential for mine action.

While the sector's current focus on Ukraine may help feed the overall appetite, innovative finance solutions must continue to be sought for all interested affected countries and territories, the funding needs of which are equally important. The future of mine action needs innovative finance, and there is a critical role as well as dire need for collaboration across various sectors.

In terms of recommended next steps, the article's authors have anticipated three main areas of effort:

1. **Develop an enabling framework to drive innovative finance for mine action:** This includes ensuring all relevant mine action stakeholders, including for example national mine action authorities, operators, and donors, are informed about innovative finance solutions and are engaged in complementary efforts to help collectively drive this work forward. This would include, for example, having more comprehensive, reliable data from affected countries and territories on funding needs; advocating for more consistency in donor reporting (including from private and philanthropic donors) on annual funding for mine action; and mainstreaming guidance on innovative finance in relevant on-going capacity enhancement efforts in the sector.
2. **Develop agreed principles and guidelines for the governance and implementation of innovative finance within the mine action sector:** Prioritizing transparency, inclusiveness, and accountability is paramount for this endeavor. This should furthermore make use of existing good practice and relevant guidance from diverse sectors, including for example guidelines for environmental, social, and governance investment, humanitarian principles, and the International Mine Action Standards.
3. **Systematically and transparently engage with the private sector and international finance institutions (IFIs):** Collaboration with the private sector and IFIs are essential for the successful development and implementation of innovative finance mechanisms. Extensive outreach and exchange, including making the effort to "speak the language" of the private sector, is crucial for all stakeholders within mine action.

The authors would like to conclude this article with a call for action to the mine action sector as a whole—join us in this effort to advance innovative finance for mine action and ultimately develop impactful solutions from which we all, and particularly all those that we serve, will be able to benefit.

To access the full study, "Innovative Finance for Mine Action: Needs and Potential Solutions," please visit https://bit.ly/4cadp0w.

See endnotes page 61

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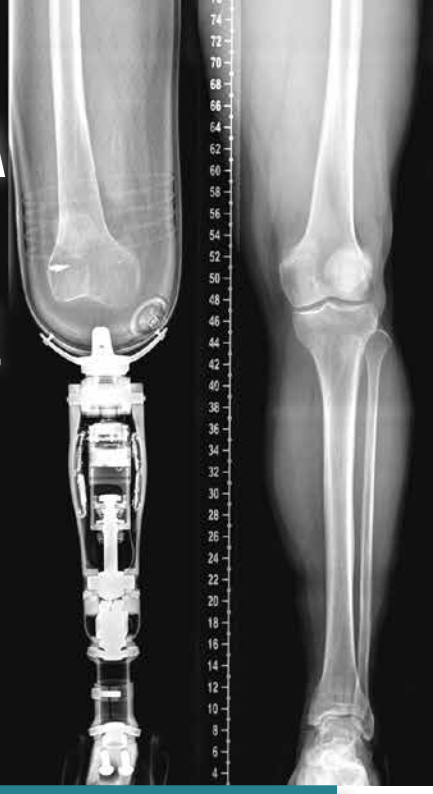
THE EXPLOSIVE WEAPONS TRAUMA CARE COLLECTIVE (EXTRACCT): A ROADMAP FOR REDUCING PREVENTABLE DEATH AMONG CIVILIAN CASUALTIES OF EXPLOSIVE INJURY

By Hannah Wild[1,2], Aparna Cheran[2], Abby Willging[2,3], Christelle Loupforest[4], Sebastian Kasack[5], Tim Gargan[6], Barclay Stewart[1], International Blast Injury Research Network[7], and Adam L. Kushner[2,8]



Transarticular amputation through the knee joint with prosthetic leg. *Case courtesy of Frank Gaillard, Radiopaedia.org, rID: 32534.*

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INTRODUCTION

In a previous issue of *The Journal of Conventional Weapons Destruction*, we introduced the rationale underpinning the need for increased emphasis on point-of-injury care as well as enhanced engagement between humanitarian mine action (HMA) and emergency care services for civilian casualties of explosive ordnance (EO).[1] The initial working group under which this conceptual foundation was developed was called the Mine Action Trauma Care Collaborative. In the intervening months, that initiative was reconceived as the Explosive Weapons Trauma Care Collective (EXTRACCT) to encompass the broad range of EO and explosive weapons (EW) that inflict harm on civilians in conflict and post-conflict settings.[2,3] In this article, we present an overview of EXTRACCT's approach to reducing preventable death and disability among civilian victims of EO/EW with a focus on low-resource settings (LRS).

PREVENTABLE DEATH AMONG CIVILIAN CASUALTIES OF EXPLOSIVE INJURY

Unfortunately, there is no global or multi-site trauma registry for civilian casualties in conflict settings that can be queried to obtain accurate insight into the precise causes and quantitative burden of preventable death.[4] However, estimates from the limited available data demonstrate that an unacceptable proportion of civilian EO/EW casualties are dying of preventable causes (e.g., lack of timely hemorrhage control, loss of airway, under-resuscitation, sepsis). The 2023 *Landmine and Cluster Munition Monitor* reported an approximately 35 percent case fatality rate (CFR) among civilian EO casualties.[5] A separate epidemiologic analysis of global civilian EO casualties pooling a wide range of independent data sources found a nearly 40 percent CFR.[6] In contrast, even severely blast-injured patients in high-resource civilian trauma centers and military treatment facilities have significantly lower mortality rates ranging from 2 percent to 8 percent.[7,8,9,10] A significant proportion of deaths among civilian EO casualties can therefore be assumed to occur due to causes that could be prevented through improvements in trauma care systems.

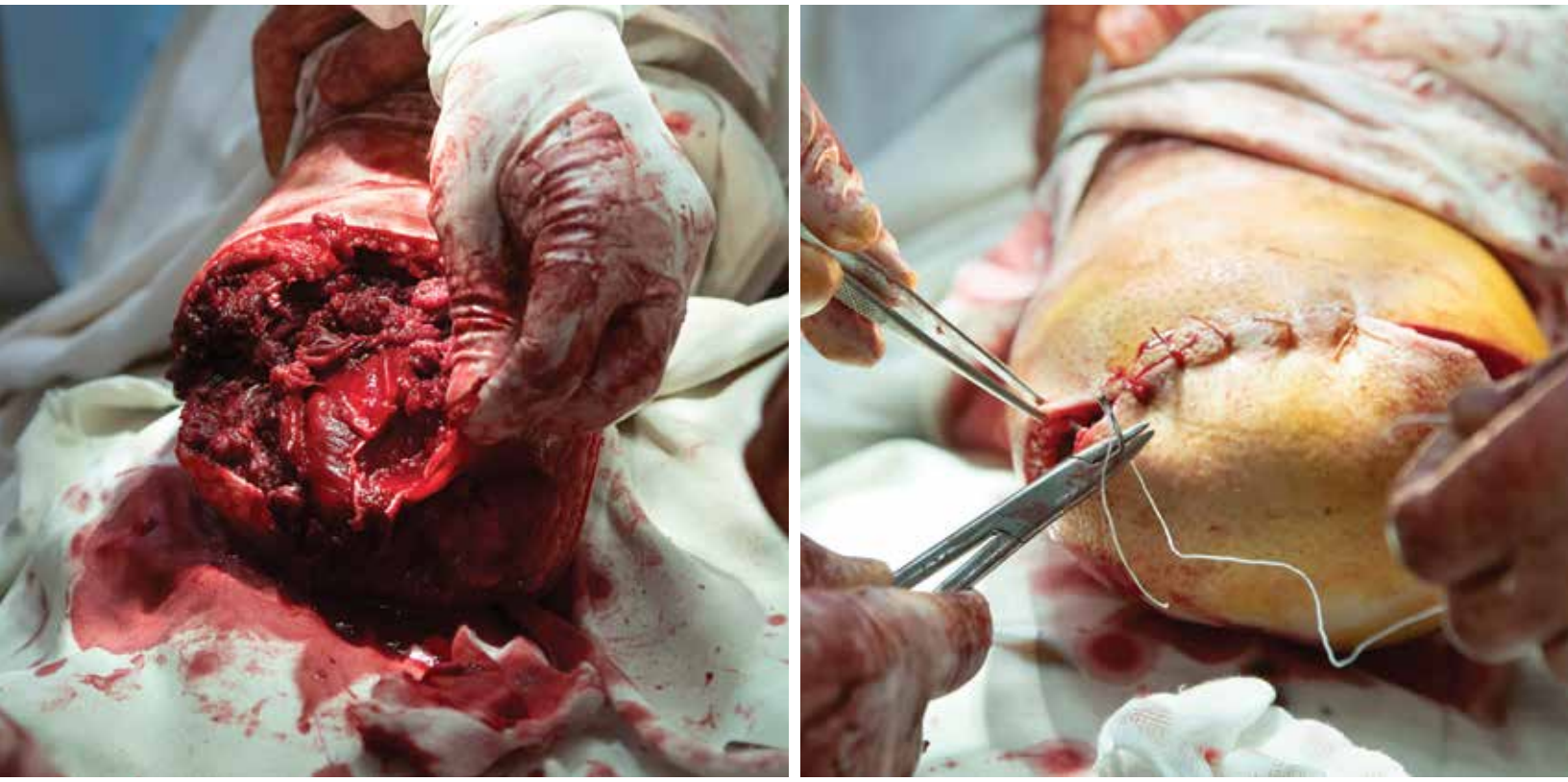
As the resource constraints in EO/EW-affected conflict and post-conflict settings are vastly different than those

that exist within high-resource civilian trauma centers and military treatment facilities, an equivalent reduction in preventable death is unlikely to be feasible. However, previous work has demonstrated that even in resource-constrained civilian settings, preventable death from explosive injury can be dramatically reduced. Specifically, the Tromsø Mine Victim Center trained layperson first responders (LFR) and prehospital personnel (e.g., paramedics, ambulance providers) in landmine-contaminated regions of Iraq and Cambodia, achieving a reduction in EO/EW-related mortality from 40 percent to 15 percent.[11] To increase survival among affected populations, renewed attention must be devoted to improving emergency care systems close to the point of injury.

To increase survival among affected populations, renewed attention must be devoted to improving emergency care systems close to the point of injury.

APPROACHES TO REDUCING PREVENTABLE DEATH IN A MILITARY ENVIRONMENT

Over the course of the wars in Iraq and Afghanistan, a series of trauma care advances were implemented that compositely reduced combat casualty mortality by 44 percent.[12,13] Many of these interventions were predicated on a well-resourced military trauma system with aeromedical evacuation capabilities and intact echelons of damage control and definitive surgical care that are not currently available in most low-resource civilian environments. Nonetheless, certain elements of the overall approach to eliminating preventable death can be translated to the context of civilian EO/EW casualties. EXTRACCT's approach is informed by the development of the mature Joint Trauma System (JTS) while on a pragmatic and operational level considering the substantial adaptations that must be made in low-resource civilian environments.[14] Key differences include: a) numerous stakeholders across sectors engaged in health, protection, and local communities; b) lack of comprehensive casualty data available to identify areas for targeted intervention as well as to benchmark facility-based or system-wide quality improvement initiatives; and c) a broad range of resource constraints.



(Left) Intraoperative photographs of lower extremity amputation and (Right) surgical closure of residual limb. *Courtesy of Adobestock.*

CLINICAL PERFORMANCE IMPROVEMENT

Clinical Process Guidelines (CPGs) are a pillar of the JTS and provide guidance to clinicians providing emergency and trauma care in the deployed environment. CPGs serve numerous functions including: a) standardization of care and contextual alignment to evidence-based medicine; b) improvement in clinical performance; and c) benchmarking of intervention impact. Care of civilian casualties in EO/EW affected settings frequently occurs in environments with limited resource availability (e.g., equipment/materials, subspecialist expertise, critical care capabilities, organized modes of patient transport) and lack of options for evacuation to higher echelons of care. Therefore, the JTS CPGs are not directly applicable but serve as a positive example for strengthening health systems if adapted to local contexts and resource availability.

EXTRACCT is developing a library of CPGs relevant to the care of civilian victims of blast injury adapted to the available material and human resources common in LRS. These guidelines are being developed with an expert review panel and contain background literature synthesis, guidance on patient assessment and treatment, and links to open-access instructional materials on relevant procedures. The intended target audience includes surgeons, medical doctors, clinical officers, and prehospital personnel working in LRS affected by EO/EW who may be required to care for blast injuries outside of their clinical comfort zone. Given the broad variance in resource availability between settings affected by EO/EW, EXTRACCT CPGs will be formatted with matrices providing tiered guidance on various aspects of management stratified based on available infrastructure and human/material resources.

The core EXTRACCT CPG topics are derived from the JTS CPGs that hold relevance to the management of blast injury in LRS, such as mangled extremity (e.g., compartment syndrome, crush syndrome, extremity fracture, traumatic amputation), thermal injury/burns associated with blast mechanisms, and specific complications (e.g., blast traumatic brain injury, blast lung). EXTRACCT welcomes proposals for new CPG topics from engaged stakeholders, particularly medical personnel providing care to EO/EW victims in LRS. Further details about the full list of planned CPGs, how to submit topic requests, and EXTRACCT's process guidelines are available through the International Blast Injury Research Network (IBRN).[15]

SURGICAL CONSULTANTS

Military trauma systems use teleconsultation as a means of providing remote support to medical providers confronted with the management of complex injuries in deployed environments where subspecialty expertise may be unavailable.[16] In civilian settings, teleconsultation has been used for a range of purposes to address gaps in access to subspecialty care even across large geographic regions.[17,18] Relatively little attention has been given, however, to the special considerations around implementation of teleconsultation in LRS affected by conflict.[19] In numerous contemporary conflicts such as those in Gaza, Ukraine, Myanmar, and Syria, informal grassroots communication networks have arisen to provide remote support to local healthcare personnel.[20] The need that such networks address is clear, as healthcare personnel with a wide range of training and capabilities face an overwhelming volume of complex casualties. However, the telecommunications platforms used, inconsistent security provisions, and lack of centralized security vetting protocols associated with such informal networks incur a potential risk in conflict settings. WhatsApp is an international messaging platform that is now being used in the setting of teleconsultation networks for care of the war-wounded.[21,22] Unfortunately, numerous security vulnerabilities exist surrounding the use of this platform including monitoring of metadata, routine shutdowns in insecure environments, and more recently, reported surveillance to identify militants and target strikes based on activity patterns.[23,24]

Relatively little attention has been given, however, to the special considerations around implementation of teleconsultation in LRS affected by conflict.

Surgical teleconsultation holds potential to increase access to higher-quality trauma care in LRS affected by EO/EW, yet teleconsultation in insecure environments is associated with a different set of ethical challenges than in LRS generally. The security of all involved parties including patients, local healthcare personnel, and remote consultants must be ensured. To address this gap and establish protocols for quality

assurance, EXTRACCT will collaborate with informatics experts to conduct a pilot of high-quality, secure surgical teleconsultation in EO/EW-affected LRS.

Three priority areas for quality improvement have been identified. First, identification of an optimal communication platform should be conducted via assessment of strength and vulnerability profiles of existing technologies, understanding the need to balance the competing requirements of adequate security protections with low bandwidth needs. If unable to identify an existing option that satisfactorily meets both, collaboration with informatics stakeholders will be pursued to develop alternatives. Second, clear processes for consultant vetting and member entry, including strict evaluation of consultant credentials, terms of reference for engagement, and standardized consultation format for providers in the field are required. Third, activities conducted through surgical teleconsultation should be leveraged to provide a dataset on civilian EO/EW victims, associated resource utilization and care processes, and outcomes. These data would contain more granularity regarding injury patterns, procedures rendered, and associated morbidity/mortality than is currently available from existing casualty data collected via the Information Management System for Mine Action (IMSMA) applying IMAS 05.10.[25,26] A pilot surgical teleconsultant network will be developed after identifying partner institutions in EO/EW-affected LRS to promote longitudinal capacity-building as opposed to one-off consultations.

OPERATIONS

EXTRACCT's operational activities are organized within the structure of the Civilian Casualty Care Chain (C-CCC), previously presented in this Journal (Figure 1).[27] The C-CCC identifies a set of activities from point-of-injury to emergency care at a health facility in which HMA stakeholders can feasibly engage to improve trauma care for EO/EW casualties. Three elements of the C-CCC have been selected for initial pilots and programmatic development:

LFR training. Improving care close to the point-of-injury is a key opportunity to reduce preventable death. In many LRS where EO/EW incidents occur, organized prehospital and emergency medical services are limited. Layperson bystanders without formal medical training are often the first responders to casualties in their communities. Numerous LFR trainings have arisen to address the burden of non-violent trauma in LRS.[28,29] Fewer LFR trainings have been deployed in EO/EW-affected conflict or post-conflict settings, with the Tromsø Mine Victim Center's Village University being a notable exception. A core component of the 2023 World Health Assembly adoption of the World Health Organization (WHO) Resolution on Integrated Emergency, Critical, and Operative Care (WHA 76.2) was an increased emphasis on LFR trainings.[30] This has taken the form of the WHO's Community First Aid Responder (CFAR) training. EXTRACCT will be conducting a pilot of joint delivery of a conflict-adapted version of the WHO CFAR curriculum with explosive ordnance risk education (EORE) among communities affected by improvised explosive device threats in Burkina Faso. This pilot (2024–2026) is conducted in collaboration with Mines Advisory Group and local partners, NGO Pull for Progress, and the Department of Public Health at the University of Joseph Ki-Zerbo, Ouagadougou. Results of this pilot may inform efforts to scale combined EORE with LFR trainings as an enhanced form of building community resilience to the threat of explosive violence and increasing survival among EO/EW casualties in LRS.

Trauma care capacity assessment and prehospital notification pathways. A series of key informant interviews with sector experts was undertaken by EXTRACCT to inform the development of the C-CCC.[31] Thematic analysis of these interviews identified an opportunity to improve standardization of trauma care capacity evaluations. Specifically, in the current state, most mine action operators reported conducting independent evaluations of health facilities in countries where they are operational. These assessments are conducted in a non-standardized manner and without formal integration either with local health authorities or with other HMA stakeholders. In 2014, the International Assessment of Capacity for Trauma (INTACT) was developed as an index for trauma care capacity assessment in LRS.[32] EXTRACCT is collaborating with the creators of INTACT to revise this tool for use by HMA stakeholders as INTACT-Blast Injury (BI). We will subsequently collaborate with HMA partners to pilot this approach to trauma care capacity assessment in an EO/EW-affected setting. Such standardization holds potential to improve the quality of evaluation, decrease redundancy and resource utilization in duplicative evaluation processes, and increase engagement with local and multilateral health stakeholders (e.g., local healthcare personnel, ministries of health, WHO). Once an in-country

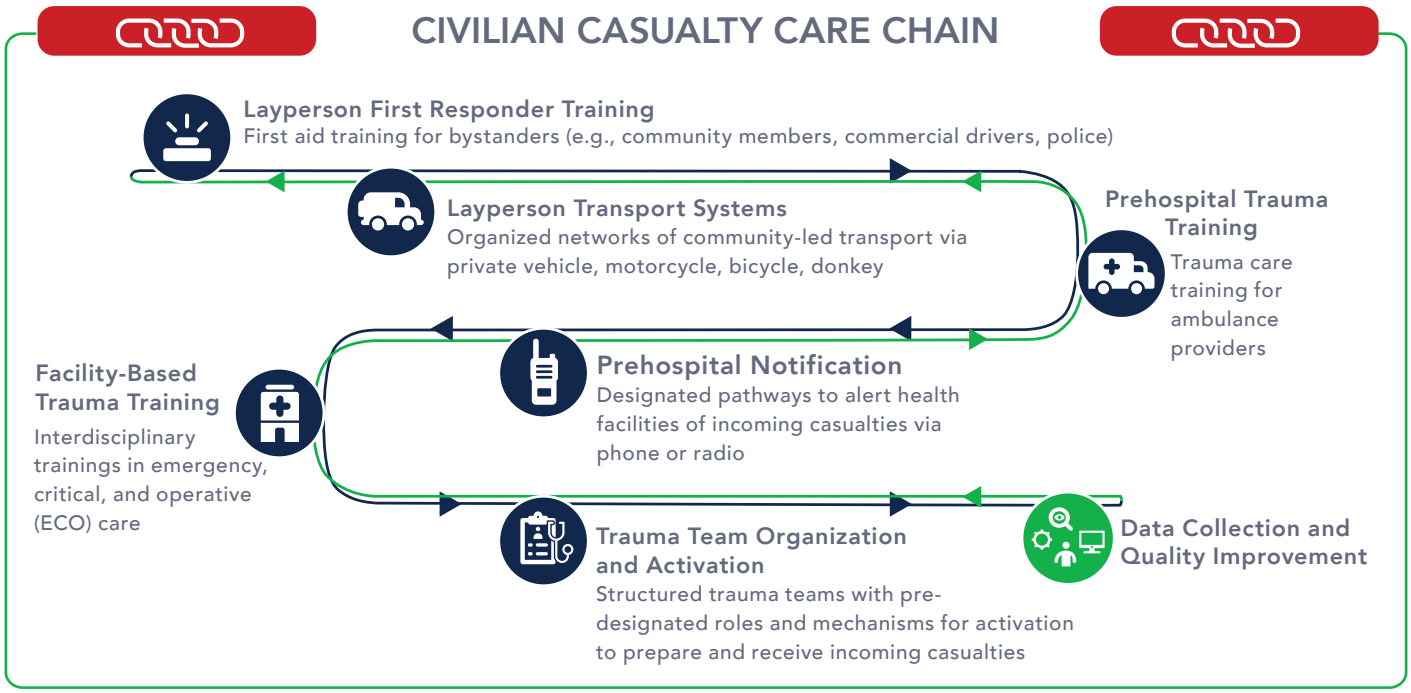


Figure 1. Visual outline of the Civilian Casualty Care Chain, which highlights selected interventions in the continuum of trauma care that can be supported by humanitarian mine action stakeholders.
Courtesy of EXTRACCT with acknowledgment to Mel Peppas.

trauma care capacity evaluations utilizing INTACT-BI has been completed, this information can be used to generate resources such as referral and casualty routing pathways as well as the development of a prehospital notification system (i.e., a standardized communication mechanism by which receiving facilities are notified of incoming casualties). In high-resource settings, prehospital notification systems have been associated with significant reduction in trauma-related mortality.[33] Implementation of similar systems in EO/EW-affected LRS can improve facility preparedness to manage blast-injured patients, and can be conducted with a range of communications strategies including mobile phones and radio.[34]

Blast trauma clinical training curriculum. In response to a need from health personnel providing trauma care during conflict in Myanmar, a collaborative virtual trauma education curriculum, the Global Trauma Collaboration (GTC), was developed by Baylor College of Medicine Center for Global Surgery.[35] The GTC covers a wide range of topics related to conflict-related trauma (e.g., damage control resuscitation, vascular trauma, chemical weapons, and post-traumatic stress disorder). EXTRACCT and the Pediatric Blast Injury Partnership (PBIP) will collaborate with the GTC to develop a focused set of blast injury modules to expand the core trauma didactics.[36] Like EXTRACCT's CPGs, these modules will be linked to open-access training materials on relevant procedures (e.g., external fixator application for management of extremity trauma; escharotomy for burns).

RESEARCH WITH OPERATIONAL RELEVANCE

EXTRACCT maintains a broad research portfolio around topics on injury prevention and trauma care for civilian EO/EW casualties with clear operational relevance. Requests for topics of inquiry that have come from humanitarian practitioners based on needs identified in the field or policy gaps are also prioritized. Current EXTRACCT projects are not reviewed exhaustively here, but selected representative examples follow:

Incendiary weapons (IW). IW have been selected as a priority area of research due to a) the disproportionate suffering inflicted through concomitant blast and thermal injuries associated with this weapon type as well as b) the clear policy relevance related to gaps in Protocol III of the *Convention on Certain Conventional Weapons* that limit its capacity to protect civilians from harm from incendiary weapons.[37,38] Current work in this area is conducted under EXTRACCT's role as Chair of the Incendiary Weapons Sub-Committee of the EORE Advisory Group Emergency Risk Education Task Teams.[39]

Sheltering guidance for civilians during explosive threats. In response to a request from HMA stakeholders, EXTRACCT is addressing an evidence gap surrounding guidance provided to civilians exposed to explosive threats, particularly the use of explosive weapons in populated areas. In the current state, recommendations being provided to civilians in this context are neither a) standardized across organizations nor b) based on empiric data. EXTRACCT is conducting a systematic review of the literature around sheltering guidance during explosive events in conflict as well as qualitative analysis of key informant interviews with sector experts to provide a current understanding of existing recommendations and the manner in which they were derived. These studies will provide the evidence base to conduct future multidisciplinary work combining blast engineering with public health and clinical trauma care to generate empirically based injury prevention strategies for civilians exposed to risk of explosive injury in conflict.

EXTRACCT's ongoing research encompasses many additional domains including: a) blast injury epidemiology (specifically, generating estimates of the global burden of blast injury by injury pattern [e.g., traumatic brain injury, orthopedics, burns, genitourinary] as well as pilot quantification of preventable death among civilian EO/EW casualties); b) management of embedded ordnance; c) post-exposure prophylaxis for infectious disease following blast injury in a range of endemic settings; d) best practice guidance on evaluation strategies in trauma care training courses in LRS; d) review of low-cost surgical simulation models to assess gaps for innovation; e) appropriate adaptation of guidance on tourniquet application in LRS; and f) the intersection of mine action and food security with implications for caloric requirements associated with complex polytrauma.

CONCLUSION

System-wide efforts to improve trauma care in low-resource settings affected by EO/EW face significant challenges in comparison to high-resource civilian and military trauma systems. Such challenges include the lack of a shared trauma registry to provide comprehensive casualty data, significant constraints in human and material resources, and limited organized prehospital transport. Despite these constraints, many steps can and must be taken to improve trauma care and increase survivability for civilian casualties of EO/EW. EXTRACCT is engaging a broad range of partners in humanitarian health and protection in a coordinated approach to meet this need through activities spanning clinical performance improvement, research, operations, and evidence-based advocacy.

See endnotes page 61

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Hannah Wild, MD, is a General Surgery Resident at the University of Washington focused on improving humanitarian surgical care for civilian casualties in conflict settings, particularly victims of explosive injury. She received her undergraduate degree from Harvard University and MD from Stanford University. In collaboration with the International Blast Injury Research Network (IBRN) and United Nations Mine Action Service (UNMAS), she leads the Explosive Weapons Trauma Care Collective (EXTRACCT), an effort to strengthen coordination between the mine action sector and trauma care for casualties of explosive weapons.

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Explosive Weapons Trauma Care Collective

Aparna Cheran is the Program Coordinator for EXTRACCT. In this role, she facilitates research initiatives aimed at mitigating the devastating effects of explosive weaponry and the consequences of conflict. She is a recent graduate of George Mason University's Master's of Health Administration program and a former student at Virginia Polytechnic Institute and State University, where she earned two bachelor's degrees in Microbiology and Religion & Culture.

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Abby Willging is a fourth year medical student at the University of Iowa Carver College of Medicine. She graduated with high distinction from the University of Iowa in 2021. A recipient of the Gold Foundation's Summer Research Fellowship, she has completed global rotations in Riobamba, Ecuador, and Moshi, Tanzania. She joined the EXTRACCT team in early 2024 and is honored to take part in such impactful and humanistic work. Her contributions focus on developing Layperson First Responder curriculum and secure surgical tele-consultation within low-resource conflict zones.

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Christelle Loupforest is the Officer-in-Charge of the UNMAS Office in Geneva. In her twenty-five years of service with the United Nations, she served in the Department of Peace Operations, the Office for the Coordination of Humanitarian Affairs, the United Nations/Organization of American States Human Rights Mission in Haiti, and at the World Health Organization. She holds a Master of Political Science and speaks English, French, and Spanish.

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Sebastian Kasack holds a master's degree in geography and has been involved in mine action since 1996, working for international nongovernmental organizations, UNMAS, United Nations Childrens Fund (UNICEF), and United Nations Development Programme. In 2016, he joined Mines Advisory Group as a Senior Technical Advisor. On victim assistance, he authored the UNICEF publication, "Assistance to Victims of Landmines and Explosive Remnants of War Guidance on child-focused victim assistance."

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Tim Gargan is the Head of Medical for The HALO Trust (HALO) and has worked in humanitarian mine action (HMA) since 2013. He is also a UK registered Paramedic with several years of experience in the UK National Health Service and now works for HALO coordinating and managing medical matters across all their programs globally.

BARCLAY STEWART, MD, PhD
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Barclay Stewart, MD, PhD, is a trauma and burn surgeon at the University of Washington. His research foci include global injury prevention/control, developing models of care for the injured feasible in low-resource settings, and benchmarking quality of care using long-term patient-reported outcomes.

The International Blast Injury Research Network (IBRN) is a trans-disciplinary network launched by the University of Southampton after identifying that leading blast research was primarily focused on military rather than civilian situations and perspectives. Addressing this gap, the multidisciplinary IBRN team was founded to improve research within the civilian context and at a holistic level. The IBRN fosters collaboration among a range of stakeholders including academics, clinicians, and humanitarian organizations to facilitate a broad portfolio of multidisciplinary research into the humanitarian consequences of blast injury.

ADAM L. KUSHNER, MD, MPH, FACS
President
A.L. Kushner & Associates

Adam L. Kushner, MD, MPH, FACS, has worked as a surgeon, educator, and researcher in dozens of countries. He was a founder of Surgeons OverSeas and a subject matter expert on human rights, humanitarian assistance, and disaster relief for the US military. He completed his general surgery residency at the University of Texas Health Science Center-San Antonio; MD at the Mount Sinai School of Medicine; MPH at Johns Hopkins School of Public Health; and BA in History and International Relations at Cornell University. He currently resides in Anchorage, Alaska, where he spends his summers fishing for salmon.

Advancements in Mine Action: ENHANCING REMOTE REPORTING AND ANALYSIS THROUGH INNOVATIVE TECHNOLOGIES

By Rory Collins [United Nations Office for Project Services],
Lionel Fragniere [Swiss Armed Forces International Command],
and Mateo Dulce Rubio [Carnegie Mellon University]

This paper examines the innovative initiatives undertaken by the United Nations Office for Project Services (UNOPS) Peace and Security Cluster (PSC) in advancing humanitarian mine action (HMA) through remote reporting and analysis technologies. It provides an in-depth analysis of key initiatives, including the development of a mapping tool in Gaza, the application of Natural Language Processing (NLP) for efficient data management in improvised explosive devices (IED) threat mitigation globally, and the utilization of advanced remote sensing and machine learning technologies in Syria and Afghanistan. Through these use cases, we demonstrate how innovative technologies can be incorporated into HMA to increase efficiency and safety, while also outlining future plans and the challenges faced in these initiatives.

INTRODUCTION

The UNOPS PSC has the largest operational mine action capacity within the UN system, implementing on behalf of partners including the United Nations Mine Action Service (UNMAS), the United Nations Development Programme, and the United Nations Office of Counter-Terrorism. To optimize operational efficiency and effectiveness, UNOPS strives to be at the forefront of integrating innovative technologies into mine action. Furthermore, as a senior service provider for UNMAS, UNOPS PSC designed, implemented, and manages the Global Information Management System (IMS) used to monitor and report on operations. This paper provides an analysis of UNOPS' key initiatives in remote reporting and analysis, detailing their practical applications, the challenges encountered, and future developmental plans. The goal is to provide a resource for the wider mine action community, illustrating how these technologies can be leveraged to improve mine action efforts globally.

Concretely, this paper outlines three key areas of innovation advanced by the UNOPS PSC to increase efficiency and safety in HMA efforts. First, automated data-sharing protocols that integrate diverse data sources such as satellite imagery, survey data, and historical records provide comprehensive, real-time information for operational planning in Gaza. Second, the application of Natural Language Processing (NLP) allows us to leverage and integrate the available reports on IEDs into the UNMAS Global IMS for IED threat mitigation. Finally, the paper discusses the use of remote sensing technologies to create 3D models of rubble in Syria, as well as the assessment of socioeconomic impacts using satellite imagery and artificial intelligence (AI) in Afghanistan.

The paper concludes by discussing the way forward to establish stronger collaborations with leading universities and technology partners to integrate state-of-the-art data science methodologies into mine action initiatives.

AUTOMATED DATA-SHARING PROTOCOLS FOR COMPREHENSIVE OPERATIONAL PLANNING

Context. The scale of the explosive ordnance (EO) problem in Gaza is anticipated to be so great that it is already significantly impacting how humanitarian actors can access areas.

To mitigate any risks posed by EO, explosive ordnance disposal (EOD) officers have been requested to join all humanitarian aid missions in the middle and northern parts of

Figure 1. Gaza operations planning and prioritization tool. *Courtesy of UNOPS PSC.*

Gaza. These mission planning processes are based on many prioritization factors, including access, threat assessments, and impact.

To assist in these processes, the UNOPS has developed an innovative planning and prioritization mapping tool that provides EOD officers with real-time access to relevant decision-making data. This tool integrates multiple data sources from various partners, including satellite imagery, survey data, and historical records to provide comprehensive, real-time information for operational planning.

Approach. The approach involves coordination with partners to acquire relevant data, discuss data-sharing protocols to inform EOD activity planning, conduct quality checks, and map multiple reporting schemas. Data is collected from various media, including Esri Distributed Collaboration and custom-made extract, transform, and load tools using Python scripting and application programming interfaces to facilitate EOD activity planning through multiple platforms. Regular quality checks ensure the validity and accessibility of the information while continually watching for relevant data from partners and open sources.

Results. The UNOPS mapping tool has significantly improved the operational planning capabilities of EOD officers in Gaza. By automating data sharing and integration, it streamlines the gathering and processing of critical information, allowing EOD officers to focus on strategic planning.

This tool provides real-time situational awareness by integrating satellite imagery, survey data, and historical records into one platform. EOD officers can quickly assess threats, prioritize areas, and plan missions with greater accuracy. Access to updated information is crucial in volatile environments.

Significantly, the tool also improves coordination among humanitarian actors and mine action partners. Serving as a central hub for EOD officers, it ensures all stakeholders have access to high-quality information, facilitating cohesive efforts. Its interoperability with systems such as the United Nations Office for the Coordination of Humanitarian Affairs' (OCHA) DataHub improves partnership efficiency and effectiveness.

Challenges. The integration of diverse data sources requires robust data management frameworks to ensure compatibility. Sustaining real-time data flow demands significant technical resources and infrastructure to support continuous data streaming and processing. Ensuring the quality of information is critical, as all datasets must be harmonized to integrate correctly with other sets presented.

Future Plans. UNOPS views mapping tools like these as hubs within a network of mine action partners, and not just siloed platforms. The automated interoperability of these tools with other systems, such as OCHA's DataHub, is changing the landscape of partnerships in mine action.

Looking ahead, predictive analytics will further enhance the tool. By leveraging historical data trends and real-time inputs, it can improve forecasting of potential EO contamination, enabling proactive measures and improving long-term planning and risk mitigation.

Figure 2. Global IMS IED dashboard.
Courtesy of Global IMS IED Dashboard.

APPLICATION OF NATURAL LANGUAGE PROCESSING FOR IMPROVISED EXPLOSIVE DEVICE THREAT MITIGATION

Context. Developed and managed by UNOPS PSC for its partner UNMAS, the Global IMS is an Esri enterprise-based GIS-centric platform for the reporting and analysis of hundreds of mine action activities for over seventeen mine action country programs.

IED reporting is one of the workflows on the IMS needed for well-informed IED threat mitigation efforts, where access to information and its accurate processing is critical. To leverage the full extent of available IED reports, UNOPS implemented advanced NLP techniques to streamline the processing of large volumes of data from multiple sources, thus enhancing the accuracy and efficiency of threat assessments. NLP scripts are utilized to automatically detect, clean, and catalog reports from a variety of sources, resulting in highly accurate and comprehensive datasets.

Approach. Data is obtained from various sources using custom methods. Relevant data is extracted from the datasets with predefined definitions via structured query language queries and NLP-enabled Python scripts.

The datasets are then harmonized, cleaned, and sometimes combined to accommodate their specific functions. NLP scripts are applied to the datasets, with models trained from existing in-house datasets containing validated information and regularly enriched with new data. Although the models return a high level of accuracy, human involvement is key to ensuring the overall validity of the data.

Results. The application of NLP in the UNMAS IMS has significantly enhanced IED threat mitigation efforts. By automating the detection, cleaning, and cataloging of IED reports from various sources, the system has improved both the accuracy and efficiency of threat assessments.

The integration of NLP scripts has streamlined data processing, allowing for the rapid and accurate extraction of relevant information from large datasets. This automation has reduced the time and resources previously required for manual data handling, enabling faster and more informed decision making. The result is a comprehensive and highly accurate dataset that supports effective IED threat mitigation.

NLP techniques have also facilitated the harmonization of data from diverse sources, including governmental and nongovernmental organizations (NGOs), each with different formats and languages. This capability ensures that data is consistently processed and integrated into the IMS, providing a unified platform for reporting and analysis. The models, trained on validated in-house datasets, achieve high accuracy, though human oversight remains essential to maintain data validity.

Challenges. Managing data from various sources, including governmental and NGOs, each with distinct formats and languages, is a primary challenge. Additionally, NLP must effectively process data across multiple languages and dialects, which vary significantly in syntax and semantics.

Future Plans. Future efforts will focus on enhancing NLP algorithms to better handle complex linguistic variations and diverse data formats, thereby improving processing speed and data accuracy. The integration of automated translation capabilities is planned to enable the efficient processing of multilingual data, broadening the system's applicability in international contexts.

USE OF REMOTE-SENSING TECHNOLOGIES IN SYRIA AND AFGHANISTAN

Context. The HMA sector faces increasing challenges in identifying and clearing landmines and unexploded ordnance (UXO) in conflict-affected areas worldwide. Adopting remote-sensing technologies, such as AI and satellite imagery, is crucial as these tools can enhance the accuracy and speed of detecting hazardous areas. This technological integration not only ensures the safety of demining personnel by reducing their direct exposure to dangerous zones but also accelerates the clearing process, allowing for quicker restoration of safe environments for local communities.

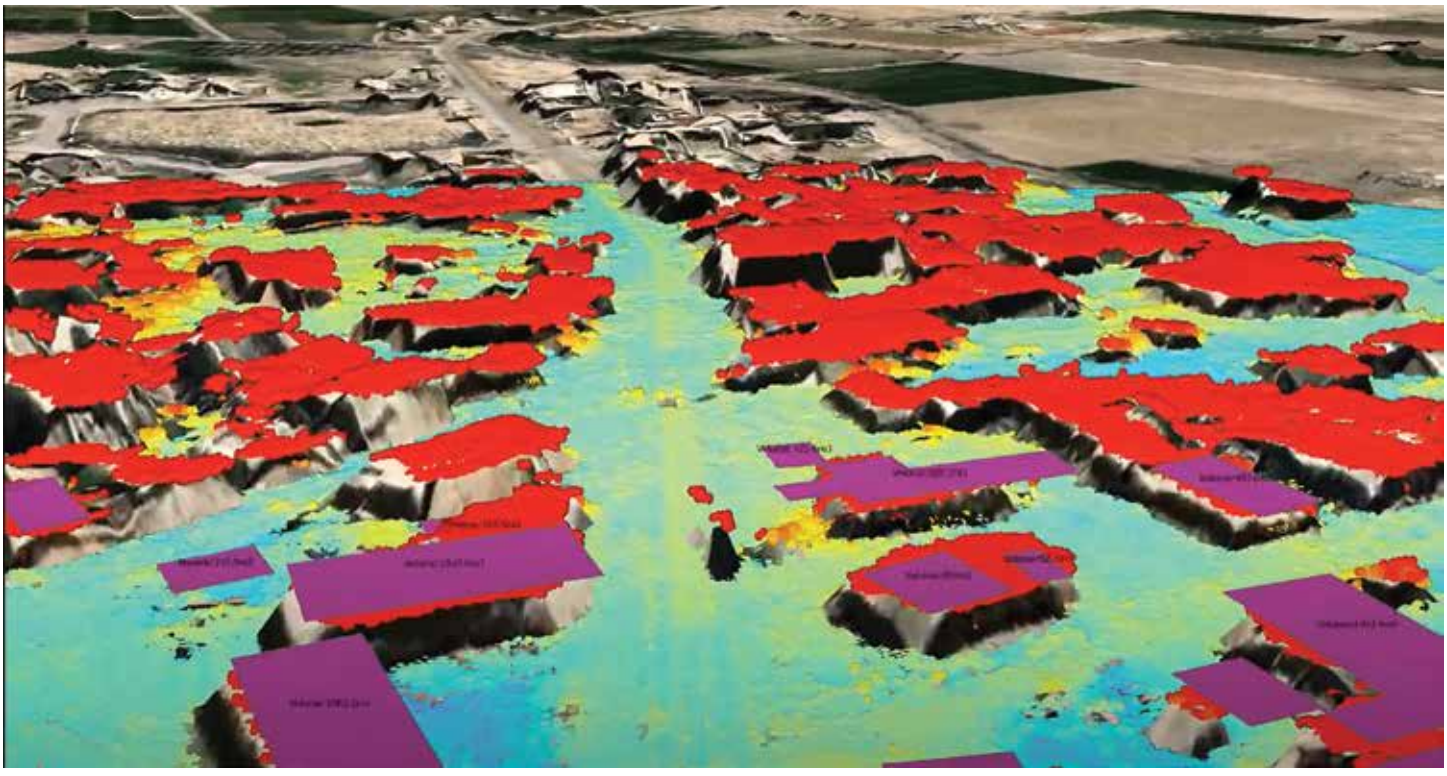
As conflicts and the resulting contamination continue to evolve, the integration of advanced technologies becomes imperative to address these complex scenarios.

Approach. UNOPS has developed two advanced remote sensing and AI technologies for diverse applications: creating 3D models of rubble in Syria to help inform planning and prioritization, and evaluating socioeconomic impacts in Afghanistan aligned with the UN Sustainable Development Goals (SDGs).

In Syria, 3D modeling of the environment based on stereo imagery returns a point cloud similar to what light detection and ranging (Lidar) would do. The process is enhanced by using off-nadir angles and shadows from the imagery to obtain accurate building heights and deduce the volume of rubble, aiding in accurate debris assessment and safe removal operations. The ability to run these assessments remotely and automatically has a significant impact on the safety of EOD officers, as well as the time and resources needed to more accurately inform the critical and extremely dangerous non-technical survey operations in the field. This 3D visualization can also be used to plan operations with improved situational awareness and run change detection models for building, agricultural, and road damage detection.

Afghanistan. AI models developed by UNOPS in collaboration with the Massachusetts Institute of Technology and regional partners such as Alcis, as well as high resolution satellite imagery from Maxar provided through strong partnerships with the US Department of State, are used to detect and

Figure 3. Global IMS Syria.
Courtesy of UNOPS PSC.



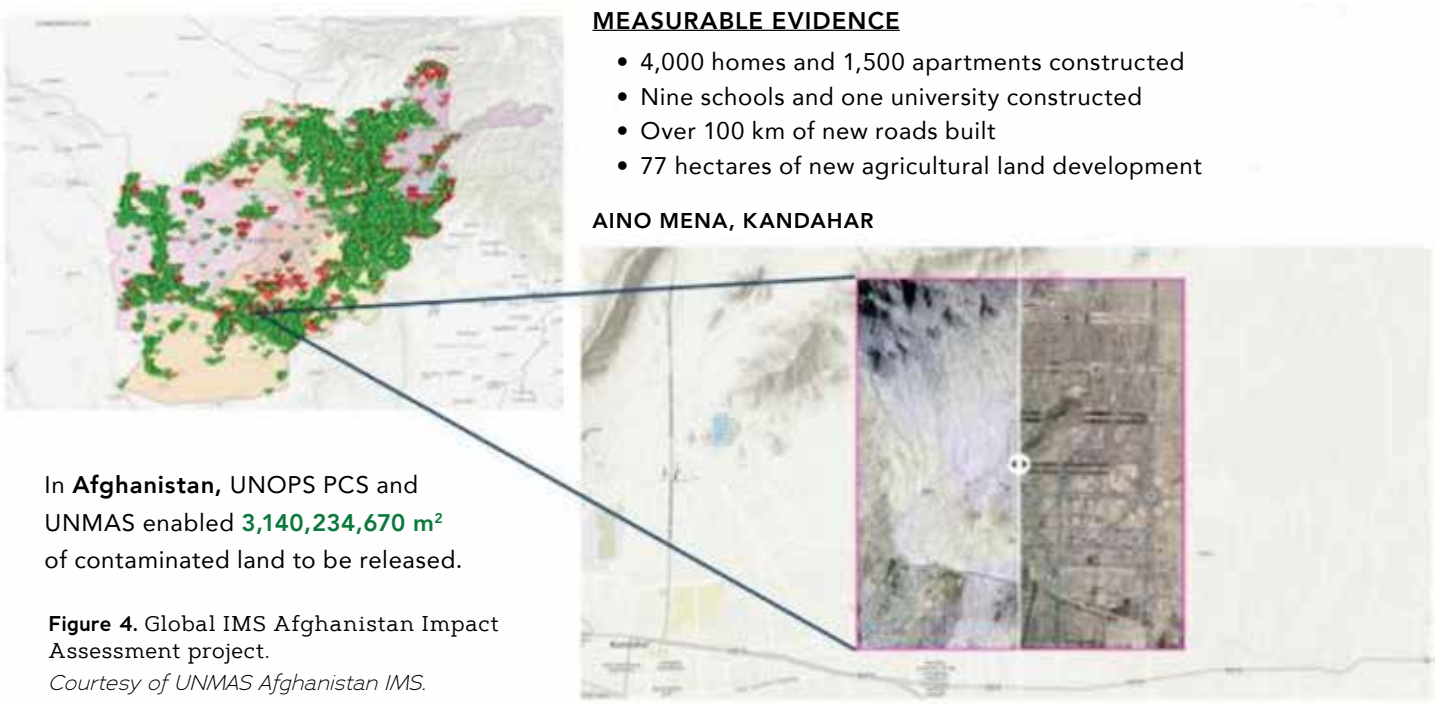


Figure 4. Global IMS Afghanistan Impact Assessment project.
Courtesy of UNMAS Afghanistan IMS.

measure positive socioeconomic changes resulting from HMA activities. This approach provides evidence of how UNOPS has enabled the development of a US$1 billion economic zone, including direct and indirect employment of over 15,000 people. This also provides the mine action program in Afghanistan measurable indicators that directly contribute to the UN SDGs, as well as evidence to support advocacy and further funding initiatives.

Challenges. Maintaining high data accuracy is essential for reliable threat assessments and planning, necessitating continuous validation and calibration of remote sensing tools. Developing AI models that are resilient to diverse environmental conditions and data quality variations remains a critical challenge.

Future Plans. Efforts will focus on advancing remote sensing technologies to include real-time monitoring, providing continuous updates on the status of mine-affected areas. Future plans include the development of AI-driven predictive models to forecast contamination and socioeconomic impacts, facilitating proactive planning and resource allocation. For example, these models could help forecast contamination risks by analyzing historical data, conflict intensity, and terrain features, allowing for targeted demining and resource allocation. Additionally, they could help assess the socioeconomic impacts of demining and infrastructure investments, predicting how these activities will affect local economies and communities. This proactive approach could contribute to safer operations, more efficient use of resources, and strategic investment in areas poised for significant growth.

THE WAY FORWARD: STRONGER COLLABORATIONS WITH LEADING UNIVERSITIES AND TECHNOLOGY PARTNERS

UNOPS PSC Information Management and Analytics Team has established a collaborative innovations group dedicated to advancing technological solutions in mine action through strategic partnerships. This group collaborates with leading universities and technology partners to explore and implement cutting-edge innovations. Benefits of this relationship can be seen almost immediately, creating a direct channel from the innovative technology developed by academia to the mine action operations personnel making critical decisions in the field.

A recent example is the collaboration with researchers from Carnegie Mellon University to build an AI-informed system that estimates the probability of EO contamination in a given hazard polygon. The developed tool can be integrated into existing planning workflows to support the identification of priority areas for mine action land release activities in Afghanistan and globally.

Approach. Historical information on finalized land release operations is used to predict whether a new hazard area will be confirmed to be contaminated or canceled. A comprehensive

Areas affected by known EO contamination
(256) Districts
(1,705) Communities
(3.4 million) People living within 1 km of EO
(475) Educational facilities within 1 km of EO
(230) Healthcare facilities within 1 km of EO

Figure 5. Global IMS Afghanistan.
Courtesy of UNMAS Afghanistan IMS.

set of relevant variables, including geographic attributes, socio-demographic characteristics, and remnants of conflict indicators is collected.

An AI model trained on this data learns the relationships between the geographic predictive features and historical EO contamination. The model is then extrapolated to new hazard areas to generate risk maps and identify the areas more likely to be contaminated.

The AI pipeline is tailored to the operations teams' needs, estimating the risk of EO contamination in active hazard areas by collecting relevant variables adapted to the Afghan context, training the models with local historical data, and presenting the results in a user-friendly manner.

Results. The final model is a weighted average of Random Forest,[1] LightGBM,[2] and a neural network specifically designed for EO contamination identification[3] (see Figure 6). The AI model maximizes the tradeoff between identified confirmed hazards and canceled false alarms. Among the top 10 percent of the polygons in the validation data with the highest estimated risk scores, 99.07 percent were correctly identified as contaminated hazards.

Each active hazard in Afghanistan is then assigned with an estimated probability of EO contamination that categorizes the polygons into areas of low, medium, high, and very high risk of EO contamination. The predicted risk score can then be used to support decision making and prioritization.

The model also outputs the most relevant features used to estimate the risk score for each polygon using SHAP values.[4] SHAP values, or SHapley Additive exPlanations, are a tool used in the field of machine learning to explain the output of any machine learning model. They help clarify which features in a dataset are most important in a model's predictions, providing transparency about how individual factors contribute. This is critical to ensure the interpretability and credibility of the system.

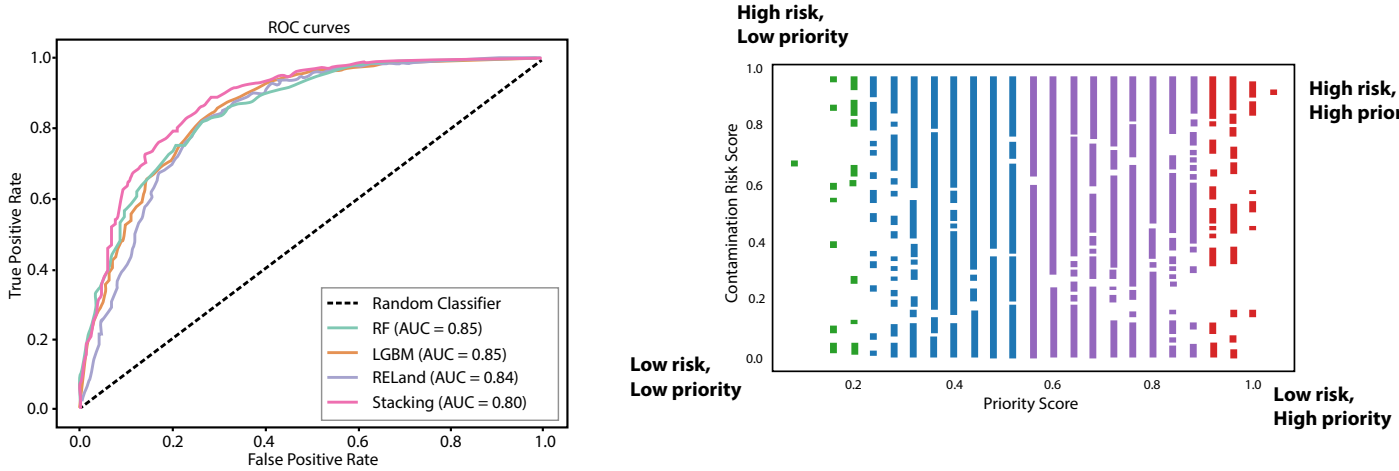


Figure 6. Predictive performance of the machine learning model to identify EO contamination in Afghanistan.
Courtesy of the authors—UNMAS Afghanistan IMS and Carnegie Mellon University research collaboration project.

Challenges. Keeping abreast of rapid technological advancements and integrating new technologies into existing frameworks is a continuous challenge. Ensuring sufficient resources and funding to support ongoing innovation and development initiatives is critical for sustained progress.

Future Plans. Plans include expanding partnerships with academic and industry leaders to leverage a broader range of expertise and technological innovations. Increased investment in emerging technologies such as machine learning is anticipated to enhance data security, operational transparency, and overall efficiency in mine action activities.

CONCLUSION

UNOPS' innovative approaches in remote reporting and analysis are transforming its mine action operations, providing enhanced efficiency and safety. Through continuous R&D and strategic collaborations, UNOPS looks forward to advancing the field further, offering practical, impactful solutions that benefit the global mine action community.

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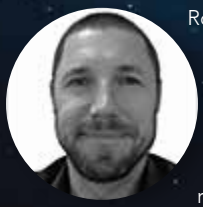

Rory Collins is an Information Management and Analytics Advisor at United Nations Office for Project Services (UNOPS), specializing in innovation and technology integration in humanitarian mine action. With a focus on enterprise system implementation and management, as well as remote sensing, Collins has led multiple projects with the United Nations that enhance operational efficiency and innovation in humanitarian mine action (HMA).

LIONEL FRAGNIERE
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Lionel Fragniere is a Senior Technical Officer with the Swiss Armed Forces International Command, supporting UNOPS with extensive experience in information management, geographic information system, and artificial intelligence applications within HMA. His work primarily focuses on developing advanced tools for operational planning and improving the accuracy of threat and damage assessments through innovative technologies.

MATEO DULCE RUBIO
PhD Candidate in Statistics and Public Policy
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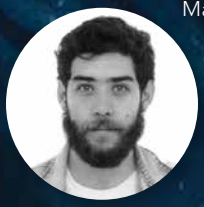

Mateo Dulce Rubio is a PhD candidate in Statistics and Public Policy at Carnegie Mellon University. His research focuses on developing flexible and robust methods inspired by challenges arising in post-conflict scenarios and peacebuilding efforts, using tools from nonparametric statistics, casual inference, and responsible machine learning.

PHASE II TESTING OF UAV/SENSOR SYSTEMS for Humanitarian Mine Action in Ukraine

By Edward Crowther
[UNDP Ukraine] and Natalia Shepel
[Ministry of Economy of Ukraine]

Unmanned aerial vehicle and magnetometer flying over the confirmed hazardous area during Phase II testing, May 2024. *Courtesy of Nazarii Mazyliuk/UNDP Ukraine.*

The United Nations Development Programme (UNDP) conducted the Phase II trials of unmanned aerial vehicle (UAV)/sensor systems for humanitarian mine action (HMA) in Ukraine in May 2024. Seven organizations participated, four of which were Ukrainian. Each organization brought systems with differing combinations of unmanned aircraft system (UAS) platforms, sensors, and data processing, and were tested against a trial area set up in central Ukraine by UNDP.

Run at the request of the Ministry of Economy, Phase II trials involving Ukrainian and international organizations yielded promising results. They demonstrated that combining technologies to detect both metal and plastic explosive remnants of war (ERW) items—whether surface-laid or buried—could significantly enhance the efficiency of traditional humanitarian demining methods by enabling more targeted clearance.

INTRODUCTION

In May 2024, UNDP conducted Phase II trials of UAV/sensor systems for HMA in Ukraine. Officially titled the "Uncrewed Technologies for Effective Mine Action In Agriculture In Ukraine," the project was more commonly referred to as "Phase II" as it built upon a previous trial held in July 2023.

The main aim of this second round of trials was to analyze the accuracy, efficiency, scalability, advantages, and limitations of such UAV/sensor systems in supporting and potentially accelerating future HMA land release efforts in Ukraine.

Phase II was generously funded by the governments of Croatia, France, Malta, the Netherlands, and Sweden.

SCOPE OF PHASE II TRIALS

The Ukrainian mine action landscape is characterized by a great deal of innovation across all sectors of mine action, and one key aim of Phase II was to test various UAS/sensor systems in an objective way, including a number of systems developed by Ukrainian organizations. Of the seven organizations that participated in Phase II, four were Ukrainian.

SETUP OF PHASE II TRIALS

Phase II trials took place on a polygon in central Ukraine and was supported by the Ukrainian National Mine Action Authority, National Police of Ukraine, and the Ukrainian State Scientific Institute for the Testing and Certification of Military Equipment; the latter being the Ukrainian state body, which ultimately certifies all HMA equipment (such as demining machines). Both the Organization for Security and Co-Operation in Europe and the Geneva International Centre for Humanitarian Demining provided an HMA technical expert to support the Phase II trials.

Three areas were laid out for the trials:

1. A control and calibration area, containing four ERW items—two surface-laid items and two sub-surface items—against which participating teams could calibrate their equipment.
2. An area replicating a confirmed hazardous area (CHA) in Ukraine. The Phase II CHA was 1.44 hectares in size, within which were twenty-seven items of mines, cluster munitions, and unexploded ordnance (UXO), placed both surface and sub-surface, mimicking real-life mined areas in Ukraine as much as possible. Though small in geographical size, the CHA test area was varied with different vegetation, trench lines, and relatively flat areas.
3. An area simulating a suspected hazardous area (SHA) with low contamination by ERW—only six ERW items were laid here. The SHA measured 5.75 hectares. The aim of this area was to determine how potentially accurate the systems were for technical survey in SHAs by measuring factors such as the false detection rate.

TM-62P3 anti-vehicle mine mounted with MVP-62 fuze, one of four unexploded ordnance items in the control and calibration area during Phase II testing, May 2024.
Courtesy of Edward Crowther/UNDP Ukraine.

Items that were laid by the Phase II team were all real, free from explosive (FFE). Surrogates or mock-ups such as 3D printed models were not used. After emplacement, the location of each item was recorded with Differential Global Positioning System (D-GPS), as well as details about its location (buried, semi-buried, obscured by vegetation, in open air, etc.). In terms of items laid during Phase II, there was a higher proportion of metal objects compared to plastic objects, and more surface objects than buried ones.

PARTICIPATING TEAMS

The Phase II trials aimed to test these various combinations of platform/sensor/data processing to see which combinations were the most successful against different categories of ERW targets: metal/plastic, surface/sub-surface, etc.

In terms of technologies used, all participants utilized electro-optical (EO) cameras. This technology can, if combined with either human and/or computer vision imagery analysis, provide a route to the detection of surface-laid ERW items.

For three of the participating organizations, a magnetometer was the second sensor of choice. For landmine detection, magnetometers are used to detect the magnetic anomalies caused by the presence of metal objects, such as UXO and landmines.

One organization used electromagnetic induction (EMI) sensors. EMI sensors detect the presence of metallic objects by measuring the response of a target to an induced electro-magnetic field. When applied to landmine detection, EMI can identify both the metallic components of landmines and other sub-surface metallic objects.

Multispectral cameras including infrared (IR) were used by four participating organizations. This method leverages the unique thermal signatures of landmines to distinguish them from other objects and materials. Usage of IR sensors appeared to increase the detection rate for those companies which used them.

Though none of the sensor technologies deployed by any of the participating organizations during Phase II were novel, the organizations were each utilizing different forms of sensor fusion, as well as aspects of artificial intelligence (AI)/machine learning, in order to process data from the platforms and sensors.

In short, it seems that advancements in sensor fusion and data processing, rather than any specific hardware breakthroughs, are likely to enhance ERW detection rates in the Ukrainian context.

Item 25, a TM-62P3 anti-vehicle mine, in the confirmed hazardous area during Phase II testing. Some items, such as this one, were semi-buried or obscured with soil or vegetation to present a more realistic and challenging environment for the participating teams. The white numbering square was not present during the actual testing.
Courtesy of Edward Crowther/UNDP Ukraine.

PFM-1 anti-personnel mine, laid in the suspected hazardous area during Phase II testing, May 2024. The white numbering square was not present during the actual testing. One participating organization was able to locate this item—the single PFM-1 laid in a 5.75 hectare area—using a combination of explosive ordnance sensors and AI object recognition.
Courtesy of Edward Crowther/UNDP Ukraine.

PHASE II CONDUCT

Each team was allocated two days to scan both areas (the CHA and SHA) using their UAV/sensor systems. All participating organizations took part in the examination of the CHA, but owing to a variety of technical issues (faulty equipment), security considerations (UAS flight bans during the testing windows), and weather conditions (wind speeds exceeding normal operating conditions), four participating organizations were unable to assess the SHA test area.

The UAS flight bans were a result of the wartime situation in Ukraine, with the airspace being subject to sudden closure at any moment. One particular ban lasted an entire day during the trial period, and as such the teams affected by this ban during their testing window were rescheduled to complete their flying.

Elements of potential electromagnetic noise and GPS degradation were observed during the testing, most likely due to the wartime conditions in Ukraine at the time of testing. However, this did not appear to have a significant effect on the overall completion of testing.

PHASE II EVALUATION

Organization four and organization seven each identified more than 55 percent of the targets across both test sites (i.e., the CHA and SHA), with varying performance in different target categories. In the CHA, organization seven (utilizing EO cameras and a magnetometer) achieved better results for metal and buried objects (71 percent and 67 percent), while organization four (using solely EO cameras) excelled in detecting plastic (62 percent) and surface objects (78 percent) with distinctive rate for metal (57 percent).

Organization five, using EO cameras, magnetometers, and pulsating electromagnetic scanning (PEMS), demonstrated distinctive results for metal and buried objects with detection rates of 50 percent and 44 percent respectively.

Organization three performed well in detecting plastic objects, achieving a level comparable to organization seven (54 percent), despite using a different type of UAS (organization seven was the only one to use a fixed wing UAS). However, organization three showed lower results for buried and metal objects, presumably due to its reliance solely on visual sensors.

These high detection rates suggest that combinations of remote sensing technologies can reliably identify ERW if the item is comprised of metal and/or is surface-laid, and could therefore be useful in humanitarian demining operations.

The success in detecting 1) metal ERW items (both surface-laid and buried), and 2) surface-laid (plastic or metal) ERW items suggests that these technologies, used in conjunction, could

significantly improve the efficiency of traditional demining methods by allowing more targeted clearance.

Detecting sub-surface plastic ERW items (e.g., the buried PMN-2 anti-personnel mines) remains a challenge. None of the demonstrated technologies were able to reliably detect such objects, especially in the highly contaminated environments likely found in real SHAs and CHAs in Ukraine.

FUTURE TRIAL DESIGN

Phase II also indicated important considerations for future potential rounds of objective testing of such systems in the Ukrainian context.

For example, the requirements of the testing polygon chosen meant that the ERW items could only be emplaced the day before testing started, meaning that even some buried items were probably readily observable owing to freshly disturbed earth and/or dead vegetation in the vicinity. For future testing, it would be preferable to place items in the ground at least a week, a month, or perhaps even longer, before testing, to give items time to settle.

The heavy contamination of the test range introduced additional noise into the data, which affected the calculations of the false alarm rate. Before commencing trials, it is recommended to conduct magnetometry or use other methods to identify metal elements and provide a detailed description of soil types and compositions. Additionally, a visual inspection of the range should be conducted to identify debris or scrap items lying on the surface, which may be picked up by EO sensors.

In general, the Ukrainian HMA sector would benefit from the establishment of a (semi-) permanent testing facility for such technologies. This would allow for a larger set of emplaced ERW items, as well as an established place where technologies could be tested on a regular basis.

PHASE II SUMMARY

The following general conclusions can be drawn after analysis of the performance of participants at Phase II:

Core remote sensing technologies. The most reliable remote sensing technologies identified during Phase II include high-resolution optical cameras, thermal cameras, and magnetometry. Future testing should focus on further improvements to sensor/data fusion, as well as adjustments for different weather conditions and types of ERW common to the Ukrainian context.

Geophysical remote sensing methods. Classic geophysical methods, such as PEMS, require further calibration and experimental diversification to detect resonance in various small-scale metal and plastic objects.

Detection efficiency by depth. All surface objects were detected by one or more of the teams, and 60 percent of buried objects were found. Future testing rounds should focus on data collection and calibration for magnetic anomalies and thermal radiation to improve detection of sub-surface ERW items. This should be with particular focus on locating buried, plastic/minimum-metal ERW items, the detection of which remains challenging for existing technologies.

Visual inspection and AI. Visual inspections using AI for detection can yield excellent results with precisely trained neural networks. AI software can potentially significantly improve data processing speed and noise reduction, though human experts are still necessary for final data review. Computer vision models trained on larger datasets with real-life images show higher accuracy and lower false alarm rates.

For further information on Phase II trials, please email the authors at edward.crowther@undp.org

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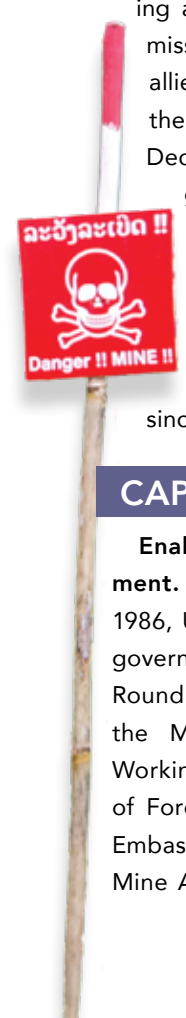
Dealing with Hidden Danger: Capacity Development of Lao PDR's Unexploded Ordnance Sector

By Kiengkay Ounmany, PhD [Southeast Asian Ministers of Education Organization Regional Centre for Community Education Development]

Lao People's Democratic Republic (Lao PDR) suffered from the heaviest bombing in its history during the Second Indochina War (1955–1975). Two decades after the war, the Lao National Unexploded Ordnance Clearance Programme (UXO Lao) was established with financial and technical assistance from United Nations (UN) agencies and donor countries. The development of Lao PDR's national UXO clearance capacity has been within the framework of multilateral and bilateral cooperation. The Lao PDR government is prepared to take ownership of the program, but additional capacity development is essential in the areas of strategic planning and funding mobilization if it is to meet the needs of its citizens who continue to live in the most heavily bombed country in the world per capita.[1] This article examines how Lao PDR's UXO sector has developed its capacity over the past three decades and identifies areas for further capacity development: strategic planning, financial and information management, and humanitarian mine action (HMA) quality management.

INTRODUCTION

Over two million tons of ordnance were dropped on Lao PDR territory during approximately 500,000 bombing missions by the US Airforce and its allies between 1964 and 1973.[2] After the proclamation of Lao PDR on 2 December 1975, the country struggled to reconstruct its nation amid this legacy of war. The National Regulatory Authority for UXO/Mine Action (NRA) in Lao PDR reports that over 50,000 casualties have occurred since 1964 from UXO accidents. Between 2011 and 2020, UXO injured 356 and killed 106 people; over 50 percent of the victims being adolescents and children.[3] Additionally, UXO constitutes a major barrier for socio-economic development. Consequently, UXO clearance was uniquely designated as Sustainable Development Goal 18 "Life Safe from UXO" for Lao PDR.[4] In the early 1990s, international nongovernmental organizations (INGOs) initiated efforts to address UXO remaining from the war. The United Nations Development Programme (UNDP) assisted the Lao government in establishing the Lao National Unexploded Ordnance Program through the creation of the Laos UXO Trust Fund.[5] International humanitarian UXO clearance operators then followed suit and initiated their own UXO clearance programs. Since the 1990s, Lao PDR's national capacity has significantly strengthened through financial and technical support from UN agencies and donor countries. With limited data or continuous assessment of national capacity, measuring the contribution of each actor in the sector's development is challenging.



CAPACITY DEVELOPMENT OF THE LAO UXO SECTOR

Enabling Lao PDR's UXO environment. Since economic liberalization in 1986, UNDP has assisted the Lao PDR government in the organization of the Round Table Process, which includes the Mine Action and UXO Sector Working Group chaired by the Ministry of Foreign Affairs. UNDP and the US Embassy in Vientiane also co-chair the Mine Action and UXO Sector Working Group, as the United States is the largest donor to the Lao UXO sector.[6,7]

Since the 1990s, UNDP has played an important role in the development of the Lao UXO sector by mobilizing funds from donors. Between 2017–2021, UNDP managed over US$12 million in contributions from Australia, the European Union, Ireland, Luxembourg, New Zealand, and the Republic of Korea.[8] Many donor countries do not have embassies or representative offices in Lao PDR, which makes it difficult for them to monitor the implementation of projects they have funded. UNDP, therefore, plays an intermediary role in the transfer and monitoring of the use of donors' funds in the Lao UXO sector.

Over the last five years, funding specifically into UNDP-managed funds has

US Ambassador to Lao PDR, Peter Haymond, met the UXO Lao clearance team during a visit to Attapeu Province, southern Laos, in June 2020.
Courtesy of the US Embassy in Vientiane.

declined, partly because many donors send funds directly to international UXO clearance operators.[9,10] Some donors stopped contributing funds, fatigued from the time and money they had already spent supporting the sector. Ultimately though, inaccurate data on the extent of UXO contamination across Lao PDR meant that donors were not sure when the UXO would be completely removed, making it difficult to justify their support.[11] UXO Lao and the NRA rely on bombing data and the results of the Cluster Munition Remnant Survey in six heavily contaminated provinces for planning UXO clearance but do not take into account the huge number of ground-launched mines and ammunition (rifle grenades, mortars, rockets, etc.) that are also spread across the country. A cross-country contamination survey to determine the precise contamination areas of UXO and other explosive remnants of war would benefit the NRA. This would lead to better allocation of limited resources and increase clearance efficiency. And by evaluating the impact of UXO clearance on local livelihoods, donors could have evidence on the impacts of their assistance.

However, a number of administrative hurdles, such as import regulations and a long memorandum of understanding approval process, have diminished the UXO sector's efficiency. The hectic import regulations have sometimes precipitated the shipment of UXO clearance equipment back to its country of origin.[12] At other times, international UXO clearance operators have had to wait over six months for governmental approval prior to commencing their operations.[13] By addressing these issues, the NRA Board could draw more support from international donors and accelerate UXO clearance.

Organizational level. The NRA, UXO Lao, and the Lao People's Army Unit 58 are key government organizations working on UXO survey and clearance in Lao PDR. The following section discusses capacity development support they received from UNDP and Japan International Cooperation Agency (JICA), Korea International Cooperation Agency (KOICA), the United States, international UXO clearance operators, and other partners.

An outstanding support is the formulation of the National Strategic Plan for the Lao UXO Sector, simply known as Safe Path Forward.[14] UNDP also provides programmatic support to the NRA and UXO Lao, including financial management and procurement, reporting and communication, data management and analysis, and strategic planning and coordination. In 2004, the Lao government established the NRA with the aim to improve planning, coordination, and regulation of the whole Lao UXO sector and was operational in 2006 under the Ministry of Labor and Social Welfare. As of September 2023, the NRA is now under the Ministry of Foreign Affairs. Representatives from eleven government ministries sit on the NRA's board, which has consequently fostered stronger commitment from the government toward the sector.[15] The board facilitates coordination among government agencies and relevant actors, including UXO clearance related INGOs and civil society organizations at different levels. The NRA is financially autonomous from

the Lao government, as over 90 percent of the NRA's operational budget is derived from donors through UNDP and other bilateral donors, allowing for more flexibility and transparency in its financial management.[16] The Lao government contributes to the NRA through sub-regional offices called Provincial Regulatory Authority (PRA), which are in nine highly contaminated provinces across Lao PDR. The government provides support to the PRA's personnel and budget, but some PRA staff have urged the government to provide more financial support for coordinating and monitoring of UXO clearance activities. The difference in financial compensation and government support between the sub-regional offices risks decreasing the efficiency in the coordination of the UXO sector at the provincial level.

The Lao government supports HMA activities in multiple ways. For instance, the Lao People's Army operates a humanitarian UXO clearance team called Unit 58 that consists of seven teams of eight deminers, a medic, and a driver in each team. Unit 58 was established in 2013 with support from the UNDP and the KOICA and became operational in 2017.[17] In 2021, Unit 58 began to build an additional thirteen teams to meet increasing demand for clearance with support from the UNDP and KOICA. However, Unit 58 still relies heavily on international support for capacity development, with only some support provided by the Lao government. Between 2022 and 2026, KOICA allocated US$11 million to the Lao UXO sector. A significant portion of the funding is spent for capacity development of Unit 58, while the Lao government provided US$100,000 for Unit 58 to work in Xaysomboun from 2019 to 2021. As part of a broader transition to national ownership, to ensure sustainability of the Lao UXO sector, the Lao government has allocated a plot of land to the unit since 2020 and plans to build an office and a training center in Vientiane. The monitoring and evaluation of the unit is conducted by an independent agency to ensure quality control. As such, while Unit 58 is a part of the Lao People's Army, the unit's operations are based on Lao's National Mine Action Standards (NMAS) and their clearance is certified by the NRA.

The NMAS, which are based on the International Mine Action Standards (IMAS), were completed in 2012 through an inclusive process led by the NRA with support from the UNDP and other stakeholders. However, the NMAS are outdated because of changes in methodology (evidence-based survey) and technology (e.g., more farmers use larger tractors, which require deeper UXO clearance). There is a pressing need to update the NMAS to meet the requirements of development partners. The existing NMAS requires the default depth of UXO clearance to be 25 centimeters, while some development projects operating in Lao PDR require UXO clearance to be over 100 centimeters in depth. The NRA has tried to update the NMAS through hiring international experts, with support from the New Zealand government via the UNDP in October 2021. However, updating the 2012 NMAS has not progressed due to the impacts of the COVID-19 pandemic and uncertainty of funding from donor countries.[18] In 2023, Norwegian People's Aid (NPA) supported the NRA to review the National Standards on Information Management (chapter 24) through workshops and discussion involving all stakeholders. In 2024, the NRA office plans to review the other chapters of the National Standards based on the same standard development process. Also in 2024, the NRA office plans to establish a Technical Committee for the review of the National Standards.

Commercial companies such as Tetra Tech have played key roles in the development of Lao PDR's UXO sector. Following US$90 million in aid from the United States following former President Obama's visit to Lao PDR in September 2016, Tetra Tech was selected to oversee funding to UXO Lao and provide technical advisory support.[19,20] In 2021, Tetra Tech employed ten full-time staff who provided assistance to UXO Lao on UXO survey and clearance, quality and information management, logistics and procurement, and finance at both

Government of Canada and UNDP supported training on Quality Assurance and Quality Control for the NRA staff in February 2024.
Courtesy of UNDP.

Cluster munitions in Laos.
Courtesy of NPA.

the capital and provincial levels. Tetra Tech also supported the NRA with prioritization, explosive ordnance disposal (EOD) expert training, and information management.

Other partners have worked to support UXO Lao and the NRA. For example, JICA funded two experts to assist UXO Lao in computerized asset management, human resource management, and coordination between national and provincial levels.[21] Additionally, NPA assisted the NRA in information management, particularly by upgrading Lao's Information Management System for Mine Action (IMSMA). These capacity development activities, however, have been concentrated at the capital level, whereas the activities at the provincial and district levels are limited. Most UXO clearance activity occurs at the local level. As such, additional capacity development efforts should be promoted at the provincial and district levels through more financial and technical support. To contribute to this, NPA is supporting the NRA national office to provide information management training to provincial and district regulatory authorities in nine provinces.

Since the establishment of HMA in Indochina in the 1990s, there have been multiple efforts to promote collaboration in the region. JICA supported exchanges between UXO Lao and the Cambodia Mine Action Centre (CMAC) on operation, quality management, and human resource management. In 2021, JICA appointed technical advisors to CMAC. These exchanges between UXO Lao and CMAC have benefited both sides in management and technology. In demining quality management, for example, the NRA staff referred to CMAC's experience in strengthening the NRA's capacity in this area and consequently additional collaboration between UXO Lao and CMAC should be promoted.

There are still crucial areas where the Lao UXO sector needs to develop its capacity. A key example is in data management and analysis. The NRA and UXO Lao have collected large amounts of data, particularly from IMSMA. However, UXO operations have made limited use of data for analysis, planning, and decision-making. Some of the data that has been collected and used in operations has been inaccurate as some staff members within the provincial teams have limited digital literacy and use handwritten forms to report data to the NRA headquarters. In 2021, NPA aided the NRA's upgrade to the UXO sector's information management system to include Esri's Geographic Information System through an NPA project. By doing so, UXO operators can now see information—such as confirmed hazardous areas—in real time, which has helped to increase the efficiency and effectiveness of their clearance operations. Further capacity development in data management and analysis, as well as digital upgrades, will enable the NRA and UXO Lao to improve their performance further.

Individual level. In 2022, the Lao UXO sector employed over 4,700 personnel, the majority of whom are local staff.[22] Since the 1990s, the NRA and UXO Lao staff have undertaken training on planning, leadership, information management, and risk education in order to develop a national UXO clearance program. However, most of the UXO sector's resources have been allocated to survey and clearance, while less are available for individual capacity development. Consequently, much of UXO Lao's senior staff, with over twenty years of experience, are quickly approaching retirement age with few plans to develop future senior management in the Lao UXO sector.[23] Without a human resource development plan for Lao's UXO sector, the NRA risks losing leadership and strategic management expertise among senior NRA and UXO Lao staff. With the NRA taking the lead, UNDP and other development partners could provide funding and technical assistance. An initial assessment of the NRA and UXO Lao's existing capacity would identify where these organizations should prioritize development. Partnerships with local institutions should be promoted by involving local academic institutions in providing training.

International UXO clearance operators have built their own training facilities and provided on-the-job training for their staff. These international organizations have also integrated UXO survivors and ethnic minorities into their workforce, with a large number of women as deminers, team leaders, and EOD experts.[24] The inclusion of women and other marginalized groups helps to improve the capacity of individual UXO operations and increase efficiency of the

UXO sector as a whole; for example, women deminers possess advantages when delivering risk education. As most of these women have experiences caring for vulnerable groups including children, elderly, and UXO survivors, they are likely to be more efficient in delivering risk education compared to their male counterparts. The inclusion of women in mine action efforts also conforms with the UN's Gender Mainstreaming in Mine Action Framework, which has the goal to "provide practical steps to mainstream gender and promote gender equality in mine action programmes..."[25] Employing local populations helps UXO clearance operators work more efficiently as citizens have greater understanding of the local languages, culture, and the environment, which helps operators liaise with local communities and identify UXO contamination areas.

Children in Laos learn mine risk education.
Courtesy of World Education Inc..

CONCLUSION

Since the establishment of the UXO sector in the 1990s, the Lao government has worked with UNDP to foster a favorable environment that attracts support from bilateral and multilateral donors. However, it has been difficult for international donors who provide funds to UNDP to justify their support as there is little consolidated evidence on the impact of the different clearance efforts that have occurred over the years. Consequently, there has been a decline in international contributions from some donors, but not all, to UNDP-managed funds, which are mainly spent to support the key national agencies including the NRA and UXO Lao.[26,27] While UNDP and development partners have contributed significantly to the increased capacity of key government institutions, such as the NRA and UXO Lao, a large proportion of these resources have been allocated for survey and clearance. As such, little funding was available for human resource development. Without this external support, the NRA and UXO Lao have struggled to establish and maintain high quality human resources. If the Lao UXO sector was able to develop additional capacity in information management, human resource management, and fund mobilization, the efficiency of the sector would improve significantly. This could contribute to Lao PDR achieving development goals and sustaining its UXO sector, reducing the impact of UXO on the people of Lao PDR.

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Deputy Director
South East Asian Ministers of Education Organization Regional Centre for Community Education Development

Kiengkay Ounmany, PhD, is the Deputy Director of the South East Asian Minister of Education Organization Regional Centre for Community Education Development. He received a PhD in Social and Economic Sciences from the University of Natural Resources and Life Science, Vienna, Austria, and is currently teaching development theories in a Master of International Development Studies Programme at the National University of Laos. A strong advocate for sustainable development, Dr. Ounmany involves his students in research on rural development, poverty reduction, and sustainable development in Lao PDR. His professional interests focus on rural development, participatory approach, human capital, and sustainable development. His key publications include "The Legacy of the Vietnam War: Making a Living amid Unexploded Ordnance in Xieng Khouang Province, Northern Laos" and "Impacts of Unexploded Ordnance Clearance on Wet Rice Farming in Xieng Khouang Province, Northern Laos."

Basic Identification of **Ammunition in Ukraine** Guide: Version 6.0

By Senior Lieutenant Perederii [National Police of Ukraine Explosive Ordnance Disposal], Tony Salvo, and Drew Prater [Bomb Techs Without Borders]

Ordnance identification is a critical tenet of any competent munition clearance operation, whether it be civilian or military. Ordnance identification information for first responders, especially safety procedures, is vital when shielding civilians from danger. This is even more important when the munitions being cleared are explosive remnants of war (ERW) from on-going conflict. To that end, Version 6.0 of the Basic Identification of Ammunition in Ukraine[1] has been released and has some important updates to help ensure clearance personnel and first responders can help keep civilians safe.

INTRODUCTION

The guide was originally developed in the summer of 2022 by Bomb Techs Without Borders[2] (BTWOB) and the National Police of Ukraine Explosive Ordnance Disposal (EOD). Since that time, the eighth Special Operations Forces Regiment EOD and State Emergency Services of Ukraine EOD have joined as major contributing partners. Numerous other agencies, units, and departments contribute in an ad hoc, unofficial capacity. The types of information contained in the guide are deliberately limited to allow for maximum distribution without compromising operational security.

In Version 6.0, indicators for specific hazards have been expanded from six to fourteen and use a clearer, more intuitive system for hazard identification. Rather than using a color-coding system bordering each affected munition, which was quickly becoming very complicated, the system was switched to utilizing basic symbols. As illustrated in Figure 1, the generic clock symbol, broken red band, and solid yellow band have been replaced by four symbols which denote *long-time delay*, *dispensed*, *magnetic sensitive*, and *do not touch*. The symbols should identify specific munition hazards to the user on sight at the munition entry and not require the user to go back to the index to identify the color code.

Another addition is the intended effects or method of operation for the munition. Like the hazard symbols, this provides important information to the user about either the munition's content or basic information about how the fuze functions, further aiding in keeping the people of Ukraine, as well as clearance teams and first responders, safe.

As illustrated in Figure 2, an additional 105 new munitions, 289 new pages, and 203 additional photos have been added to Version 6.0. This graph does not show the additional information added to existing entries or the updated photos with better images from the field as new information and pictures become available.

In a never-ending effort to ensure (as much as humanly possible) that the information presented in the guide is 100 percent accurate, a formal quality assurance/quality control process has been in place since Version 4.0. Prior to publication,

Figure 1. The top row shows the old color code system, and the bottom row shows the new, more intuitive picture-based system of munition hazards.
All graphics courtesy of Bomb Techs Without Borders.

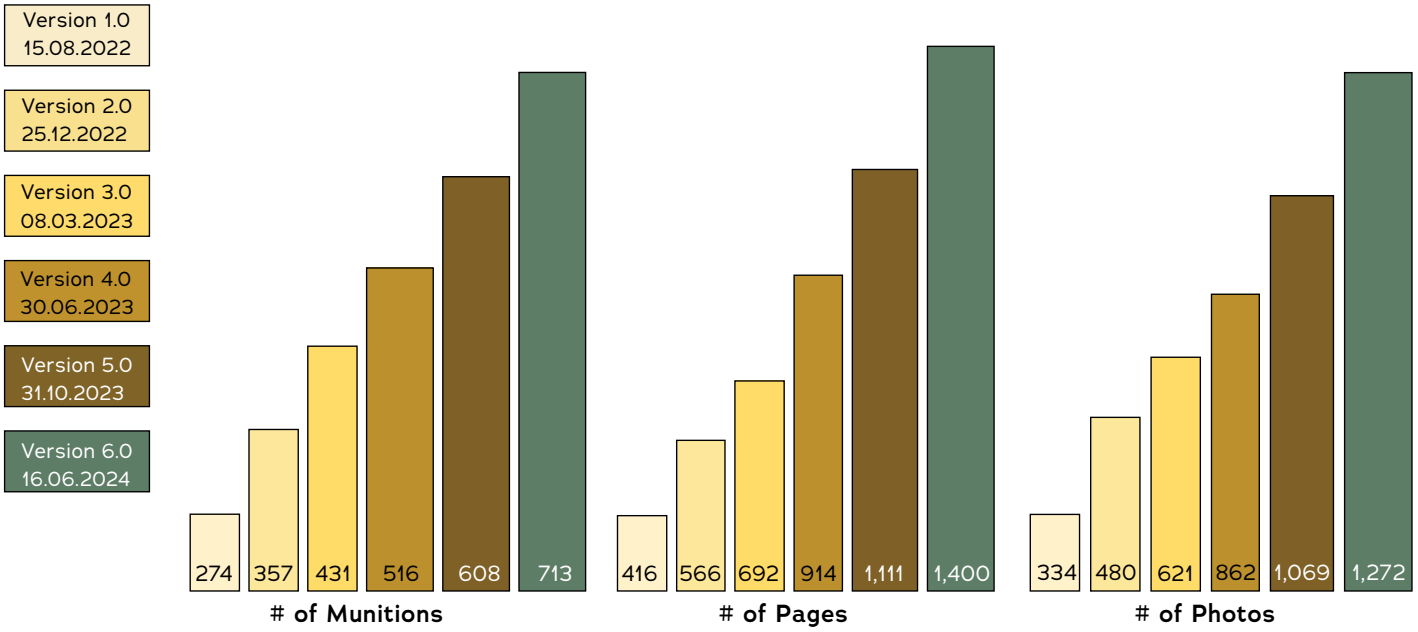

Figure 2. Progression from Version 1.0 to Version 6.0, showing an increase in the number of munitions, pages, and images included in the guide.
Courtesy of BTWOB.

EOD volunteers from the team from all over the world selected random entries in both the Ukrainian and English editions and checked the information against other references and/or field data. BTWOB linguists also conduct a thorough review to ensure the correct language and descriptions are used.

While the guide is expansive, additional information is always needed for new and old entries alike. Countless munitions have been donated/sold to Ukraine to help in the war, but that does not mean the guide has the required basic technical information to ensure safety for the people of Ukraine. Additionally, accurate information is always needed, especially if provided by the donating entity.

Version 7.0 is currently in development and is planned for publication in October 2024. The main focuses for Version 7.0 will be:

- Adding new munition entries to keep up with the ever-growing influx of ammunition from both friendly and hostile sources.
- Exploring a different platform or media through which to publish the guide. Due to its ever-expanding size, there is probably only one more version that can exist as a .pdf document.
- Convincing other Ukrainian demining and EOD departments to contribute to the guide.

See endnotes page 63

SENIOR LIEUTENANT PEREDERII
National Police of Ukraine EOD

Senior Lieutenant Perederii currently serves in the National Police of Ukraine (NPU) EOD and has been the primary NPU representative for the ammunition ID guide's development since the first edition. Senior Lieutenant Perederii has been in law enforcement for over nine years and an EOD officer for five years. He graduated from the EOD school in Merefa, Ukraine, in 2020 and has also attended numerous training courses overseas throughout his career.

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Tony Salvo is a former US Army enlisted EOD technician (eight years) with extensive combat experience in the Iraq and Afghanistan conflicts. Previously, he has worked in the humanitarian sector in Iraq and Syria clearing explosives hazards left from the ISIS conflict. Currently he serves as the Branch Director and Senior Technical Advisor for Bomb Techs Without Borders in Ukraine.

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Greening Mine Action in Armenia as a Component of Sustainable Development in the Economy of the Country

By Vaghinak Sargsyan [Center for Humanitarian Demining and Expertise]

Contamination in Armenia stems from the long-term conflict with Azerbaijan, affecting four out of eleven regions in Armenia: Tavoush region, Syunik region, Gexarquniq region, and Vayots Dzor region. The contamination covers an area of more than 42 km^2, with more than 10 km^2 confirmed hazardous areas and over 31 km^2 suspected hazardous areas. Land affected includes pasture (66 percent), arable (22 percent), and forest (12 percent). There are 805 registered victims of landmine and explosive remnants of war (ERW) incidents.

Additionally, among the 120,000 displaced Karabakh Armenians, more than 700 are survivors of landmines and ERW, many of whom find themselves in a socially vulnerable position.

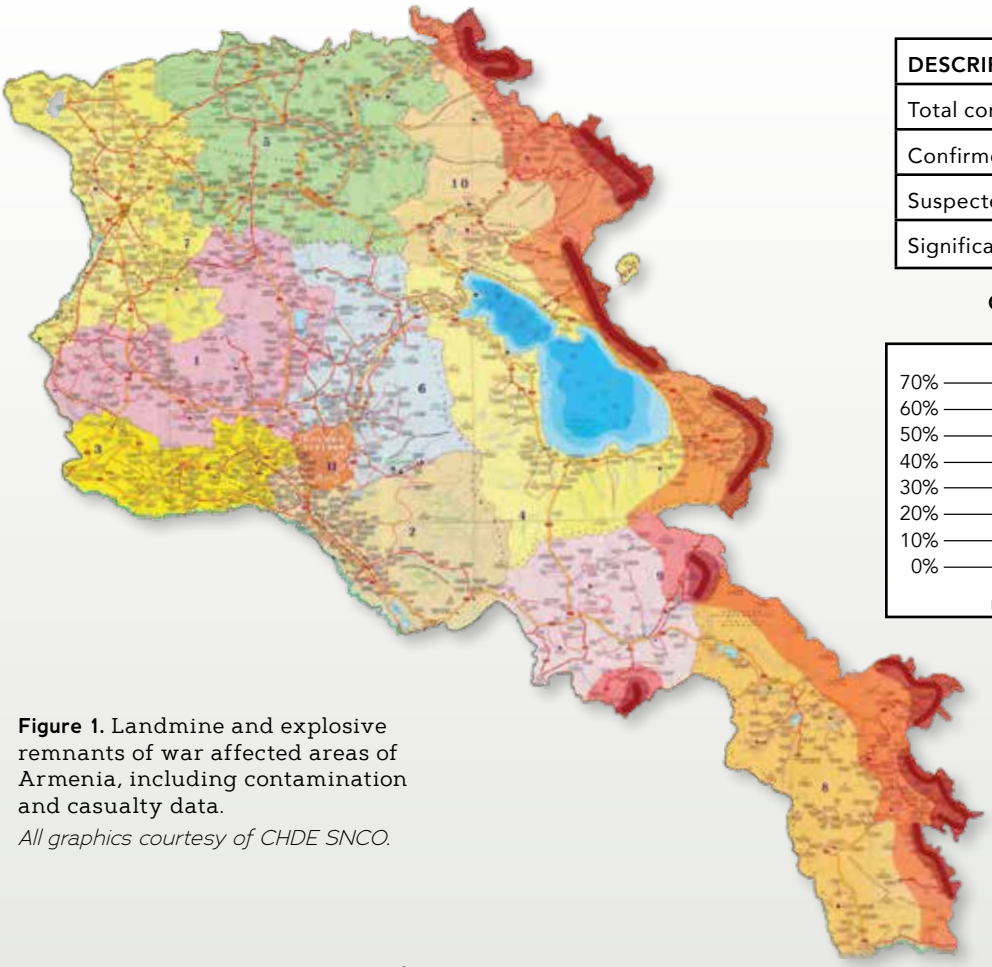


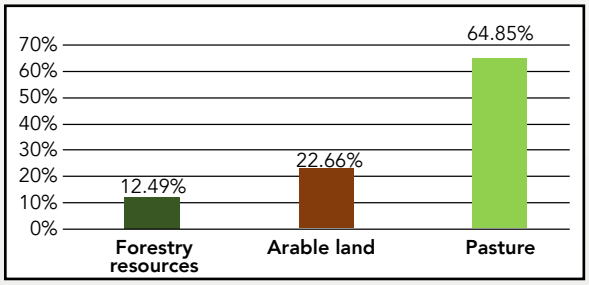
Figure 1. Landmine and explosive remnants of war affected areas of Armenia, including contamination and casualty data.

All graphics courtesy of CHDE SNCO.

REPUBLIC OF ARMENIA

DESCRIPTION	
Total contaminated area	42,165,966 m^2
Confirmed hazardous area (CHA)	10,641,178 m^2
Suspected hazardous area (SHA)	31,524,788 m^2
Significance of contaminated land	community

Category of agricultural importance of contaminated land



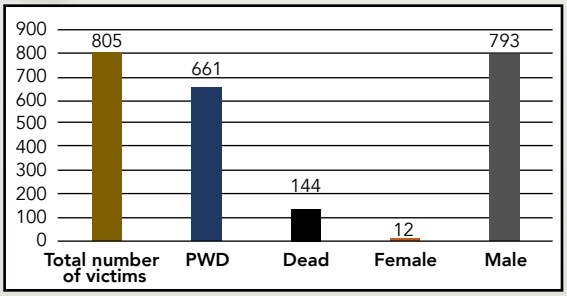
MAP SYMBOLS

- Direct contaminated area
- Indirect contaminated area
- The general zone of pollution influence

Demographic data of endangered communities

DESCRIPTION	COMMUNITY/ SETTLEMENT	POPULATION	%
Total population of the province	4	530,800	
Population of endangered communities	10	198,646	100%
EO direct danger zone	32	28,105	14.15%
EO indirect danger zone	35	31,123	15.67%

Victim data



CONSEQUENCES OF LANDMINE AND EXPLOSIVE REMNANTS OF WAR CONTAMINATION

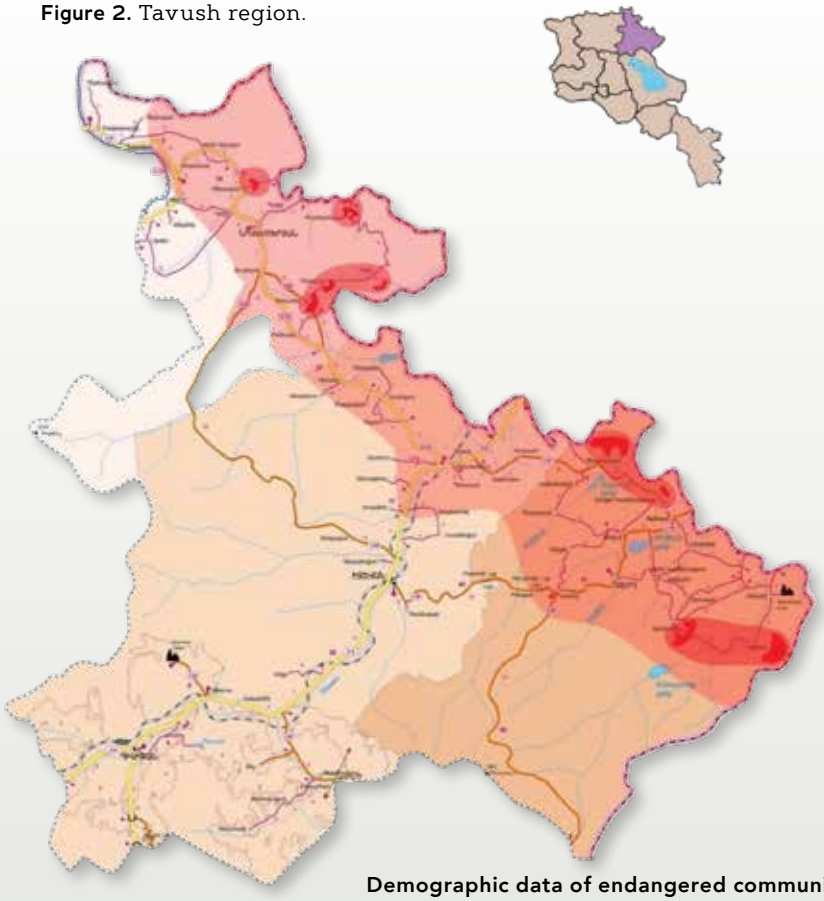
Areas contaminated with anti-personnel and anti-tank mines, cluster munitions, and other remnants of war present a threat to the residents of Armenia, impeding free movement, development of infrastructure, and the cultivation of land; endangering residents' safety; and the implementation of various social and economic programs in affected areas. This causes a chain reaction disrupting the sustainable development of the Armenian economy.

ERW have left thousands of people in Armenia with physical and psychosocial disabilities. Some survivors' inability to work due to their physical injuries can lead to psychological issues. Adopted in 2021, the Law on the Rights of Persons with Disabilities[1] aims to protect people with disabilities from discrimination and provide more inclusive opportunities, guaranteeing accessibility, independent living, access to justice, and reasonable accommodations.

Mine action is an important activity for any country with contaminated areas. It is imperative to increase the efficiency of such work, organize clearance and land release activities in a short time frame, set targeted priorities for the areas to be cleared, raise awareness among the population and promote behavioral change, carry out interconnected activities for targeted and coordinated victim assistance, and facilitate the implementation of various socioeconomic programs enabled by the clearance process.

Mine action cannot exclusively be a professional function in narrow terms, operating on the principle of "clearance for clearance's sake." It should function within the context of socioeconomic programs implemented by the state, local self-governing authorities, and international institutions.

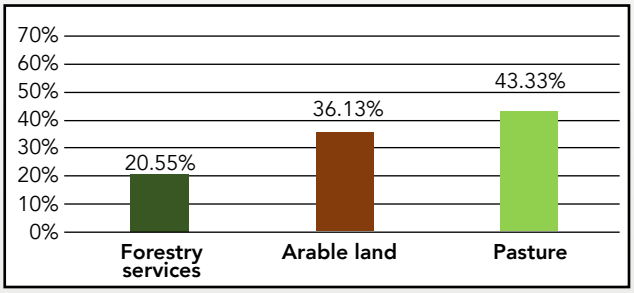
Figure 2. Tavush region.



TAVUSH REGION

DESCRIPTION	
Total contaminated area	214,330 m²
Confirmed hazardous area (CHA)	214,330 m²
Suspected hazardous area (SHA)	-
Significance of contaminated land	community

Category of agricultural importance of contaminated land



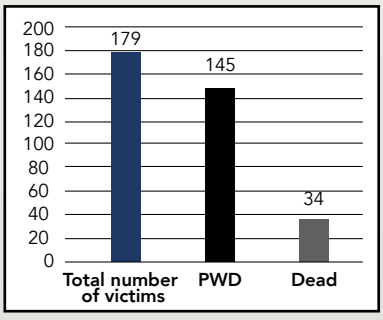
MAP SYMBOLS

- Direct contaminated area
- Indirect contaminated area
- The general zone of pollution influence

Demographic data of endangered communities

DESCRIPTION	COMMUNITY/ SETTLEMENT	POPULATION	%
Total population of the province	1	119,800	
Population of endangered communities	2	65,475	100%
EO direct danger zone	9	14,252	21.77%
EO indirect danger zone	8	9,052	13.83%

Victim data



THE CENTER FOR HUMANITARIAN DEMINING AND EXPERTISE

Since 2023, Armenia's Center for Humanitarian Demining and Expertise (CHDE) has conducted research on the aforementioned issues in cooperation with the UN Development Programme, World Food Programme, and UNICEF. Several pilot projects were jointly developed and implemented, aiming to find the optimal solutions to these issues. Currently, the mine action sector in Armenia works within a complex but innovative landscape. It is not only about what we do, but also how we and our partners translate the results of our joint work into long-term socioeconomic and environmental benefits for affected people and communities.

These include a wide range of operations within the context of mine action, including cooperation with public institutions, the private sector, international entities, and local and international nongovernmental organizations; setting priorities; collecting and managing data; conducting clearance operations; developing risk education to encourage behavioral change; victim assistance and involving survivors in the risk education process; environmental protection; and the application of artificial intelligence in analysis and planning activities. The process forms a roadmap that can help mitigate the problems caused by landmine and ERW contamination.

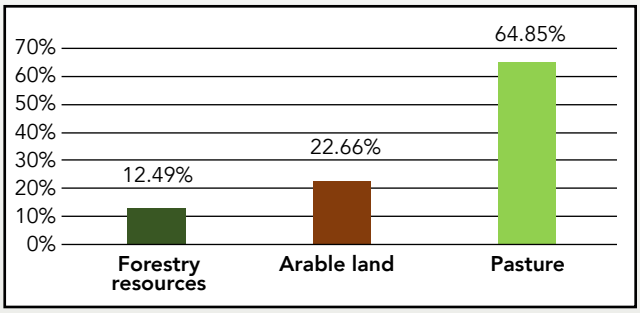
Within the scope of these programs, the CHDE coordinates with local self-governing authorities of contaminated regions, as well as with local and international organizations. During this coordinated work, certain activities are carried out in the prioritized communities (and in time, in all affected communities) thanks to complex cost-benefit planning. These activities include the survey, clearance, and handover of formerly-contaminated areas to local communities, development and implementation of socioeconomic programs, and monitoring and analysis of overall mine action activities, including residual risks.

Figure 3. Syunik region.

SYUNIK REGION

DESCRIPTION	
Total contaminated area	4,594,959 m²
Confirmed hazardous area (CHA)	3,132,298 m²
Suspected hazardous area (SHA)	1,462.661 m²
Significance of contaminated land	community

Category of agricultural importance of contaminated land



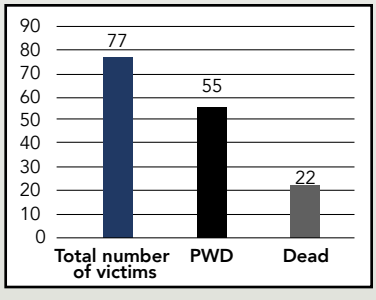
MAP SYMBOLS

- Direct contaminated area
- Indirect contaminated area
- The general zone of pollution influence

Demographic data of endangered communities

DESCRIPTION	COMMUNITY/ SETTLEMENT	POPULATION	%
Total population of the province	1	134,600	
Population of endangered communities	4	88,993	100%
EO direct danger zone	19	7,621	8.56%
EO indirect danger zone	11	5,443	6.12%

Victim data

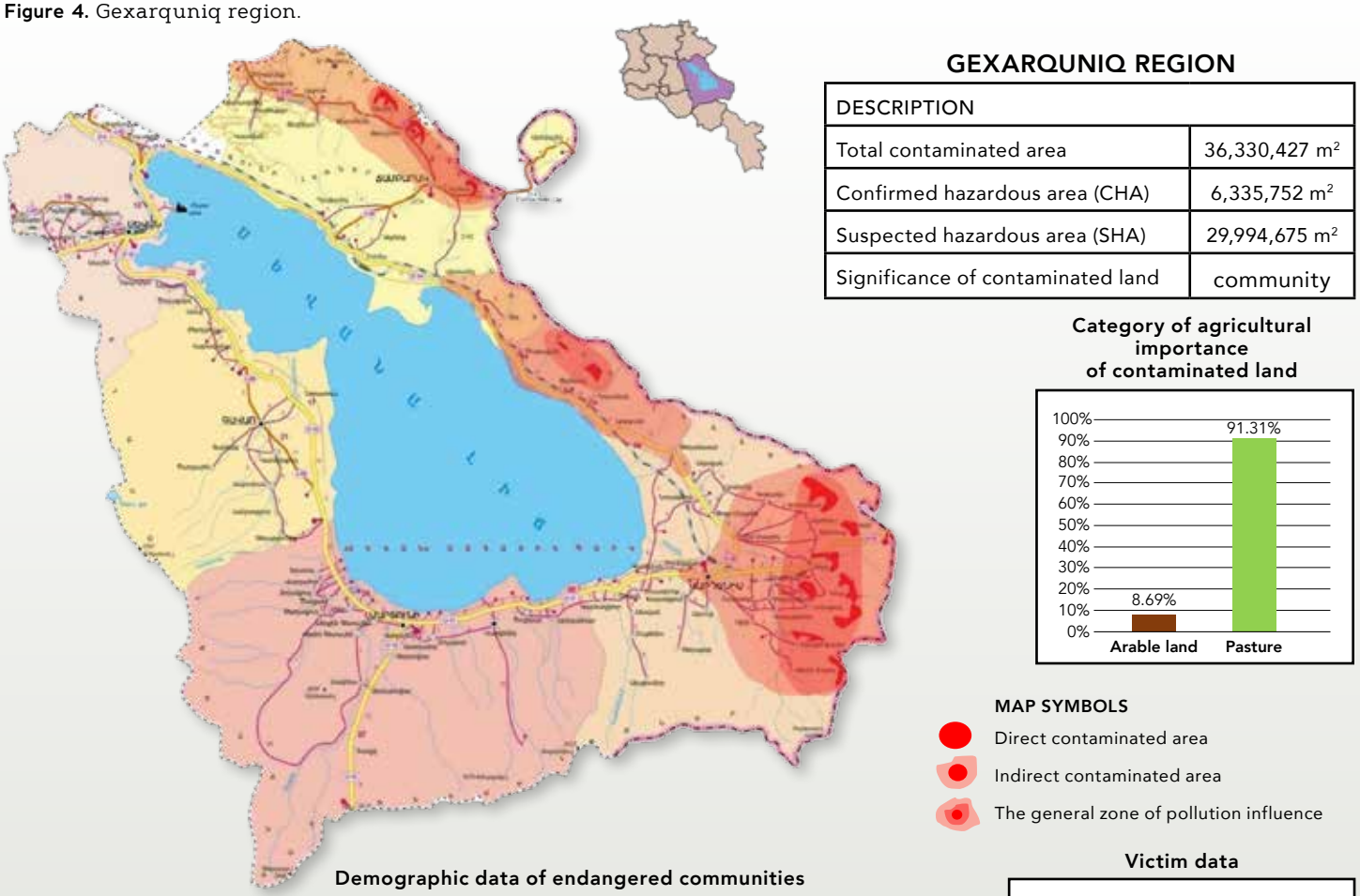


With this approach, where *Greening Mine Action* equates to safety and development, the CHDE prioritizes defining the landmine and ERW problem not only in terms of the number of affected communities or the size of contaminated areas, but also within the larger impact of explosive contamination on people and communities. The CHDE emphasizes the importance of social, economic, behavioral, and environmental impacts on people and communities in the context of sustainable development, land release, and environmental protection. This transformation not only leads to major improvements in the quality of mine action, but also facilitates the integration of mine action within the broader field of post-conflict recovery and development. Greening Mine Action encompasses three distinct stages.

STAGE 1: Design a Monitoring System of Contaminated Areas

Stage one consists of the short- and long-term monitoring of contaminated areas, known as pre- and post-clearance. Confirmed hazardous areas are cleared by both technical survey and land release activities, and explosive ordnance risk education (EORE) is conducted among the local population. EORE is conducted in person, particularly for schoolchildren and community members living in affected regions. With support from the UNDP, summer camps were organized in 2022 and 2023, attended by sixty families of mine/EO victims. In 2024, in cooperation with UNICEF and the Ministry of Education, Science, Culture, and Sports, EORE was introduced into school curricula, reaching 1,670 people.

Figure 4. Gexarquniq region.



STAGE 2: Assessment of Socioeconomic, Behavioral, and Environmental Impacts

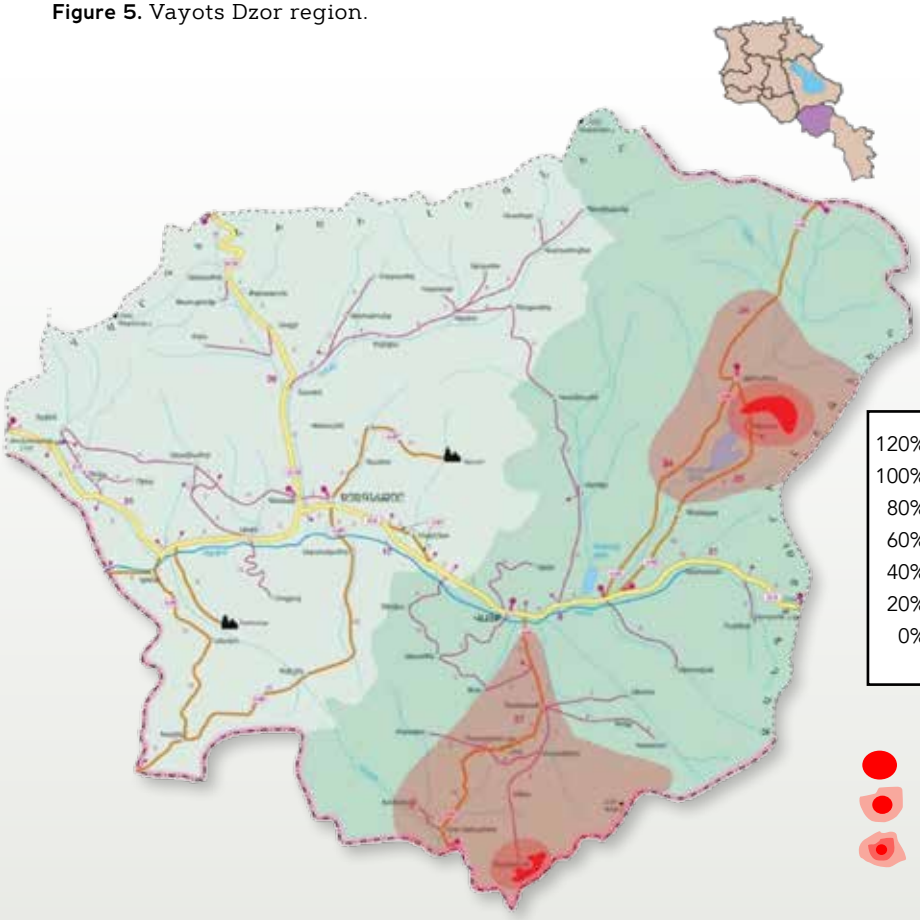
Stage two includes socioeconomic impact analyses, including the identification of food security components, assessment of behavioral change, and activities to eliminate the impact of landmines and ERW on the environment. Following clearance in contaminated regions, the UN's World Food Programme implemented socioeconomic activities in the Kechut community. Other examples include the construction of a reservoir in the Jermuk community, solar panels in the Vayots Dzor region, and the construction of waterlines in the Syunik region.

STAGE 3: Victim Assistance

Stage three includes monitoring and updating landmine and ERW victim data, conducting needs assessments and priority setting, social reintegration of survivors, and assisting with individual primary problems such as health, everyday activities, and more. CHDE established a new database system, the VICTIM Information System (VIS), which includes gender, age, and need-disaggregated data.

Since 2022, in the framework of the Greening Mine Action initiative, the CHDE has implemented pilot projects in cooperation with several UN programs in Davit Bek and Vorotan settlements, Syunik region, Sotk and Geghamasar settlements, Gegharkunik region, Jermuk and Kechut settlements, and Vayots Dzor region. As a result, an analytical-operational program on the socioeconomic impact of contaminated areas was created.

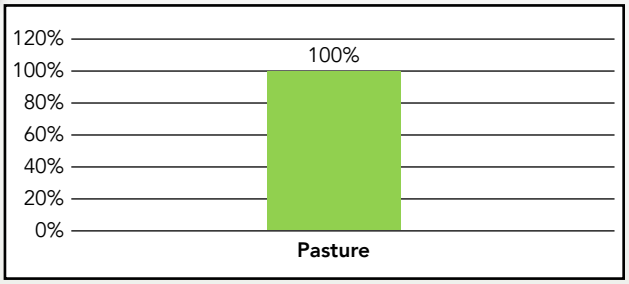
Figure 5. Vayots Dzor region.



VAYOTS DZOR REGION

DESCRIPTION	
Total contaminated area	1,026,250 m²
Confirmed hazardous area (CHA)	958,798 m²
Suspected hazardous area (SHA)	67,452 m²
Significance of contaminated land	community

Category of agricultural importance of contaminated land



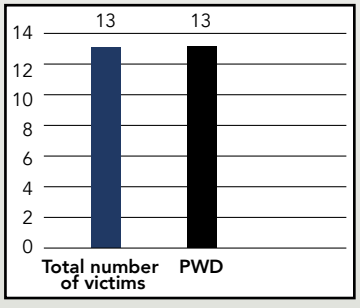
MAP SYMBOLS

- Direct contaminated area
- Indirect contaminated area
- The general zone of pollution influence

Demographic data of endangered communities

DESCRIPTION	COMMUNITY/ SETTLEMENT	POPULATION	%
Total population of the province	1	47,700	
Population of endangered communities	2	18,268	100%
EO direct danger zone	2	1,224	6.70%
EO indirect danger zone	4	4,860	26.60%

Victim data



A number of activities have been implemented within this framework. These have included conducting clearance operations according to the "do no harm" principle and providing "Green Label" certification to cleared areas, implementing economic projects such as irrigation systems, greenhouse farming, and grassland restoration, expanding explosive risk education among schoolchildren and teachers, and expanding targeted social programs to support survivors and their family members.

As a result of Greening Mine Action, new links of cooperation have been established and strengthened between state and local self-governing authorities in Armenia and international institutions, preparing for the full and effective implementation of international humanitarian programs in Armenia.

STABLE ECONOMIC DEVELOPMENT OF ARMENIA

To ensure its effective duration, significant importance is attached to the dynamic and systematic development of CHDE capacities. It also includes formal and informal learning, cooperation with international organizations, and forming a network of partnerships while organizing and implementing mine action activities.

The Advisory Group, established in 2023, consists of representatives from national and international organizations, UN offices operating in Armenia, the Geneva International Centre for Humanitarian Demining, and other organizations. This Advisory Group supports the CHDE and provides consultation on solving the most important issues in applying and introducing the latest tools and technologies in mine action. Furthermore, the Advisory Group supports the CHDE and other stakeholders with non-binding strategic advice, professional experience, knowledge, and invaluable contacts.

The objective of the CHDE is long-term capacity development for effective mine action activities in Armenia, aimed at clearing contaminated land to ensure civilians can move freely, succeed economically, and live safely in their communities. While the CHDE has laid the groundwork through surveys and mine action operations, the challenge remains in translating these initial successes into sustainable, enduring socioeconomic and environmental benefits for individuals, communities, and the country as a whole.

See endnotes page 63

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Vaghinak Sargsyan is the Director of the Center for Humanitarian Demining and Expertise state non-commercial organization (CHDE SNCO). Mr. Sargsyan served in the Armed Forces of the Republic of Armenia, holding a number of positions, and is a Reserve Colonel. In addition to his work with the CHDE, he is a master of sports and was awarded the title of Honored Coach of the Republic of Armenia.

ENDNOTES

An Interview with John Stevens [from page 5 **]**

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