EDITORIAL: Landmine Free 2025: A Shared Responsibility

FEATURE: Unmanned Aircraft Systems in Mine Action

SPOTLIGHT: South and Central Asia

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FROM THE DIRECTOR

Ken Rutherford

Our summer has been a busy one, with CISR recently completing the Regional Senior Managers’ Course in Conventional Weapons Destruction in Dushanbe, Tajikistan, this past June and July. With funding from the U.S. Department of State’s Bureau of Political Military Affairs’ Office of Weapons Removal and Abatement and in partnership with the Tajikistan National Mine Action Center (TNMAC), CISR’s fourth regional course, and the second held in Tajikistan, enrolled 25 senior managers from Afghanistan, Kazakhstan, Sri Lanka, Tajikistan, and Turkmenistan. In line with the concerns of the South and Central Asian region, the course focused on management topics pertinent to these countries, drawing on the expertise of JMU College of Business professors. It also included technical training and field visits on survivor assistance, improvised explosive devices (IED) in the humanitarian context, weapons and ammunition destruction, as well as demining in mountainous and border environments. Local implementing partners and technical experts, including Fenix Insight, Norwegian People’s Aid, Swiss Foundation for Mine Action, the Organization for Security and Cooperation in Europe, the United Nations Development Programme (UNDP), the Tajikistan Ministry of Defense, and the Union of Sappers of Tajikistan joined CISR and TNMAC in providing instruction. The course bolstered the skills of already high-quality programs in the region, adding to the network of nearly 400 senior managers trained by CISR across the globe.

For this issue of The Journal, we turn our attention to the Middle East, specifically Iraq and Syria, which present complex work environments for those working in humanitarian mine action. In their article, “Shattered Lives and Bodies: Recovery of Survivors of Improvised Explosive Devices and Explosive Remnants of War in Syria,” Médecins Sans Frontières (MSF, Doctors Without Borders) describes the types of injuries and the often difficult journey to treatment that internally displaced persons face when encountering improvised explosive devices (IED) and explosive remnants of war (ERW). MSF highlights the urgent need for a comprehensive mine response in Syria, including risk education, victim assistance, and mine clearance, and a greater coordinated effort from the international community to sponsor, support, and lead demining and other mine action activities. Moreover, Pehr Lodhammer (UNMAS) proposes the need for the mine action community to determine standards for properly assessing clearance values, specifically in Iraq. As with the Fallujah Iron Bridge, the monetary cost of clearing two IEDs from a major piece of infrastructure in two weeks should be judged on the socioeconomic impact it has on the area and not compared to the per unit price of clearing landmines under ideal conditions.

In the feature section, contributions from Small Arms Survey, the Geneva International Centre for Humanitarian Demining (GICHD), and the United Nations Office for Disarmament Affairs (UNODA) discuss the safe and secure management of ammunition (SSMA). In their article, “Life-cycle Management of Ammunition: Safety, Security, and Sustainability of Conventional Ammunition Stockpiles,” Small Arms Survey explain how ammunition stockpiles threaten national security and public safety and how improving the technical, structural, and political aspects of the stockpile management process can ensure a safe and secure national stockpile. In their article, “Increasing Efforts in SSMA: What Does it Take?” GICHD and UNODA build on a GICHD study illustrating the current state of SSMA while reviewing developments, as well as identifying capacity and implementation gaps in ammunition stockpile management.

In Notes from the Field, MMG Lane Xang Minerals Limited Sepon (LXML), a mining company, discuss how they have integrated unexploded ordnance (UXO) clearance into their mining operations and development projects in Laos. Sepon mine, owned by LXML, is situated in Vílabouly District, Savannakhet Province—one of the most bombed districts in Lao PDR.

And finally, Donald Pratt at Messiah College and Nicholas Torbet from The HALO Trust present their research and development on the Hybrid Thermal Lance. The article presents an alternative method to destroy landmines and other thin-cased ordnance through burning and deflagrating the explosive inside. While at a relatively early stage of testing, the authors believe that sharing the results and making the concept open-source will benefit the HMA community.

September will be a busy month for CISR as we attend the Eighth Meeting of States Parties to the Convention on Cluster Munitions in Geneva and present at both the regional workshop on Improvised Explosive Devices Threat Awareness in Astana, Kazakhstan, sponsored by the OSCE Programme Office in Dushanbe and Astana, and the Middle East Institute’s “Explosive Hazards in the Middle East: Addressing a Growing Threat,” which is the first conference in Washington, D.C. to focus exclusively on explosive hazard removal efforts in the Middle East. As our focus continues on the South/Central Asia region, we welcome contributions on HMA operations and programs in Afghanistan, Kazakhstan, Kyrgyzstan, Nepal, Sri Lanka, Tajikistan, Turkmenistan, and Uzbekistan. In addition, as the HMA community increasingly leverages unmanned aircraft systems (UAS) for various uses within the field, we welcome contributions from the community on UAS technology, case studies, and standards. Please be in touch with Journal staff regarding any questions you may have regarding submissions.

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Ammunition is an essential resource for the implementation of a national defense and security policy. National ammunition stockpiles—regardless of their functional classification—can pose risks to national security and public safety. Poor accounting and inadequate physical security of storage facilities can lead to the diversion of ammunition from the national stockpile to terrorists, criminals, and other armed groups, increasing insecurity and instability. Furthermore, the deterioration of munition components can contribute to unplanned explosions at munitions sites (UEMS), which can have significant negative socio-economic and political consequences for the public and national governments. Comprehensive ammunition management ensures that the right types and quantities of ammunition are available, at the right time, to support national strategic and operational needs. It is also seen as the only long-term strategy for preventing the excessive accumulation of surplus and for mitigating the safety and security risks inherent to all ammunition stockpiles. Such an approach takes into account the technical aspects of ammunition management that are often covered by stockpile management efforts, as well as the related structural and political dynamics. This results in planning challenges and has significant budgetary implications for governments. A systems-based approach to the life-cycle management of ammunition (LCMA), and a long-term strategy to execute it, can help a state to address these challenges by minimizing the probability of excessive surplus accumulation and mitigating diversion and UEMS risks while meeting national strategic and operational needs.

This article provides an overview of the LCMA approach. Drawing on previous Small Arms Survey work such as A Practical Guide to LCMA Handbook and the case study, "LCMA: Lessons Learned from Bosnia and Herzegovina," this article provides an abridged version of the LCMA model and the lessons learned from efforts to establish LCMA in Bosnia and Herzegovina (BiH). Perhaps more importantly, it also invites policy-practitioners to think creatively about ammunition management and argues that national ownership creates an enabling environment that supports the effective functioning of LCMA. The political and structural aspects of ammunition management determine the efficiency of LCMA-related processes and activities: rather than being opposing concepts, the political dynamics and technical aspects of ammunition management are tightly intertwined.

What Is LCMA?
Ensuring effective management of ammunition requires a comprehensive approach that allows states to meet their long-term strategic and operational requirements and ensure safe and secure ammunition stockpiles. LCMA is an example of such an approach and recognizes the importance of adequate technical capabilities but also emphasizes the political dimension of managing ammunition across its life cycle: planning, procurement, stockpile management, and disposal. This section provides an overview of the safety and security implications of improper stockpile management before introducing the concept of LCMA.

UEMS, Diversion, and Surplus Accumulation
Despite growing awareness, in many states ineffective management of ammunition stockpiles continues to be the norm. All ammunition stockpiles pose a risk of UEMS and diversion...
along all points of the national stockpile chain: manufacture, storage, employment, and disposal. According to the Small Arms Survey’s UEMS Database, about 580 UEMS occurred in more than 100 countries between 1979 and February 2018, often with grave social, economic, and political consequences (see Figure 1). In addition to fueling crime and terrorism, ammunition that is diverted from state stockpiles can affect the duration and intensity of armed conflicts.

States view conventional ammunition stockpiles as assets rather than liabilities and thus have a tendency to retain ammunition stockpiles in excess of strategic and operational requirements. In some contexts, together with ineffective stockpile management practices, this leads to the accumulation of unsafe, unserviceable, and obsolete surpluses in the national stockpile. The result is a build-up of ammunition and an increase in safety and security risks. Surplus accumulation also leads to a considerable financial burden for states in terms of operational, maintenance, and destruction costs.

Historically, national authorities, international donors, and practitioners have adopted technical approaches for dealing with surplus accumulation and mitigating the risk of UEMS and diversion. Often under the heading of physical security and stockpile management (PSSM), the aim is to improve stockpile management practices by bringing them in line with international best practices, such as the measures elaborated in the International Ammunition Technical Guidelines (IATG). Technical approaches have a number of benefits: they can be cost-effective and help to mitigate the risk of UEMS, diversion, and surplus accumulation at storage locations.

One of the main shortcomings of the technical approach is its lack of sustainability. Despite the increase in safety and security, most technical programs and initiatives to reduce ammunition-related risks are not usually designed or implemented in a way that would address the systematic failures in stockpile management that lead to UEMS, diversion, and excessive surplus accumulation. A key challenge faced by national authorities, donors, and implementing organizations is to deliver appropriate technical programs to respond to incidents of UEMS and diversion, as well as to address the underlying, higher-level causes of these events. The effectiveness of technical initiatives cannot be guaranteed without addressing systemic shortcomings. International guidelines emphasize that states take a proactive, rather than reactive, stance in ensuring the safety and security of stockpiles to the highest possible standards.

Effectively addressing both is contingent on adopting a comprehensive approach to ammunition management, as outlined by the Small Arms Survey’s LCMA model.

**LCMA: A Comprehensive Means of Ammunition Management**

LCMA comprises a comprehensive set of integrated processes and activities that ensure sustainable and cost-effective management of ammunition, delivering a safe and secure stockpile that meets national strategic and operational needs. The LCMA approach recognizes the importance of adequate technical capabilities but also emphasizes the political dimension of managing ammunition across its life cycle. It requires that state actors at the strategic, operational, and tactical levels work together on multiple ammunition-related aspects to ensure cost-effective management of the entire national stockpile.

The LCMA model draws on current practices among a number of states that participate in NATO’s Partnership for Peace (PfP) program as well as other NATO partners that...
implement comprehensive ammunition management systems. These states have well-established militaries and a long history of ammunition management. While national approaches may differ, one feature is central to all: the effectiveness of LCMA systems in these states is ensured by a high degree of national ownership. This feature guarantees an enabling environment, a prerequisite for sustainable ammunition management.

**LCMA Model**

By analyzing the various LCMA systems observed in the NATO and PfP states, the Small Arms Survey developed a general LCMA model (Figure 2). It is composed of one structural element and four functional elements. To be effective, all elements must work together as an integrated and efficient whole.

The structural element, which involves national ownership and its associated enabling conditions, supports the effective and efficient management of ammunition across the life cycle to ensure the integrity and sustainability of the LCMA system. Often recognized as a key aspect of LCMA, the structural aspects of ammunition management are rarely elaborated in detail by international guidelines. The LCMA model also consists of four functional elements: planning, procurement, stockpile management, and disposal, which ensure the safety, security, and cost-effectiveness of ammunition stockpiles. The four functional elements draw and, where necessary, elaborate on the best practices for stockpile management according to the IATG.

**Milestones**

Throughout an LCMA system, decisions are made in order to manage the national stockpile and mitigate the risk of UEMS and diversion. Milestones are points in the life cycle where the most critical decisions are made regarding transition across the functional elements of LCMA and their related processes and activities. There are a number of milestones within any LCMA system. Examples include:

- **Planning to procurement:** involves the development and approval of strategic plans and budgets for the acquisition and management of types and quantities of ammunition necessary for achieving defense goals and operational requirements.

- **Procurement to stockpile management:** involves the procurement of ammunition based on confirmation that the items being acquired are safe and suitable for service (also known as an S3 process).

- **Stockpile management to disposal:** involves the approval of disposal of ammunition following a national disposal review.

- **Disposal to planning:** involves the certification or confirmation of disposal activities.

**Prerequisites for Implementing LCMA Systems**

An enabling environment is a prerequisite for sustainable ammunition management. It allows for long-term policies and plans to become targeted, integrated, and coordinated programs aimed at effectively managing the national stockpile.
and mitigating the risks posed by the ammunition. There is agreement, both within and outside the U.N. system, that a high degree of national ownership is necessary for sustainable ammunition management. Despite the recognition that national ownership matters, there is little guidance on what it means in practice. This section provides an overview of the concept of national ownership before discussing the enabling conditions that foster it and support effective implementation of LCMA.

National Ownership for Ammunition Management

At its core, national ownership is grounded in the premise that states need to take responsibility for ammunition management and be actively engaged in ensuring the safety and security of their stockpiles. A state demonstrates national ownership when national actors—including relevant political decision-makers, armed forces planning and logistics staff, and procurement authorities—have defined and active roles in designing, implementing, and monitoring all processes and activities across the ammunition life cycle, such as planning, procurement, stockpile management, and disposal.

The IATG state that “the primary responsibility for conventional ammunition stockpile management shall rest with the Government of the state holding the ammunition.” It follows that national ownership is not simply about political buy-in for ammunition management but also about taking responsibility for setting up and maintaining an LCMA system by:

- Establishing a set of effective life-cycle and enabling processes that allow them to make milestone-relevant decisions and to plan and implement programs for each functional element of LCMA.
- Providing national financial resources for the system to cover the cost of procurement and post-acquisition costs, such as those associated with storage, surveillance, transportation, maintenance, security, and disposal.
- Facilitating the establishment of the enabling conditions necessary for supporting the effective management of ammunition over its life cycle.

Enabling Conditions for LCMA

There is a dynamic relationship between national ownership and the enabling conditions that make LCMA possible. In turn, these conditions foster national ownership for ammunition management and ensure the sustainability of the LCMA system as a whole. They include a normative framework, an organizational framework, infrastructure and equipment, and human resources.

The concept of enabling conditions is inherent in U.N. General Assembly Resolution 72/55 “Problems arising from the accumulation of conventional ammunition stockpiles in surplus” (2017), which recognizes “the importance of appropriate national ammunition management structures and procedures, including laws and regulations, training and doctrine, equipment and maintenance, personnel management and finances, and infrastructure in order to ensure sustainability in ammunition management.” The rest of this section presents the four enabling conditions in more detail.

Normative Framework

An LCMA system needs to be anchored in and informed by a normative framework that provides guidance on ammunition management at different operational levels. The development of an appropriate framework is a national responsibility and is based on national needs and priorities. For states without a normative framework in place, the IATG offer concrete guidance and tools for ammunition safety and security, as well as a model for effective stockpile management. They also provide advice on developing technical directives for ammunition management and on the roles and competencies of ammunition specialists.

Organizational Framework

National ownership for ammunition management calls for context-specific organizational frameworks (i.e., relevant institutional and organizational structures that are led and staffed by national personnel) and allows for coordination and oversight of ammunition management processes and activities, and ensures efficient implementation. Establishing a framework involves meeting a number of preconditions, including:

- A high level of institutional and organizational development. An LCMA system demands a high level of institutional and organizational development, with clearly defined tasks, competencies, and responsibilities.
- A high level of flexibility. The organizational structure must also be flexible enough to ensure that there is information exchange, coordination, and oversight among relevant stakeholders, both international and national.

Infrastructure and Equipment

Infrastructure and equipment are essential to support the implementation of LCMA. A state cannot claim to have the capacity to ensure the safety and security of its stockpiles or the disposal of surplus without them. For this reason, the last decade has seen a considerable increase in the number and scale of international assistance programs related to capacity
since 2012, the international community has coordinated its efforts to provide infrastructure upgrades to strategic ammunition (and weapon) storage. Similar efforts have also been seen in Mali, where the international community has focused on improving physical security infrastructure in order to prevent weapons and ammunition from getting into the hands of insurgent groups.21

Human Resources
The implementation and sustainability of an LCMA system depends on the availability of adequately trained personnel at all levels (strategic, operational, and tactical) and the existence of effective personnel management systems. Training on basic stockpile management activities—such as cleaning, storehouse maintenance and organization, inspection and surveillance of ammunition, inventory management, and accounting—can help to reduce the probability of UEMS and diversion. In addition, training is key in fostering national ownership and is most effective when it is transferred and integrated into a recipient state’s institutions.

Functional Elements of an LCMA System
There are four functional elements of the LCMA model that relate to the different stages of the ammunition life cycle: planning, procurement, stockpile management, and disposal. The elements must be managed in order to ensure that they operate in a coordinated manner and that the risk of UEMS and diversion is kept to a minimum. Each functional element is summarized below.

Planning
Planning is essential to the overall management of ammunition. An LCMA system must be thoroughly planned from the outset, with dedicated resources and procedures put in place in advance of any new acquisitions or other alterations to the system. Direction is provided by a state’s national defense policy, which is translated into a comprehensive, long-term defense strategy that defines the scope of LCMA planning (Figure 3). Consequently, a primary milestone of the planning element is the development of a cohesive national ammunition stockpile plan that meets the long-term defense planning goals.

The LCMA planning begins by defining the nation’s ammunition requirements and continues through the development of integrated programs. It is incumbent on planners to understand all of the downstream ramifications of their stockpile-related decisions. For this to take place, an information management system must be in place to ensure oversight is maintained over the entire system. An information management system also allows planners to gather essential information for the development of element-specific programs, which turn identified needs into achievable outputs given financial and human resource constraints.24

Procurement
An effective procurement process delivers ammunition that is suitable for the implementation of the national defense policy in a safe and secure manner.25 While the planning element of the LCMA model determines the general parameters for the quantity and type of ammunition to be procured, the procurement element begins with the approval of ammunition for acquisition and concludes with its entry into service. Ever before an order is placed, a limited amount of ammunition is usually acquired for testing (i.e., demonstration and evaluation) purposes to determine the safety and suitability for service of the ammunition.26 Once ammunition is deemed suitable for service, it can be acquired either from producers located within their national territory or, more commonly, from commercial suppliers in other states. States import new and surplus ammunition via commercial sales, government-to-government sales, or gifts. The import of surplus ammunition is cost-effective if it is in good condition.27 However, purchasing from old stockpiles can lead to “controversial quality control, dubious traceability issues, and procurement fraud.”28

Procurement systems are expected to adhere to good governance principles and include robust anti-corruption provisions. Regardless of the mode of acquisition, states manage the safety and security of ammunition during the acquisition process, with a focus on ensuring state control and oversight, comprehensive registration and record-keeping, and safe and secure transportation.29 States also develop laws, regulations, and administrative procedures to control and regulate the import, export, transit or transshipment, and brokering of military items and technologies, including ammunition. Recording each stage of the acquisition process and of the ammunition’s entry into service is essential to ensuring the safety and security of the ammunition.30 This is particularly true at moments when the ammunition is susceptible to theft, loss, or an unplanned explosion.

Stockpile Management
In order to meet operational and strategic requirements, as well as to ensure the safety and security of stored items, it is important to embrace effective stockpile management policies and practices. Stockpile management begins when ammunition enters the stockpile and ends when it leaves, be it...
through issuance (for training or operations), consumption (ammunition spent), or disposal (through exports or demilitarization). With many complex and interrelated processes and activities, stockpile management requires continuous review and assessment to ensure the adequacy of resources, infrastructure, equipment, and personnel. These review processes form the key milestones of the stockpile management element.

The stockpile management element of the Survey’s LCMA model is based on the IATG—more specifically, the IATG core groups of activities around which all stockpile management processes and activities are structured. To ensure effective stockpile management and reduce the risk of unplanned explosions and diversion, the core groups interact very closely, with individual activities depending on or influencing each other across group boundaries. The six core groups of ammunition-based activities are accounting, destruction, maintenance, stockpile security, storage, and transport.

Management of the risks inherent to ammunition storage is a fundamental component of stockpile management. Adherence to the IATG fulfills many of the requirements of an integrated risk management system. Figure 4 outlines the overarching risk management approach of the IATG, in particular the relationship between the different components of risk management. The IATG also offer detailed explanations of each component of risk management and techniques for stockpile management.

Disposal

Disposal is the removal of unsafe, unserviceable, obsolete, or excess ammunition from the national stockpile. Until it has been physically removed from the stockpile, disposal-designated ammunition is treated as part of the national stockpile. A state’s decision to dispose of ammunition as part of a national disposal review is the first step in the process, and a number of factors can influence that decision. The process ends with the physical removal of disposal-designated ammunition from the stockpile as a result of a disposal action. A number of milestones are related to disposal and include

- The decision to dispose of ammunition.
- The selection of a disposal method and process in the case of demilitarization.
- The completion of disposal activities.
- The confirmation that ammunition has been disposed of properly and in accordance with a disposal decision.

While historically various disposal methods were available to a state, there currently are only two internationally-accepted disposal methods: exports (sales or donations) and demilitarization. Of these two, states tend to prefer export; however, international arms and ammunition control efforts emphasize demilitarization. The Arms Trade Treaty (ATT) establishes legally binding commitments governing the export, import, transit, transshipment, and brokering of conventional arms and ammunition. A number of technologies are potentially available for demilitarization, each one with advantages and disadvantages. Although commonly used, open burning (OB) and open detonation (OD) are modes of disposal that are increasingly discouraged by states due to health and environmental concerns.

Age, unclear history, or the existence of internal damage, corrosion, and other dangerous conditions (such as exudation or crystallization) can mean demilitarization causes significantly greater risks than those associated with new ammunition. Advanced planning is key to fully addressing ammunition disposal methodologies and risks, and can reduce costs and ensure appropriate equipment and training for individuals assigned to accomplish safe and efficient disposal and decommissioning tasks. Managing risk for demilitarization also requires developing effective munitions emergency response processes and procedures for the decommissioning of contaminated sites, both of which require the participation of specially trained individuals.
LCMA in Context: Lessons Learned from Bosnia and Herzegovina

Recognizing that a comprehensive approach is best suited to address complex ammunition management challenges, this section uses the LCMA model presented as a framework for analyzing the emergence of an LCMA system in BiH during the period 2012–2016. The section stresses the importance of focusing on ammunition management as a distinct area of concern when considering ammunition, weapons, and explosives (AWE) challenges in post-conflict settings. It highlights ten lessons learned from implementing four of the five main elements of an effective LCMA system: national ownership, planning, stockpile management, and disposal. The fifth element has not been implemented, as BiH has not yet made provisions for the procurement of ammunition.

The disintegration of Yugoslavia had serious repercussions for ammunition management in BiH. The onset of conflict, in June 1991, combined with a U.N. arms embargo on Yugoslavia’s successor states in January 1992, had serious negative consequences for ammunition management capacities and practices. The immediate post-conflict period was characterized by efforts to exercise basic control of ammunition and weapon stockpiles in BiH instead of developing life-cycle management systems for ammunition and weapons.

By 2000, the focus had switched toward defense reform, military downsizing, and the identification and disposal of surplus weapons and ammunition. Despite the urgency to deal with the surplus ammunition, and the establishment of a normative framework to do so, competing political interests undermined the disposal process (Figure 5). Consequently, international pressure for addressing the safety and security concerns of the national ammunition stockpile increased by the end of the 2000s, paving the way for the development of a plan to establish an LCMA system in the country. The priority for BiH to date has been to identify and dispose of excessive, unstable, and unsafe ammunition and to put in place the planning and management processes that will ensure the safety and security of the ammunition that the country needs to implement its national defense and security strategy.

Lesson 1: National ownership is fundamental for effective LCMA. The international community substituted for a lack of national capacity to manage and dispose of surplus ammunition in post-conflict BiH. Since 2012, however, the international community has focused on building national capacity to ensure ownership of the LCMA system. As a result of these efforts, high-ranking BiH Ministry of Defence (MoD) and Armed Forces of Bosnia and Herzegovina (AFBiH) personnel, including the minister of defense and chief of defense, are now taking the lead in related decision-making and planning on ammunition as well as ensuring that armed forces personnel are sufficiently trained.

Lesson 2: The coordinated, long-term commitment of international partners is essential for the establishment of LCMA in a post-conflict setting. Prior to 2013, there was a lack of coordination, communication, and information sharing between international and regional organizations, states, and NGOs working to address BiH’s ammunition stockpile...
challenges.40 To address these issues, all key international stakeholders committed to providing expertise and resources in a complementary and coordinated way to help the BiH MoD and the AFBiH address the challenges posed by the AWE stockpile.41 By the end of 2012, thanks to the non-paper, the international community had streamlined its efforts on how to address BiH’s ammunition stockpile challenges.40

**Lesson 3:** Implementing effective LCMA in a post-conflict setting requires early agreement on overall objectives, specific priorities, and resource requirements. During the first quarter of 2013, the international community convened a task force consisting of key international and BiH stakeholders to develop an AWE Master Plan that defined the desired outcome for addressing AWE challenges as “the transparent disposal of surplus ammunition and weapons and the introduction of a sustainable ammunition and weapons lifecycle management system in BiH.”42 The AWE Master Plan provided clarity on the international community’s capacities, resources, and potential contributions in addressing BiH’s AWE challenges. It also defined the roles and responsibilities of the different international actors, the BiH MoD, and the AFBiH.43 The AWE Master Plan was endorsed by all relevant national and international stakeholders.

**Lesson 4:** Sustainable LCMA requires robust organizational structures and appropriate personnel.

The AWE Master Plan defined the organizational structure required to support the programs and activities for the transparent disposal of surplus ammunition and the implementation of sustainable LCMA.44 This organizational structure ensured effective and efficient coordination of national and international activities, confidence among all key stakeholders, and empowered BiH authorities and senior leaders within international organizations.

Moreover, appropriately experienced, skilled, and motivated personnel should be placed in key positions to ensure that the organizational structure delivers the desired changes. A critical factor in the case of BiH was the European Union Force (EUFOR) commander’s decision to create the position of senior advisor for weapons and ammunition disposal (SAWAD) in April 2013. SAWAD can influence decision-making, oversees implementation, and ensures the overall coordination of Master Plan activities.

**Lesson 5:** Successful LCMA rests on a comprehensive inventory of the ammunition stockpile.

It was not until 2012 that a decision was made for BiH to conduct a comprehensive inventory—locally referred to as the 100 per cent inventory—of its ammunition stockpile, create a single national ammunition list, and establish a national inventory management system.45 BiH’s limited capacity made it difficult to conduct the 100 percent inventory in an effective and timely manner.46 Therefore, from 2012 to 2013, AFBiH personnel received training in basic ammunition handling, testing, storage, LCMA regulations and standard operating procedures (SOP), and inventory management.47 The AFBiH began the ‘100 percent inventory’ in 2013 MoD, and it is expected to be finished by the end of 2018.

**Lesson 6:** Stockpile safety depends on an assessment of the condition of stored ammunition. A key component of effective LCMA, more specifically of the 100 percent inventory referred to previously, is the ability to determine the physical condition, chemical stability, and hazard classification of ammunition in the national stockpile.48 With the support of the international community and as part of the 100 percent inventory mentioned in Lesson 5, the BiH MoD decided to undertake:

- A stock-check of the entire ammunition stockpile.
- A visual technical inspection of all the ammunition.
- A chemical test of the propellant, using quick propellant analysis kits (QPAK) provided by the Austrian component of the mobile training team (MTT) Project.48

These additional assessments laid the foundations for the development of an ammunition surveillance system in BiH.

**Lesson 7:** Adequate resources and capacities are needed for a safe and secure ammunition stockpile. Effective stockpile management involves the safe and secure storage, transportation, and handling of ammunition.49 In accordance with BiH’s Law on Defence and the future operational requirements of the AFBiH, OSCE SECUP, and UNDP EXPLODE, assistance projects upgraded safety and security standards for two prospective ammunition storage sites in BiH: Kula 1 and 2, and Krupa. The Doboj demilitarization facility was also upgraded, because these sites have capacity to house BiH required ammunition and can be maintained by the AFBiH.50 These infrastructure upgrades, as well as donations of equipment and training provided by the EUFOR MTT Project troop-contributing nations, reflect good coordination between BiH and its international partners.51

**Lesson 8:** Effective and efficient surplus disposal requires adequate normative and institutional frameworks, as well as the necessary political will. As noted previously, ammunition disposal was a politically sensitive issue during the late 2000s. While presidential approval was (and continues to be) required for any form of disposal, the process for authorization is now more efficient, and approval is granted more quickly than in the past.50 The reduction in the time...
taken for the presidential approval led to a significant increase in the ammunition disposal rate during the period 2015–2016 (see Figure 5).52

Despite BiH authorities preferring to export their surplus ammunition, demilitarization continues to be the primary mode of disposal in the country.53 International stakeholders have facilitated the demilitarization and destruction process by increasing the capacity and skills of AFBiH personnel and employing independent contractors at the TROM Doboj demilitarization facility and the Glamoc range.51

**Lesson 9: Serviceable but surplus ammunition may be disposed of through export sales authorized in conformity with a country’s international commitments.** Prior to 2013, international partners and key BiH stakeholders had divergent views regarding the export of surplus ammunition.50 Stakeholders have come to accept export sales as a valid method for the disposal of surplus if carried out by national authorities in accordance with international standards, such as those of the ATT.54 Several independent assessments have concluded that BiH’s arms export control legislation and administrative procedures meet such standards.55 The BiH MoD has developed administrative guidance for the disposal of surplus by export in the 2012 Plan for Resolving Surplus.56

**Lesson 10: Serviceable but surplus ammunition can also be disposed of through international donation to demonstrate support for international partners.** The BiH president must approve the disposal of surplus through international donation after an assessment of political, strategic, and foreign policy considerations. MoD BiH and AFBiH representatives have raised two sets of concerns regarding such donations. The first is a concern over foregone profit. International stakeholders, however, have stressed that donations help to dispose of ammunition that, while still serviceable, needs to be used quickly.52 Such ammunition is unlikely to meet the quality needs of commercial importers. The second concern relates to the perceived risk of donated material diverting.57 This reflects recent media coverage of the possible diversion of BiH donations intended for Iraqi government forces to non-state armed groups in the Middle East and North Africa.58 Yet diversion risks can be reduced via international cooperation and good practice.55 At the same time, such donations can allow BiH to contribute to efforts to strengthen international peace and security.59

**Looking Forward**

A comprehensive ammunition management approach is required to ensure that a state’s national stockpile is safe, secure, and operational when needed in order to meet national and strategic objectives. The LCMA approach not only allows for the mitigation of the risk of UEMS and diversion, but also
ensures sustainability of international cooperation and assistance projects. The most recent General Assembly Resolution on the “Problems arising from the accumulation of conventional ammunition stockpiles in surplus” (A/RES/70/35) stresses the need to develop and implement cooperation and assistance programs that ensure sustainability—i.e., are able to mitigate the immediate risk of UEMS and diversion and have a lasting impact on ammunition management practices at the national level. To date, a limited number of international cooperation and assistance projects have been designed and implemented with the intention of ensuring sustainability by addressing ammunition management practices across the life cycle: from planning to procurement, stockpile management, and disposal. The case of BiH is an illustrative example.

From a practical perspective, this article provides an overview of the experience and lessons learned from efforts to establish and implement a sustainable LCMA system in BiH. The BiH experience is useful for other prolonged post-conflict environments or those states aiming to establish an LCMA system. Establishing and implementing better stockpile management processes and ultimately LCMA are long-term and challenging endeavors. These efforts do not need to be accomplished all at one time. Improvements can be incrementally structured and implemented based on national priorities, available resources, capacities, and capabilities, considering the potential efficiencies and benefits that will be derived along the way with regards to the national stockpile’s functionality, safety, security, and ability to meet national strategic and operational needs.  

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Inconsistent management of conventional ammunition results in negative consequences such as diversion to illicit groups and unplanned explosions at munitions sites (UEMS). Both diversion and unintended blasts can result in a severe humanitarian impact, undermine development efforts, compromise defense capabilities, and lead to instability.

In recognition of this recurring danger, political, normative, and operational efforts have increased to promote the safe and secure management of ammunition (SSMA). As the issue enjoys greater national, regional, and international attention, stakeholders should simultaneously take stock of achievements, consider if current efforts address the challenges at hand, and appreciate what further steps are needed to achieve greater success.

This article builds on a Geneva International Centre for Humanitarian Demining (GICHD) study depicting the current state of SSMA. It reviews recent normative developments and identifies capacity and implementation gaps for further consideration by relevant stakeholders.

Better Safe Than Sorry: The Case for SSMA

Ammunition is usually stored in a legal, state-owned stockpile. Unfortunately, diversion from state-owned stockpiles is not uncommon. Such diversion risks fueling regional proliferation as recently evidenced in Libya, Southeast Europe, Kenya, and Côte d’Ivoire, and is increasingly understood as a major threat to peace and security.5,4

Diverted conventional ammunition can be leveraged by non-state actors, including terrorist groups. Ammunition diversion and use by such third parties is widespread, including as energetic material for improvised explosive devices (IED). Considering the manufacture of IEDs, large-caliber ammunition such as artillery shells and mortar bombs are particularly dangerous due to their substantial high-explosive content and casings designed to spray quantities of lethal fragments over a wide area.

Poorly-managed ammunition also poses a safety threat—a development experienced by half of the world’s countries in the last forty years.5 In 2017, at least one major incident involving a UEMS was reported every month.6 In light of the sensitivities surrounding ammunition management and the reputational concerns of states, the actual number of incidents may be significantly higher than reported.

When ammunition depots are located in urban areas, explosions can have an even greater humanitarian impact, further resulting in considerable socio-economic, environmental, and financial repercussions. The implications for national defense capabilities are also apparent. A sudden loss of serviceable ammunition may reduce the state’s ability to defend national territory, and the armed forces may attempt to resupply with an urgent procurement for an often-significant cost. Conversely, preventing incidents is known to cost a fraction of repairing the damage and replenishing stock. Beyond financial considerations, regaining trust with affected communities is also a formidable task.7

To address the risks of diversion and unintended explosions, SSMA is growing as a political, normative, and operational priority. What are the key recent developments related to ammunition safety and security, and what are their implications for the future direction of SSMA?

Expanding Normative Framework

In the early 2000s, poor ammunition-management practices became obvious. In response, and after a recommendation by a Panel of Governmental Experts in 2008, the United Nations created a set of International Ammunition Technical Guidelines (IATG) in 2011. The IATG are meant to offer practical, coherent, authoritative, step-by-step advice for those who wish to improve the safety and security of ammunition storage sites. Simultaneously, the U.N. SaferGuard Programme was established, which provides the United Nations with knowledge management to oversee and disseminate the IATG. Both were welcomed in the U.N. General Assembly by resolution 66/42. With universal acceptance of the IATG, a clear and coherent reference point is now available for national ammunition management regulations and relevant regional initiatives, as well as state- and non-state-led SSMA programs.8
Since ammunition was initially addressed under U.N. guidance in a 1997 report of a Panel of Governmental Experts on Small Arms, a patchwork of international and regional instruments—particularly well developed on the African continent—now address ammunition. Most instruments have approached ammunition through specific reference to small arms and light weapons (SA/LW). Adopted in 2013, the Arms Trade Treaty (ATT) is the latest addition to this framework through its prohibitions and export assessment criteria, which apply to ammunition utilized in weapons covered by the ATT’s scope. This includes all major categories of conventional weapons as well as SA/LW. In exporting ammunition, adequate stockpile management is key to mitigating the risk of diversion. Stockpile management also features areas for

The terrifying scale of the blast of an arms warehouse that sparked a mass evacuation of 20,000 people in Balakleya, Ukraine, March 2017. Images courtesy of YouTube/Oleksii Tamrazov.
treaty-related international cooperation and assistance. It remains to be seen how ATT States Parties will concretely share good practices and report on effective measures taken to address the diversion of transferred ammunition.

Current frameworks, which sometimes differ in their definition of ammunition, pose challenges to their effective and coherent implementation. More systematic scrutiny on how to bring regional regimes closer to global frameworks is also warranted. A positive example of this is the call by the Organization for Security and Co-operation in Europe’s (OSCE) Ministerial Council in 2017 to explore the possibility of voluntary use of the IATG in relevant OSCE assistance projects.

Toward More Coherent Political Action

In parallel to normative developments, several political processes on ammunition management have taken shape within and outside of the United Nations. Since 2015 and through its SSMA initiative, Switzerland has stimulated open and inclusive discussions among policy-practitioners and technical experts on ammunition management implementation challenges and responses. By doing so, the Swiss initiative has contributed to setting the stage and focusing political attention to an issue that has historically been sensitive and sometimes difficult to address in multilateral settings.

The General Assembly has addressed “problems arising from the accumulation of conventional ammunition stockpiles in surplus” since 2004 when it first decided to include this topic as a stand-alone agenda item. The resolution has been generally adopted on a biennial basis with the latest iteration from 2017. In this context of heightened political momentum on SSMA, the latest version established a multilateral platform for discussions. Coordinated by Germany, the lead sponsor, the resolution mandated to identify urgent issues on which progress can be made in the area of conventional ammunition. These informal discussions are intended to inform the work of a Group of Governmental Experts, which will be convened by the U.N. Secretary-General in 2020. In parallel, the African Union (A.U.) adopted its regional Ammunition Safety and Security Management initiative in 2017 in support of the A.U.’s vision of silencing the guns in Africa by 2020.

Importantly, the scope of discussions in international and regional fora appears to be expanding from surplus ammunition to address broader issues related to the safety and security of ammunition management. This development is positive as the risks of diversion and explosions are best addressed through a comprehensive, whole-life-cycle approach to ammunition management. Proper management of all conventional ammunition, including but not limited to surplus stocks, is necessary.
Deliberate efforts are now needed to ensure that the various political initiatives do not duplicate one another. The U.N. General Assembly track has thus far prompted substantive exchanges on trends in diversion and on the provision of technical assistance and capacity building, thereby clarifying current gaps and possible remedial actions concerning ammunition safety and security. Concurrently, the rather regional and more ‘operational’ SSMA initiatives of Switzerland and the A.U. could be harnessed to complement and enhance the General Assembly platform.

Seeing Big: From Providing Security to Broader SSMA Dividends

Historically, policymakers have perceived ammunition management as a highly technical activity involving only armed forces and state security preparedness. This perspective has, however, started to encompass the bigger picture, including the community safety and environmental contamination aspects of ammunition management, as well as to recognize the complementary role and capabilities of non-military personnel and organizations. Indeed, SSMA can demonstrate considerable dividends in view of broader peace and security efforts and the 2030 Agenda for Sustainable Development (see Figure 1, next page). The Sustainable Development Goals (SDG) provide a framework to systematically articulate the many dividends of ammunition management.

Improving stockpile management and data collection capacities is key to curbing illicit arms flows and helps to prevent unplanned explosions, enabling at-risk countries to better protect civilians; increase urban safety for all groups of society such as the safety of housing, basic services, and education facilities; and provide a safe and secure work place for ammunition storage guards. The SDGs can also serve as a vehicle for strengthening national institutions in charge of SSMA and promoting their effectiveness, accountability, and transparency, as well as for more consistent participation of women in decision-making. Finally, the international cooperation and assistance in SSMA contributes to reducing inequalities among countries, supporting those in greatest need.26 The U.N. General Assembly has called on states to consider ammunition management as part of their national efforts to achieve the SDGs and to consider the development of ammunition-related national indicators.27

Similarly, by reducing the risk of diversion, SSMA can be understood as a means to sustain peace and represents a tangible contribution to the U.N. Secretary-General’s new agenda for disarmament. “Securing Our Common Future,” the newly-minted disarmament agenda, argues that poorly-managed stockpiles of conventional arms and ammunition constitute humanitarian hazards and pose threats to peace and security. The Secretary-General acknowledges that proper physical security and stockpile management supports and sustains
development efforts and is an important component of how disarmament saves lives.21

At a time when many donors consider their political and financial support as concrete investments, implementing partners are called upon to demonstrate tangible impacts. Whether or not these investments are perceived to pay off may determine future funding trends and modalities. To date, SSMA has largely remained reliant on output-based measurements (e.g., the number of munitions destroyed or storage areas refurbished).22 Approaching SSMA as an element of wider frameworks, such as normative (treaties, IATG), development (SDGs), governance (security sector reform), or peace and security, and embracing a longer-term, broad perspective for support, could help identify and better demonstrate the long-term impact and effectiveness of SSMA projects.

From Ad Hoc to Investing in Sustainable Change

Years of practice in the SSMA domain have shown that immediate, short-term interventions can be essential in preventing a disaster from materializing and saving lives. However, experience has also illustrated that a comprehensive, gradual approach to institutional, legislative, and operational changes
in ammunition management is necessary to attain sustainable solutions. Supported by international and regional good practice, expertise, and guidelines, international assistance has taken place through direct engagement with national authorities. Investing in lasting change should logically drive international assistance. For example, ammunition planning should entail its entire life cycle: all technical, financial, and normative aspects concerning its safe arrival in a stockpile, security of stocks, sheltered and cool storage locations, inspections and maintenance protocols, trained personnel, transport, use, and final disposal. Whole-of-life assistance should become the norm rather than the exception.

National ownership has not always been sufficiently prioritized in international assistance frameworks. In the area of ammunition management, assistance has sometimes lacked adequate national responsibility and accountability. This, compounded by a persisting lack of awareness of the risks associated with the consequences of inadequate ammunition management practices, has hampered progress in SSMA. A mix of tailored incentives must be offered more convincingly to increase appreciation of these risks and foster understanding of the breadth of measures an appropriate response entails. As opposed to focusing only on the Ministry of Defence and relevant departments of the armed forces, greater awareness is
required across state institutions on the accountability of the state for ammunition management. Sensitizing and involving oversight bodies such as parliaments could be considered to that effect. Moreover, national commitment may need to be nurtured from the top all the way down to the keeper of a local ammunition store. To do so effectively, trust building over time is essential and presupposes a long-term partnership with international stakeholders.

Effective and well-coordinated national structures are evidence that ammunition management is nationally owned. Yet the reality is that structures often lack adequate authority, skills, and resources if they exist at all (e.g., national SA/LW commissions). The establishment, equipment, and empowerment of national institutions should thus be given increased attention, which includes the development of skills and knowledge specific to stakeholder groups at all levels. Equally important is to anchor a clear division of labor and responsibilities between national and international partners in national action plans and/or roadmaps.

As important as such documents are in activating national ownership, they may not succeed without concurrent competent guidance and capacity development. This is particularly true for identifying and establishing context-specific, needs-based national priorities. Failing to do so presents the risk of open-ended, ineffective international assistance.

In this vein, the development of a national normative and technical framework that draws on the IATG is crucial for sound implementation and the sustainability of SSMA. Certain national norms might often be in place, but these are generally spread over disciplines associated with fire safety, construction standards, inventory controls, and transport and storage of hazardous materials. They are rarely considered together as one entity to address the full scope of SSMA. Additionally, national principles of ammunition management may not always reflect the latest normative or technological developments. There may also be challenges related to oversight and enforcement. Therefore, familiarity with the IATG should be increased at an early stage in those contexts where national regulations are incomplete or not yet established.

Matching Needs With Resources

In the last decade, countries that are considered at risk have increasingly benefitted from international assistance. Assistance has been provided through multiple channels and by an array of governments and other actors, sometimes resulting in duplication of efforts, lack of coordination, and ensuing inefficiencies. The various coordination mechanisms have largely not kept up with the speed at which support has grown. This is compounded by the difficulty to fully grasp the magnitude, modalities, and destinations of assistance globally; mapping the available technical expertise in this field, taking into consideration regional and language needs, and then matching it with the needs at a national level. Furthermore, many governments may not yet be fully familiar with the IATG as an international baseline for good practice. This knowledge gap risks thwarting a wider donor
involvement in SSMA and continues to impinge on the effectiveness of matching resources, needs, and expertise. The conduct of the comprehensive survey of assistance provided and expertise available, the review of national reports submitted pursuant to the U.N. Programme of Action on the illicit trade in SA/LW and requests for assistance contained therein, and the fostering of knowledge and use of existing good-practice tools under the U.N. Safeguard Programme could help transcend that gap.

Accelerated IATG rollout, establishment of national regulatory and strategic frameworks, and enhanced international cooperation may not sound particularly revolutionary as possible solutions; however, they remain essential components of effective and sustainable SSMA efforts. There is significant potential to promote more structured in-country coordination to overcome the often-fragmented responses, with the national counterpart in the driving seat. Similarly, where strong regional leadership is in place, regional mechanisms should be strengthened to better respond to and act on requests, including by developing and availing local training capacities. The A.U.-Germany coordination platform for the Greater Sahel is a useful example in this regard. At the international level, an effective multilateral forum for donor coordination could also be beneficial.

Conclusion
SSMA is becoming a key consideration of the international community at various levels, from the normative to the technical. International support has stepped up to strengthen national efforts. These are highly positive developments in recent years. However, major bottlenecks persist, particularly in view of more effective and sustainable SSMA efforts. Greater awareness around the risks stemming from inadequate ammunition management should be a priority, along with communicating available expertise and instilling national responsibility in risk-mitigation measures. Additionally, more efforts are needed to move away from ad hoc and short-term responses toward sustained efforts in building national capacities, designing laws, standards and roadmaps, and seeking systemic improvements. In parallel, international cooperation and assistance must be coordinated and allocated more effectively.

The GICHD and the United Nations Office for Disarmament Affairs (UNODA) have deepened their collaboration and continue to work to address these gaps jointly with their partners, in line with the spirit of partnership called for by the U.N. Secretary-General’s new Disarmament Agenda. In particular, the GICHD and UNODA collaborate closely on operationalizing the U.N. Safeguard Programme, from establishing a truly global roster of expertise to the further updating of the guidelines and making them more accessible. In light of the challenges ahead, many SSMA stakeholders, from donor and at-risk countries to implementing partners, are resolved to scale up their engagement. Deepening commitment and expanding activities are promising developments toward the safe and secure management of ammunition.

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in the SPOTLIGHT

IRAQ AND SYRIA
Shattered Lives and Bodies: Recovery of Survivors of Improvised Explosive Devices and Explosive Remnants of War in Northeast Syria

by Médecins Sans Frontières (MSF)

In northeast Syria, fighting, airstrikes, and artillery shelling have led to the displacement of hundreds of thousands of civilians from the cities of Deir ez-Zor and Raqqa, as well as rural areas along the eastern bank of the Euphrates River. Now that active fighting has moved toward the Syrian-Iraqi border, the population is beginning to return home. However, explosive remnants of war (ERW), improvised explosive devices (IED), and booby traps (remaining from conflict or planted purposefully in homes) continue to put the returning population at immense risk and further obstruct vital humanitarian access.

From November 2017 to May 2018, Médecins Sans Frontières (MSF) treated more than 150 patients injured by ERW and IEDs, nearly one patient every day. There was a peak of 39 cases in December and 41 in January, correlating with the return of populations from displacement camps in the region. Seventy-five percent of those patients came from the Deir ez-Zor governorate, mostly from Abu Hamam and Dhiban in Mayadin district but also from Hajin in Abu Kamal district. Half of the patients were children. The victims were those with the means or necessary support to survive the journey’s various obstacles and checkpoints. The 60 minutes after a traumatic injury (sometimes referred to as the golden hour) is a window of time in which the patient is thought to have the greatest chance of survival provided they receive adequate medical attention.

One of the major issues for the context of Deir ez-Zor is the increasing difficulty to provide care within this timeframe, as medical assistance and the most basic health services are currently widely restricted across the governorate. An MSF surgeon explained that, “Only those patients with less severe prognoses manage to come to us, the rest die.”

Nizar, 14-years-old, was riding a motorcycle in Deir ez-Zor with his friend Hayyan. Near Al-Mayadin bridge, some children were playing when one of them took an object from the ground and threw it. They did not know it was a mine. It exploded immediately. Two of the children died. “I felt nothing,” said Nizar, but he was bleeding profusely and had a fractured leg, shrapnel throughout his body, and multiple cuts. His uncle, Khalif, explained what happened: “We took the boy to Hakel Alomar camp, but there was no medical point there so we went to Dhiban hospital. Health services there were not functioning properly either with only two nurses. They needed gauzes, which I had to buy myself for 1,500 SYP in a pharmacy. After that we tried in Bussera, where a doctor put him on an IV. In Shadade they could not treat him because they lacked capacity to deal with that kind of injury. In another medical structure they refused to treat him because our car plate was from Deir ez-Zor. We went to another camp then, where they cleaned the wounds, wrapped the injury in some bandages and requested an ambulance that finally brought us here to the hospital.”

For the victims and their relatives, reaching the health structure is only the first stage of a longer journey toward a complex and uncertain recovery. If a patient survives, they will need long rehabilitation, physical therapy, and psychological support. Some will suffer lifelong consequences requiring specific support.

Patients usually arrive at the MSF-supported facility by ambulances or in private cars, sometimes having already been stabilized at a field or private hospital, usually where basic care is provided before referring the patient to another facility. Often, the treatment in those facilities is insufficient due to limited surgical and wound-management capacity, and a lack of postoperative care or appropriate infection control measures. Moreover, availability of equipment, capacity, or conflicting priorities also limit their services and level of attention given to the patients.
“Ayla was going to fetch water from the river with my daughter and other children. She then stepped on a land-mine. ‘My foot! My foot! My foot!’ they told me she screamed. Bleeding, crying... It was terrible for her. She didn’t faint, so she was fully aware of everything and is now worried that she will not be able to walk again, that her friends have two feet and she will not have one anymore.” At the time of the interview, Ayla was receiving treatment in the intensive care unit and about to enter the operating theatre for an amputation of her leg at the knee. According to the MSF surgeon, if the tourniquet that initially was applied had been removed earlier, it would have been possible to save more of her limb.

Patients are then directly admitted to triage and the emergency room, where their status is assessed according to the severity of trauma they suffer. Green for minor injuries, yellow for semi-critical injuries, and red for severe and immediately life-threatening injuries. One percent of patients receive red status, which usually means multiple traumas, as is often the case with explosion-related injuries. The first steps are to control any hemorrhaging, keep the patients still if they have open fractures, and provide blood transfusions to compensate for the loss of blood, which poses further challenges in conflict zones because of the shortage of available blood. It is a very resource-demanding process, as it takes significant time and personnel, especially when several people have been wounded in the same explosion.

Everyone is involved, from doctors and nurses to laboratory specialists, surgeons, and anesthetists. Special equipment is also needed such as tourniquets to stop the bleeding and splints for broken bones. The surgical team then assess who will require surgery first and what is needed, as each case often requires multiple types of surgery depending on injuries: abdominal, shrapnel extraction, amputation, internal bleeding, or burns. Conservative surgery is performed when possible but in most cases amputation is decided from the onset for these types of wounds.

With ERW and IEDs, the pattern of injuries and devastation observed varies according to the type of device, the amount of
explosive, and the situation. Effects are always substantial considering the velocity of the projectiles, the accompanying high temperatures, and the extremely violent shocks. From a surgical point of view, there are usually three types of patterns observed with IED/ERW injuries, which are linked to how the incident happened.

Firstly, when a victim steps on a mine, this primarily affects the feet, perineum, scrotum, and waist. Secondly, when a victim is exposed to a fragmentation explosion such as a landmine or an anti-tank mine, different kinds of high velocity shrapnel may affect the body, often requiring intra-abdominal exploration for bowel injuries. Finally, when the victim picks up the explosive device, it can wound and maim fingers, hands, and arms as well as the head. This often happens with children who are naturally curious and tend to be more affected by this type of pattern. An MSF surgeon explains

"It takes a lot of time and a lot of patience. We are able to manage main injuries, but cannot do everything ideally required such as neurosurgery, advanced chest surgery, perforated eardrums or eye operations (although with shrapnel, eyes are often affected and end up being lost). There is a big gap in specialists. Often, you can save a patient with good post-operative management, with a full-fledged intensive care unit but in war zones it is often not possible. We do the maximum with the minimum."

When patients affected by explosions come out of surgery and are moved into the inpatient department, there is always an initial chaos for a few minutes. Relatives are nervous and agitated, while patients, especially children, often find themselves in a state of shock. The violence, shock, and lack of understanding of what has happened to the patient produces a state of stupefaction. This is an emotional stupor in which the patient blocks everything to protect and distance themselves from their suffering, to the point that emotions seem almost absent. This contrasts with the chaotic atmosphere around them, which is disturbing to the patient who has no preparation or time to comprehend what happened to them or their limbs.

Post-surgery, the first phase of the treatment is ensuring proximity care, which means closely monitoring patients via the continuous presence of caretakers. This is when the understanding of what has happened begins to develop and when the patient’s status is closely monitored to prevent complications, which can include the occurrence of phantom pain, a particularly difficult sensation generated by the remaining nerves of the severed limbs that continue to transmit information to the body as if the limbs are still present. From time to time, juxtaposing a mirror in front of the stump as if the limb appears whole is used to alleviate suffering. Mirror therapy is simple but has positive effects in half of the cases.

Pain management is generally a challenge in itself because it is not culturally accepted. We use several scales to understand the pain depending on the age and situation of the
patient. For children, we have faces that express the levels of pain (see Figure 2).

Patients are then transferred to a hospital ward to continue the healing process. Depending on the severity of the case, they return to the surgical block every two or three days for dressing changes. This is often accompanied by apprehension, as memories of the intervention and of the incident reemerge. For others, dressing changes are made in the ward with a doctor. Caretakers are involved as early as possible in the patient’s recovery and are crucial in preventing further complications such as phlebitis (when the veins become inflamed); skin retraction, which further impedes movement (when the skin is altered through the operation, it retracts in on itself and therefore limits movement); bleeding of the wounds; muscle
loss; and atrophy. They also help the patient with early rising. Following surgery, a patient is encouraged to move as soon as possible, which improves circulation and healing during the recovery period. The risk of additional infections is also very present because fragmentations can leave lots of shrapnel in the body. Whereas some shards will come out naturally, others will need further intervention.

The recovery process varies according to the wounds. For instance, abdominal wounds can have greater consequences on diet, food absorption, and also bed rest, more so than with limbs. It often means a long healing period because the wounds are easily soiled by the content of the bowels. At the same time, although orthopedics is much cleaner than abdominal surgery, it has an extremely long rehabilitation and

<table>
<thead>
<tr>
<th>Items</th>
<th>Scoring</th>
</tr>
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<tbody>
<tr>
<td>Face</td>
<td>No particular expression or smile</td>
</tr>
<tr>
<td></td>
<td>Occasional grimace or frown, withdrawn, disinterested</td>
</tr>
<tr>
<td></td>
<td>Frequent to constant frown, clenched jaw, quivering chin</td>
</tr>
<tr>
<td>Legs</td>
<td>Normal position or relaxed</td>
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<tr>
<td></td>
<td>Uneasy, restless, tense</td>
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<tr>
<td></td>
<td>Kicking or legs drawn up</td>
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<tr>
<td>Activity</td>
<td>Lying quietly, normal position, moves easily</td>
</tr>
<tr>
<td></td>
<td>Squirming, shifting back and forth, tense</td>
</tr>
<tr>
<td></td>
<td>Arched, rigid or jerking</td>
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<tr>
<td>Cry</td>
<td>No cry (awake or sleep)</td>
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<tr>
<td></td>
<td>Moans or whimpers, occasional complaint</td>
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<td></td>
<td>Crying steadily, screams or sobs, frequent complaints</td>
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<tr>
<td>Consolability</td>
<td>Content, relaxed</td>
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<td></td>
<td>Reassured by occasional touching, hugging or being talked to, distractible</td>
</tr>
<tr>
<td></td>
<td>Difficult to console or comfort</td>
</tr>
</tbody>
</table>

Figure 2. FLACC scale (Face, Limb, Activity, Cry, Consolability). Figure courtesy of MSF.
hospitalization period with long-term effects. If the surgical intervention has not taken the orthopedic aspect sufficiently into consideration and failed to create a clean flap to close the stump and allow for a prosthesis to be put in place in the future, the patient’s best chances of resuming movement are sharply reduced.

Little information is available about the levels of ERW and IEDs in Deir ez-Zor. However, the number of patients treated and the stories they tell suggest a dramatic situation requiring an urgent need for a comprehensive mine response. This includes risk education, victim assistance, and mine clearance in order to avoid more preventable deaths, injuries, and psychological trauma. The situation is also very acute in Raqqa, where MSF treated close to 500 victims of ERW and IEDs over the same period of time, thanks to the better proximity of stabilization points prior to referrals. Along with the tremendous humanitarian impact these incidents are having on the population, the high levels of contamination are also hindering the arrival of much-needed humanitarian support. The scale of the contamination shows that a greater coordinated effort is needed from the international community to fund, support, and facilitate demining and other mine action activities in Deir ez-Zor and Raqqa. See endnotes page 62

The author would like to thank colleagues for providing their experience and support in writing this article.

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Iraq is changing what we think, say, and do about mine action. The terms, standards, and measurements used by the humanitarian mine action (HMA) community need to be revised as Daesh remains a destabilizing influence. While the Al Maedam district of Mosul fell to Iraqi Security Forces in a ‘last battle’ on 10 July 2017, the government declared an official end to the conflict in Iraq on 10 December 2017.

Whereas HMA followed the signing of the Dayton Peace Accords, HMA started in East Mosul while fighter jets were still bombing West Mosul. Although defeated, Daesh remains active. One year later, the same pop-up tactics used by Daesh to harass communities continue with reports of killings, kidnappings, and also to disrupt explosive ordnance clearance operations, leading to the need for ‘day-of’ adjustments to avoid potential new threats. Regrouping in parts of Kirkuk, Daquq, and Hawija, Daesh is now patrolling day and night, collecting taxes from locals.

The distinction for explosive hazard clearance, whether conducted as a peacekeeping or a humanitarian mission, is not trivial. When United Nations Mine Action Service (UNMAS) Iraq teams enter communities for the first time, they come as unknowns, sometimes seen as extensions of a peacekeeping mission or an occupying foreign power. Their first task is to overcome suspicion and gain the trust of the local community, street-by-street. Relying on community liaison officers fluent in the local language and experienced operators selected for their interpersonal skills, teams endure a time-consuming but necessary process. However, these efforts yield an important return: community sources that provide essential information for teams to locate, survey, and assess contaminated sites. The second task is to deliver clearance in a timely way so that stabilization can happen sooner rather than later.

During 2018, funding for the explosive hazard response will be focused in the five priority governorates identified by the government of Iraq: Ninewa, Kirkuk, Anbar, Salah al Din, and Diyala, in addition to the explosive hazard activities supporting the five pillars of Iraq’s Recovery and Development Framework (RDF), and as documented within the Recovery, Resilience Programme (RRP) that were both officially launched at the Kuwait conference in February 2018.

Context

Delays work for Daesh while urgency works for an economically thriving, politically-stable Iraq and for the Middle East region as a whole. Therein lies the strategic, geopolitical importance of explosive hazard clearance in Iraq today. International focus has shifted from the legacy of millions of landmines left from the Iran-Iraq War and two Gulf wars, a legacy that is now handled exclusively by Iraqi authorities, to the one-third of Iraq formerly occupied by Daesh. Roughly the equivalent of New York state, this region is home to more than 1.9 million internally displaced persons (IDP) who still live in camps. Clearance contributes to a safe home for all.

Producing stable communities is arguably the most important component of a shared Iraqi-international community soft power strategy to secure economic and social recovery. Communities depend upon stabilization programs, all of which cannot begin until explosive hazards have been removed.

Adaptation

Initially, the comprehensive data collection phase that normally precedes explosive hazard clearance did not happen in Iraq for the following reasons:

1. The urgent need to clear key infrastructure so as to begin stabilization and humanitarian programs shifted government priorities.
2. The changing security conditions limited access to certain areas.
3. The time-consuming procedures for registration and accreditation of additional operators limited in-country resources.
Headlines as reported for 26 June 2018

- Official questions government’s intention to strip militias of arms (The Baghdad Post)
- Terrorists linked to kidnapping incident on Kirkuk road arrested (NINA)
- Kurdish citizen killed in Islamic State attack in Kirkuk (Iraqi News)
- Booby-trap found in the district of Hawija (NINA)
- Kurdish official makes serious warnings on IS re-emergence in Khanaqin (Bas News)
- IS insurgents raid south of Daquq (Bas News/Iraq TradeLink)
- Two terrorists arrested in Sulaymaniyyah (NINA)
- Iraqi security in ongoing operation against Islamic State in Diyala: Local politician (Kurdistan 24)
- Diyala Operations Command announced the destruction of the so-called Sharia court and Daesh caches in operation to hunt down terrorists (NINA/The Baghdad Post)
- Four Islamic State members arrested in joint operation, north of Diyala (Iraqi News)
- Ten ISIS guesthouses torched as operation in Hamrin Mountains continues (The Baghdad Post)
- Seven IMIS terrorists killed, wounded in ISIS attack in Samarra (The Baghdad Post)
- Terrorist infiltrated from Syrian territory into Iraqi territory arrested (NINA)

Accordingly, the explosive hazard management community at large joined in support, with all operators assigned tasks from a common Funding Facility for Stabilization (FFS) list developed and managed by Iraqi authorities and the United Nations Development Programme (UNDP) to coordinate clearance of critical infrastructure to be followed by repair and reconstruction known as stabilization programs. Many teams, including those funded by UNMAS, have achieved significant results in a relatively short period of time; however, early successes came with an indirect cost and a predictable result (see Figure 2).

Without comprehensive data collection as a starting point, the extent of contamination one year later remains an unknown pending completion of a comprehensive, non-technical survey and assessment of the liberated areas. UNMAS Iraq will field NTS teams during the latter part of 2018 to conduct this survey. Meanwhile, explosive hazard management and operations continue on a daily basis (see Figure 2).

The absence of a comprehensive survey to assess and quantify contamination by type meant that UNMAS Iraq teams needed to integrate surveys into clearance tasks to record concentration, dispersal, location, and type of hazards, so that information could be shared with the government of Iraq. This has led to a catch-up effort to upload data into a developing information management system for shared use and transfer to Iraq’s Directorate of Mine Action (DMA).

**Unique Environment**

In conventional mine action, if operators have access to the surface, they most likely have access to the threat. Whether arrayed in a pattern to defend a military position or used in isolation, landmines typically target personnel or vehicles. Their known fit-for-purpose design, properties, and function make landmine clearance a surface or near-surface activity; procedures and standards evolved accordingly. Similarly, clearance of known explosive remnants of war (ERW) —e.g., large, air-dropped munitions—even when buried or submerged, differs mostly by proximity to the surface.

In legacy contamination areas, such as along the Iran-Iraq border, Iraqi authorities focus conventional clearance methods on threats posed by unknown amounts of ERW and
During the 12-month period ending June 2018, UNMAS Iraq teams assessed and cleared critical sites and conducted training in both urban and rural areas.

- More than 350 explosive devices from 30,000 sq m bordering a power grid serving 60,000 people and seven schools near Fallujah.
- Thirty-four IEDs weighing a total of 435 kg from a fuel station in Jadidah—enough to completely destroy the building, and kill or injure anyone within a 100-m radius.
- Forty-four IEDs from under or on the Fallujah 'New Bridge,' totaling 380-400 kg of homemade explosives. UNMAS divers found and safely removed two submerged IEDs from Fallujah's 'Iron Bridge.'
- Forty-four IEDs, 51 main charges, three items of unexploded ordnance, and 343 IED component parts from a 37,995 sq m asphalt factory in Fallujah.
- Forty-plus IEDs along a 50-m stretch of road which, due to earth compacted by rains, made search-find-remove-and-render-safe extremely hazardous for operators.
- From commencement of clearance operations in Mosul's Old City on 28 November 2017 through 31 May 2018, UNMAS teams completed 790 tasks resulting in the removal of approximately 33,500 explosive hazards, including 610 suicide belts.
- In the Al Maedam district alone, 491 explosive hazards, of which 232 were suicide belts, and of these, approximately 100 were removed from human remains.
- Conducted 70 surveys in Al-Anbar, Salah al-Din, and Ninewa governorates in support of high priority stabilization and humanitarian interventions.
- Removed 15,700 ERW and 900 IEDs, including 610 suicide belts in liberated areas.
- Conducted 750 clearance tasks enabling the UNDP and government to begin rehabilitation of critical infrastructures.
- Completed 10 joint assessment missions enabling the United Nations and humanitarian partners to deliver aid in liberated areas.
- Trained 170 police officers in first response techniques, including identification, marking, and reporting explosive hazards; and 20 U.N. security staff to safely respond to IED and explosive-hazard threats.
- Trained 1,600 UNDP cash-for-work employees, 800 government, and 300 U.N./NGO staff working in high-risk environments to recognize and behave safely in the presence of explosive hazards.
- Conducted risk education sessions attended by 147,000 people in schools, IDP camps, and other high-priority areas.

Figure 2. Critical sites cleared.
Figure courtesy of United Nations Mine Action Service Iraq/CISR.

landmines estimated to be in the millions. In liberated areas of Iraq, the mix of conventional threats with improvised explosive devices (IED) adds a three-dimensional aspect to clearance since the operator must contend not only with hazards on or below the surface but with IEDs placed in walls, ceilings, fixtures, etc.
presence of IEDs in Mosul varies by district, five of Mosul’s eight districts searched through June 2018 yielded 27,000 explosive hazards. Until battle damaged buildings are searched and debris is safely inspected, managed, and removed, there is no way to know the extent and level of the three-dimensional contamination.

In rural environments, IEDs arrayed in belts have substituted for landmines to defend combatant positions during conflict and continue to contaminate agricultural land. IEDs have also been used to deny villagers access to wells, schools, government offices, and virtually any other asset essential to livelihood.

If the HMA community considers the use of IEDs in Iraq as a fundamental change to explosive hazard clearance, what is a satisfactory term for an acceptable clearance standard for this surface-and-above threat? Whether debris from collapsed buildings or the space within a battle-damaged building, the problem deals with volume and certification, not just of cleared land but also of cleared space. The International Mine Action Standards (IMAS) do not have such a reference, but if experience in Iraq to date is an indicator of a need for similar environments, IMAS may need such a reference and the development of a surface-and-above standard. The implications of such a standard would seem important for the HMA community for certification and for accountability purposes.

For certification, cleared buildings, debris management, and disposal need standards. However, in an environment such as Iraq, the community may need to settle for something less than previously accepted standards. With debris and structural assets above ground, what if 100 percent clearance is not possible? What level of risk is acceptable? Compared to conventional clearance, what are the implications for time, cost, and the priority of tasks and commitment of resources?

The search conducted at Fallujah’s Iron Bridge may serve as a case in point for an honest and open exchange of views. The impact of the open bridge measured in socioeconomic terms is arguably the real outcome of clearance and should be a measurement of success rather than the lingering perception that the operation cleared only two IEDs for

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**Iron Bridge, Fallujah**

Reconstruction suspended in February 2018 due to suspected IEDs at or below waterline.

- Total dive time underwater: 17 hours and 53 minutes
- April 8 - Dive team briefed
- April 9 - Dive 1 to check conditions:
  - Water depth at 7.0 meters
  - Current of 5 to 6 knots
  - Visibility at 3 cm due to the current
  - Divers adjust plan, hold onto the bridge structure continually or be swept away from the task, slowing progress
- April 9 - Dive 2
  - Suspected main charge case was found and photographed
  - Fingertip search established that no other hazards were present, i.e., battery pack detonator or pressure plate
- April 9 - Dive 3, suspected main charge (1) safely recovered
- April 10 - Dive 4, suspected main charge (2) safely recovered
- April 11 - Dives suspended, following holidays, resume
- April 14 - Dives continue: An AK47 assault rifle was located and recovered
- April 15 - Dives conclude, confirming no further hazards
- Area searched: 900 sq. m.
- Found:
  - Two IEDs, 20 kg main charge cases, plastic, filled with homemade explosives (HME)
  - One AK47 assault rifle

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Figure 3. Case study: Iron Bridge, Fallujah.
Figure courtesy of United Nations Mine Action Service Iraq/CISR.
a week’s effort. What matters is that the elimination of the threat led to the resumption of the rehabilitation work.

If all tasks on the stabilization list are deemed high value and there is no way to quantify cost-benefit, they must compete with one another on some basis for purposes of priority. But what is that basis? Since priority remains a matter for Iraqi authorities to decide, UNMAS Iraq’s best response is to anticipate needs and quickly deploy clearance assets in the case of Fallujah’s Iron Bridge case study (see Figure 3).

**Eliminate Suspicion**

Whether mine action ultimately returns cleared land or cleared space to communities, eliminating suspected threats and achieving security and safety should be a measure of success. Even if nothing is found, the suspicion of IEDs needs to be removed before rehabilitation can begin. While the problem of “who comes first” belongs to the government, the solution is partly a function of the HMA community and its ability to mobilize, deploy, and use resources efficiently based on an internationally agreed upon common value statement.

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**Impact**

This value statement should speak to the impact of mine action instead of the number of explosive hazards cleared. Although UNMAS Iraq teams typically clear enough explosive hazards in a given week to fill a 20-ft (6-m) container, such inventories are quantitative measures of explosive hazard management, which underestimate the cost-benefit, value-added, and socio-economic outcomes associated with environments such as Iraq with its 1.9 million IDPs waiting to safely return home.

Consider the lesson learned by the Fallujah Iron Bridge experience: if the operation were measured in terms of contamination alone, the two IEDs destroyed during the week-long effort would seem costly in terms of efforts expended, yet more than commensurate when valued by the socio-economic impact. Effectively, this indicates that the mine action community should reevaluate its model for measuring outcome for nonconventional clearance.

Inevitably, limited resources delay stabilization and humanitarian tasks in post-conflict environments. Similarly, UNMAS surveyed and assessed clearance needs for two textile factories in western Mosul used by Daesh to manufacture ammunition. The buildings were believed hit by two 500–1000 lb (226.8–453.6 kg) airdrop weapons, one of which exploded when delivered. Clearance will require intensive manual operations since the building structures could be severely damaged by the use of mechanical assets. When operational, the factory employs approximately 6,500 staff—mostly women—producing textiles largely for export. In rural areas, the devastation may appear less, but the net effect is the same: denial of the means of production and loss of livelihoods. IEDs arrayed in a traditional minefield pattern are known to contaminate some agricultural land; similarly, individual IEDs contaminate key infrastructure, such as the village well in Al Bokald near West Mosul.

**Al-Shifa Hospital, Al Maedam district**

- Used by Daesh as a treatment center and for ammunition and IED manufacturing
- August–September 2017: Phase 1 clearance of accessible areas: 653 explosive hazards and 10 kg of IEDs removed
- April 2018: Phase 2 clearance of previously inaccessible areas begins using newly arrived armored heavy equipment and manual methods to remove
  - 4 kg of improvised explosives
  - 85 explosive hazards
  - 48 small arms ammunition (SAA)
  - 12,350 kg of de-bulleted SAA (Daesh propellant harvesting)
  - 29,945 m³ of rubble and debris
- May 2018: Clearance complete
- June 2018: Site reverts to UNDP and reconstruction begins

Figure 4. Case study: Al-Shifa Hospital, Al Maedam district, West Mosul. Figure courtesy of United Nations Mine Action Service Iraq/CISR.
Following clearance, the now-repaired Al Qasoor Water Treatment Plant in East Mosul again supplies clean and safe water to more than 300,000 people across 34 service areas. In Ninewa province, following clearance, the land registry office offers access deeds to validate land claims of residents seeking return. Following clearance of the fuel station in Al Jadidah, 20 employees pump fuel for more than 300 vehicles daily after a three-year hiatus. Following clearance and repairs to the Fallujah Iron Bridge, travel time for some residents to the only maternity hospital in a 50 km (31.1 mi) radius will be reduced from two hours to five minutes. Moreover, the asphalt factory reopened after four years and will employ 65 workers when operating at full capacity.

**Difficult Choices**

Looking back with perfect hindsight does not solve the problem for government decision makers responsible for determining task priority. The model to predict socio-economic benefits is not new but the application of such thinking to mine action probably is. The problem comes with the value judgment made between a large workforce employed by the Mosul textile factory previously mentioned and a small agricultural community dependent upon land contaminated with an IED belt. While the decision on where to prioritize clearance does not belong to the HMA community, standardizing the mine action variables involved in efficiently delivering clearance can influence this decision beginning with operational and security reasons. The anticipation of needs, operational flexibility, and response is key for the HMA community. However, in terms of clearance, Iraq’s working environment is unique in a number of ways:

- Narrow, cluttered streets increase clearance time in urban environments, whereas relatively open spaces in some outlying neighborhoods and rural areas may take less time.
- Travel time to and from sites and checkpoints effectively limit teams’ access to sites. For example, there are 14 checkpoints between the UNMAS Iraq base in Erbil and contamination sites in Betu, Kirkuk, and Naweji, extensively reducing clearance time to half a day of work.
- Heavy contamination linked to human remains causes a stop-start-stop sequence to clearance, whether manual or mechanical. Mechanical operations stop-start-stop for each new discovery to allow government authorities to recover, identify, and return the remains for a proper burial.
- Deteriorating security conditions influence operations.

Clearance teams use diversionary routes to avoid predictability, adding time to mission planning and execution. Armored vehicles located close to operations may limit access to certain areas entirely.

- Specialized and highly-trained operators, as with the Fallujah Iron Bridge divers who deployed in record time, may lead to the government reprioritizing clearance based on asset availability.

**Quality Assurance**

Complexity of design, manufacture, and quantity of IEDs creates a mix of threats and a unique operating environment for clearance teams in Iraq. IEDs vary significantly by manufacturing methods. IEDs have been found in artificial rocks, in air conditioning units, and under hanging garments triggered by an infrared device. Components can include repurposed common objects such as plastic tubing, washing machine timers, and syringes. In one of two bomb factories located within the Al-Shifa Hospital complex, UNMAS teams found more than 150,000 electronic components intended for use in IED manufacture (see Figure 4).

The combination of scarce resources and/or inadequate clearance, as well as IDPs eager to return home inevitably lead to cleared areas being recontaminated. For example, when returnees collect explosive hazards from their land and homes and deposit these in an already cleared street, this leads to recontamination and creates problems in terms of mapping, recording, and managing data.

Although Daesh officially has been defeated, daily security reports confirm what UNMAS Iraq teams know from experience in the field: Daesh remains an active if sporadic threat, often returning to recontaminate cleared areas.
Observations

Convention. Iraq’s National Strategic and Executive Plan for Mine Action 2017–2021 outlines Iraq’s commitment to work toward a safe environment free from explosive hazards, designating the DMA as the national authority for explosive hazard management charged with the responsibility to survey, mark, and render safe 50 percent of known contamination by 2021. Iraq’s commitment to the National Strategic and Executive Plan currently covers only landmines and ERW, not IEDs.

Outcomes. UNMAS Iraq reports explosive hazard management results in terms of square meters and items cleared on a monthly basis; however, without an accompanying narrative, numbers can understate the complexity of the situation. Planning is integral for both mine action professionals and those agencies responsible for stabilization and humanitarian tasks.

Priorities. Should we clear rural communities last because urban populations are larger? Do the 50 families in Al Bokald matter any less than the 6,500 workers waiting to return to their jobs in the textile factory? Government
authorities could benefit from a system that measures an economic and/or social return and avoids perceptions of political, ethnic, or other arbitrary influences when setting priorities. The HMA community can assist decision makers with this responsibility by efficiently managing and deploying assets and managing conditions that reduce task times while meeting quality standards.

Assessment. How might government authorities assure themselves and donor organizations of maintaining capacity once it is enhanced? One idea the mine action community might adopt is to formally recognize the need to recertify staff based on peer reviews or skill audits conducted by a professional board or regulatory authority as commonly practiced by other professions. Organizations and individuals would need to meet standards and demonstrate proficiency in managing information and conducting surveys as well as generating, monitoring, and closing tasks.

Costs. Although explosive hazard clearance precedes stabilization and humanitarian tasks, the HMA community has yet to recognize high-value clearance, as illustrated by the
Fallujah Iron Bridge or scenarios involving long-distance travel, high-threat environments, physical constraints such as heavy debris, collapsed buildings, or limited access to infrastructure, all of which add to costs. For many, the conventional thinking and measures regarding cost date from battle area clearance or legacy mine fields where experience says clearance can cost as little as US$3.50 for one meter cubed (one square meter to a depth of one meter). The HMA community needs to develop and refine appropriate benchmarks as a basis for value statements consistent with clearance costs related to stabilization and humanitarian returns.

Disposal. Although the Iraqi government understandably restricts exclusive use of explosives to Iraqi Security Forces, this procedure demands the secure and timely transportation of explosive hazards to secure sites for safe disposal to avoid potential buildups of large amounts of explosive hazards. A handover methodology and a certification procedure could leverage available international organization expertise to include destruction after rendering safe, removal, and collection of explosive hazards, thereby maintaining accountability while alleviating a potential delay.

Knowledge management. IED removal is predicated on problem-solving skills and understanding how the devices function so as to identify the different components. How IEDs are manufactured, function, IED composition variety, and knowing what to look for before going into the field have become daily tasks for operators and caused UNMAS Iraq to re-invent its information/knowledge management capabilities.

Community. UNMAS Iraq has relied extensively on community liaison officers to help establish trust with the local community to gather information regarding possible IED
locations and areas to avoid should Daesh have a presence. Casual cash-for-work cadres when trained have proven successful as a multiplier for areas thought to be cleared when paired with other UNMAS clearance teams. Cash-for-work workers are hired as casual laborers to remove debris in destroyed neighborhoods in Mosul and elsewhere. While they are hired only to remove and clear debris, they are given risk education to be able to identify, report, and warn of explosive hazards. By doing this, local citizens identify and report on potential hazards.  

See endnotes page 62
Sepon Supports UXO Clearance in Laos

by Saman Aneka and Michael Valent [MMG LXML Sepon]

Sepon mine, owned by the largest international mining company in Laos, MMG Lane Xang Minerals Limited Sepon (LXML), is situated in a remote area of Vilabouly District, Savannakhet Province—one of the most bombed districts in Lao PDR. Over 21,000 people have been killed or injured as a result of unexploded ordnance (UXO) accidents in the post-war period (1974–2018), of which 25 percent were in Savannakhet Province. This legacy brings unique challenges to mining operations, development projects, and agricultural production.

LXML has integrated UXO clearance as an essential activity in its mining cycle. This ensures employees and communities are safe and will sustain a lasting legacy for agricultural activity in the future. Additionally, LXML has invested in software and hardware via strategic partnerships to enhance technical capacity and improve clearance practices in Laos.

LXML UXO technicians use the UltraTEM to detect items of UXO up to 3.5 m (3.8 yd) deep at Sepon mine. Image courtesy of MMG.
**UXO Work in Numbers**

Since 1996, LXML has invested over US$45 million in UXO activities, clearing around 2,900 ha (7,166.1 ac) of land and destroying over 58,000 UXO items. Up to 80 percent of the 125,000 ha (308,881.7 ac) of concessional land granted to LXML by the Lao government was heavily bombed during the Indochina War as part of the logistics route known as the *Ho Chi Minh Trail.*

In Sepon, UXO clearance is conducted before exploration, mining, civil engineering, and to support projects and local villages’ activities surrounding the mine and archaeological site areas. In the 1990s, UXO clearance was conducted before exploration and local roads and tracks were cleared and enlarged during the exploration phase, allowing the local population safer and better access to rice fields and plantations.

UXO clearance before civil engineering, such as the rehabilitation of Road 28A—a main transport route linking Vilabouly with Road 9 (Savannakhet Province’s main east-west highway)—involved a shallow search to a depth of 25 cm (9.8 in) followed by a deep search to a depth of 250 cm (98.4 in) along the entire stretch. Thousands of submunitions, bombs, rockets, and other ammunitions were cleared, allowing safer road access for the Vilabouly community.

In partnership with Sunlabob Renewable Energy, LXML supported development projects and provided safe, sustainable water supplies to villages in Vilabouly by using solar-powered pumps to draw water from unusually deep bore holes, which were not amenable to using hand pumps. This project resulted in UXO clearance for the twelve targeted villages comprising almost 3,400 community members.

The Mandarin Project, a partnership with Australian company Ironbark Citrus, created an avenue for Lao farmers to move from subsistence to commercial agriculture by enabling smallholder families to grow mandarin oranges using best practices and current technology. Before any planting could commence, land areas were cleared from UXO. To date, beneficiaries of the project have planted mandarins covering nearly 22 ha (54.4 ac) of land.

**Software: Enhancing Capacity and Leveling to International Standards**

LXML and the Lao Ministry of Defence’s Engineering Department signed a memorandum of understanding in mid-2013 in a joint effort to clear UXO within Sepon Mine, including the site of the mine as well as potential areas for exploration and mining activities. LXML received full National Regulatory Authority (NRA) accreditation to conduct UXO clearance within its vicinity.

Building on this framework, LXML partnered with the Lao Ministry of Defence, the National Regulatory Authority (NRA), and Lao National Unexploded Ordnance Programme (UXO Lao) to improve UXO clearance standards in Laos by enhancing the capacity of Lao UXO technicians. The accredited explosive ordnance disposal (EOD) training programs were developed in cooperation with the NRA to provide recognized qualifications and experience in UXO clearance techniques.

In 2016, LXML founded, hosted, organized, and managed the 5th NRA Senior Explosive Ordnance Disposal (SEOD) course to build capacity for Lao Explosive Ordnance Disposal (EOD) technicians. The EOD training materials provided by LXML are systematically sent to NRA for quality assurance and to ensure they align with NRA standards and the battlefield clearance operator (BCO) EOD levels 1, 2, and 3, as well as SEOD, the in-country EOD level 4 qualifications.

In 2016, 35 LXML employees successfully completed the EOD levels 1 and 2, increasing the number of qualified Lao personnel capable of supporting UXO operations. A further nine employees completed the *pathfinder* training, an in-house training to those who have completed and qualified for EOD level 1. The pathfinders are trained to accompany non-EOD LXML technicians (geologists, environmentalists, and community-relations employees) to work areas that have not been cleared and may potentially contain UXO. Pathfinders use a basic metal detector to find the safest path for people they accompany. Pathfinders’ roles are to detect and mark UXO, not to excavate UXO. Instead, they will mark each contact found or spotted item of UXO from a safe distance and guide their group safely around the hazards. The qualified employees who completed the above training are now working in survey or geology and continue to support LXML’s UXO and other operations.

**Hardware: Increasing Speed and Accuracy of Detection**

LXML continues to investigate and invest in technology to improve target detection and identification. It has developed advanced geophysical gravitational and electromagnetic survey methods to deliver productive clearing activities to support operations, particularly open pit mining. In 2015, LXML introduced new equipment to enhance UXO detection. The UltraTEM II Deep Bomb Detection System was developed by Australia’s Gap Explosive Ordnance Disposal (GapEOD) in close coordination with LXML geophysicists.

UltraTEM is a time domain, electromagnetic system using multiple three-component sensors on a mobile frame.
The system provides high-definition mapping of buried UXO, accurate estimates of position and depth, and produces a digital recording. The stored digital recording can be further analyzed and calibrated with results in the field. UltraTEM can detect UXO in a single pass in a range of background conditions that proved difficult for other equipment, increasing both speed and reliability. The system is capable of detecting Mk 81 aerial bombs at depths of up to 5 m (5.5 yd) in good geophysical ground conditions, although the operational target is a clearance depth of 3.5 m (3.8 yd). In areas where the geophysical ground conditions are poor, based on the quality of the data and operating experience, the detection depth is reduced by up to 50 percent.

The UltraTEM loop is powered by a low noise generator and signal generator mounted on a support truck, allowing for the unit to be easily relocated.

The UltraTEM is maintained by a team of five operators under the supervision of a specially trained Lao EOD level 3 supervisor. The supervisors send data collected for interpretation. Data is then sent back with a list of potential UXO that need to be investigated. The system has proven robust and reliable in the field with electrical connectors requiring checks and maintenance for operation.

LXML has a strong commitment to ongoing improvements and has fully supported these activities by participating in standardization and field trials. The company’s experience...
is shared with the local and international UXO clearance community working in Laos. LXML attends the NRA UXO Technical Working Group that meets every three months in Vientiane. The activities undertaken by the attendees is shared openly at this forum.

Additionally, LXML held a detection trial at Sepon in late 2014 to assess the suitability and cost effectiveness of advanced ordnance detection systems for small ordnance. Using blind seed (i.e., free from explosive (FFE) inert material) test sites, a number of advanced systems were compared with each other as well as with systems that were currently in use. Multiple systems were considered to be viable UXO detection systems, but the trial highlighted the importance of accreditation, operational standards, and quality management processes.

The organizations that were involved included the Geneva International Centre for Humanitarian Demining (GICHD), LXML, UXO Lao, and NRA.

Assurance: Maintaining the Quality of UXO Clearance

Throughout 2017, LXML reinforced quality management via UXO blind seed, which was planted in the ground to be detected and cleared. This ensures UXO teams are consistently achieving and delivering high-quality clearance for the benefit and safety of mining operations and surrounding communities. LXML’s UXO quality management coordinator plants a
number of blind seeds, which consist of one-half of a FFE BLU 26 (a single shell of a cluster bomblet BLU 26), at the UXO clearance sites planned for the day. The ratio is a minimum of one blind seed for every twelve detectors working that day, i.e., additional blind seeds being planted for each additional set of twelve detectors. Blind seed positions are recorded by GPS and are entered and overlaid by the Lao National Geographic Department’s Graphical Information System (GIS). The blind seeds are monitored every day by the GIS when entering the daily work record in the system. Any blind seed remaining and appearing in shallow, cleared-area maps would immediately alert the UXO coordinator of a deficiency and would initiate an investigation and preventive action. The daily clearance record by operators and site supervisors also identifies the operator that cleared the lane where the UXO was missed and where EOD level 2 and 3 supervisors conducted their quality check.

Blind seed FFE Mk 81 250 lb (113.4 kg) UXO were also placed regularly throughout the year in different mine pits to maintain assurance of the quality of the geophysical digital data collected by UXO teams in the field and the quality of the geophysicist’s interpretation. Random dataset samples were regularly sent to a third party for independent verification and review, with both parties of geophysicists (independent and LXML) critiquing the results.

With a single international EOD expert remaining in the LXML UXO team at Sepon since 2016, the newly qualified SEOD national employees (EOD level 4 qualification) now take a larger role to ensure compliance with NRA standards and to maintain a safe and professional approach. SEODs are now more involved in the NRA technical working group and LXML SEODs are in charge of planning and coordinating UXO field operations. This experience will enhance capacity in future.
Harnessing UXO Knowledge: Saving our People and Communities

LXML achieved zero UXO-related incidents within its clearance team and consistently champion one of LXML’s core values: Think Safety First regarding the unique hazards associated with UXO clearance. In 2017, fifty LXML employees and contractors joined hands for an UXO awareness day. The purpose was to raise awareness around UXO hazards.

LXML also provides financial support to the Cooperative Orthotic and Prosthetic Enterprise (COPE) in Vientiane in its awareness raising activities. COPE was established by the Lao Ministry of Health in 1997 to ensure that people with physical disabilities have local access to affordable, nationally-managed rehabilitation services. In 2008, COPE opened its visitor center to increase awareness around UXO hazards. Throughout its history, COPE has provided comprehensive support for the government of Laos’ mobility-related rehabilitation efforts. COPE services are also used for amputees in road accidents and other trauma.

In Laos, LXML is supporting development and is keeping people safe by enhancing capacity, investing in modern technology, and raising awareness of UXO through active partnerships with key players in the UXO sector. See endnotes page 62

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Managing Director and Stakeholder Relations Manager
MMG LXML Sepon

Saman Aneka is Managing Director and Stakeholder Relations Manager at LXML, and Vice President to the Advisory Board of the Lao National Chamber of Commerce and Industry. He currently provides strategic guidance to the LXML Board as Managing Director and leads the Stakeholder Relations function. Aneka has over thirty years of experience in the mining industry, locally and internationally. He has extensive field experience in Australia, China, Indonesia, Papua New Guinea, Philippines, and Thailand. With his expertise, Aneka was involved in the early days and inception of LXML. He has extensive institutional knowledge of the company and industry in Lao PDR. Aneka holds a master’s degree in hard rock geo-mineral exploration.

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THE HYBRID THERMAL LANCE: A PROMISING NEW TECHNIQUE FOR THE DESTRUCTION OF LANDMINES AND UXO BY DEFLAGRATION

by Donald Pratt [Messiah College] and Nicolas Torbet [The HALO Trust]

Explosive ordnance can be destroyed by a variety of methods. Destruction in-situ using an explosive charge is generally the preferred means; it is reliable, technically straightforward, and often the safest option. Other techniques include thermite-based tools or low-explosive powered disruptors. However, in a number of current humanitarian mine action (HMA) operating environments, clearance organizations are faced with restrictions on explosive use and/or importation of other energetic materials such as thermite. This may be due to the legitimate security concerns of mine-affected states, or legislative frameworks that do not account for non-military use of explosive ordnance disposal (EOD) tools. This takes place against a broadening range of explosive ordnance, particularly given the proliferation of improvised explosive based hazards in the Middle East.1

This article presents an alternative method for destroying landmines and other thin-cased ordnance by burning through the case and deflagrating the explosive inside so that it is consumed without detonating. The device, referred to herein as the Hybrid Thermal Lance (HTL), is made from low-cost parts readily available in almost all countries, none of which are prohibited from carry-on baggage or likely to be subject to dual-use import restrictions. Single-use fuel tubes and locally-sourced gaseous oxygen make the HTL simple and inexpensive to use. While at a relatively early stage of testing, the authors felt sharing the results thus far (and making the concept open-source) would best meet the urgent needs of the HMA community, allowing other individuals or organizations to develop the concept further as they see fit.

Following a meeting in Cambodia between Donald Pratt and staff from The HALO Trust, there developed a research and development partnership between HALO and the Messiah College Collaboratory for Strategic Partnerships and Applied Research. The Collaboratory is an interdisciplinary undergraduate research initiative of Messiah College that connects students and faculty mentors from many different disciplines with real-world projects involving clients from around the world. HALO’s need for a method to destroy ordnance in locations where explosives are highly regulated prompted an investigation into the idea that a modified hybrid rocket motor might be a suitable solution.

SIMILAR METHODS FOR THE DISPOSAL OF EXPLOSIVE ORDNANCE

Techniques using heat to enable the disposal of explosive ordnance are well established.2 They are often employed as they can allow for mass disposal of ordnance, with a significantly reduced chance of a high-order explosion, or as an alternative to explosives where licensing issues do not permit the use of high explosives:

◊ Thermite EOD tools. Thermite is an energetic material composition in which a metal-based powder, incorporating a fuel and an oxidizer, upon ignition undergoes an exothermic process producing significant amounts of heat in a focused area for short periods. For EOD purposes, aluminum powder is commonly used as the base fuel and, along with an oxidant mix, is initiated electrically using a magnesium-based (or similar) ignitor. The heat is focused onto the ordnance by either a crucible, flare, or direct placement system. Producing a high-quality thermite delivery system is relatively challenging, but a number of commercial products are available and have been employed by the HMA community with some notable successes. However, thermite-based EOD tools are often subject to licensing and import restrictions as, while comparatively safe to transport, they are considered to have potential military applications.3 Moreover, the price per demolition is often relatively high.

◊ Gas-combination torches. Torches that combine oxygen with liquid gas (or other similar fuel) have also been developed. These tools use principles similar to oxy-fuel welding/cutting torches to produce focused heat and flame. These have often been found to be overly complex to set up and challenging to reliably deploy in the field.

◊ Incinerators and open-pit burning. Although generally used for different purposes, this technique is mentioned for completeness. Large quantities of unfuzed, safe-to-move munitions can be destroyed using incinerators or burning of stacks in the open. In this case, wooden fuel is normally stacked among or under the munitions and ignited, often supplemented by a diesel mixture. This has the benefit of disposing of large quantities of munitions over time without detonating them. Disposing of mines or fuzed munitions using this technique is normally impractical or unsafe, although grill burners have been used successfully to destroy smaller anti-personnel mines in some instances.
CHARACTERISTICS OF HYBRID ROCKET MOTORS

Hybrid rocket motors, consisting of a solid-fuel and liquid or gaseous oxidizer, have been around for a long time. Figure 1 shows the basic components of a typical hybrid rocket motor. A recent notable example is the liquid nitrous oxide/hydroxyl-terminated polybutadiene (a type of polyurethane elastomer) motor used in the suborbital Space Ship One developed by Mojave Space Ventures, which won the X-Prize in 2004. In contrast to solid rocket motors, having the oxidizer in liquid or gaseous form allows the reaction to be throttled, stopped, and restarted easily, without the complexity of mixing and metering required of rockets using liquid/gas fuel and liquid/gas oxidizer. Hybrid rocket motors are also safer than solid rocket motors, since mixing of the fuel and oxidizer in a hybrid does not take place until the point of combustion. In addition, many different types of materials can make effective fuels, including commonly available plastics, like polyvinyl chloride (PVC), acrylic, and polyethylene. Nitrous oxide is commonly used as an oxidizer, primarily because it’s easier to concentrate in liquid form than pure oxygen.

Small hybrid rocket motors gained popularity with large-scale model rocket enthusiasts in the United States after 9/11 when shipping solid rocket motors for large-scale models became increasingly difficult. Early versions used PVC as the fuel and liquid nitrous oxide in aluminum or composite tanks small enough to fit within the rocket tube. Modelers experimented with a variety of different fuels, including cast rubber and machined and/or 3D printed polymers. Polymethyl methacrylate (PMMA) became a popular option due to its availability, low cost, ease of ignition, high combustion temperature, and minimal production of harmful byproducts during combustion. Typical model rocket engines produce an impulse lasting from 0.5 to 4.0 seconds, with thrust levels ranging from about 20 to 100 Newtons.

APPLICATION TO THE DESTRUCTION OF UNEXPLODED ORDNANCE (UXO) BY DEFLAGRATION

A hybrid rocket motor is intended to produce high pressures in a confined chamber to eject gases at high velocity to create thrust, usually for a relatively short duration. A suitable torch for burning explosives need not produce thrust but does need to run for a longer period of time. Ideally, it would also be able to be throttled, and so easily started and stopped. The HTL, shown in Figure 2, meets all of these requirements. It produces a focused flame that exits the fuel tube at a relatively low pressure, producing a very minimal thrust reaction, and burns for a much longer time than...
a similarly sized hybrid rocket motor. Also, since the HTL is stationary while functioning and need not be light enough to fly, the use of gaseous oxygen is practical. Gaseous oxygen used for oxyacetylene welding is very suitable and readily available virtually anywhere in the world. Medical oxygen can be used but high purity oxygen is not required. The HTL is fueled by a consumable plastic tube, which can be easily machined from stock, cast, or 3-D printed plastic shapes. PMMA (more commonly known as acrylic), was chosen for the initial laboratory tests and also the first field trials of the HTL, and found to be practical and effective. The HTL requires very little energy to ignite, and remote ignition can be achieved with a small electric arc or similar methods. The field tests described on the next page used an electric match for the ignition source, operated from the firing point by standard demolition equipment.

During early development, simple tests conducted by Pratt and his students in the Collaboratory using plastic tubing and gaseous oxygen were encouraging enough to warrant the construction of a fireproof test chamber equipped with high-impact glass observation ports, shown in Figure 3. Simple prototype fuel tubes were machined from 1” diameter acrylic rod stock cut in 4” lengths. A ¼” diameter hole was drilled down the center of each rod, and one end was threaded for ¼” national pipe threads (NPT). Figure 4
shows an unused fuel tube alongside one that has been subjected to four 30-second burns. A 3” long brass nipple was threaded into a bulkhead fitting that passed through the end plate on the test box. The oxygen was delivered through a rubber hose connected to an oxy-acetylene torch oxygen tank, using a stock regulator. Noting that the hose could potentially become a fuel source if the flame were allowed to propagate back through the tube, an aluminum plug was pressed into the outlet end of the brass nipple, with a 0.05” diameter hole drilled through the center to create a venturi to block propagation of the flame front. An emergency shutoff valve and an adjustable metering valve were attached to the brass tube to provide precise control of the oxygen flow to the test sample.

Tests confirmed that the HTL was easily ignited and controlled by adjusting the flow of oxygen. Even at relatively low flow rates of under 0.5 cubic feet per minute, the HTL proved capable of producing an intense flame, which was easily throttled and quickly extinguished by simply cutting off the oxygen supply. While the ignition temperature of PMMA is only about 450°C, the combustion temperature is considerably higher. PMMA burns in the presence of oxygen and produces monomer methyl methacrylate (MMA), which decomposes to generate methane, methanol, propylene, formaldehyde, acetone, acetylene, etc. These molecule products undergo combustion and produce carbon monoxide (CO), carbon dioxide (CO₂), water vapors, and other gases with the generation of high temperatures. For purposes of comparison, thermit burns at temperatures between 2,200° and 2,500° C, and a properly adjusted oxy-acetylene torch can reach temperatures close to 3,500° C. During initial tests in the laboratory, the destructive power of the HTL was evaluated by placing a 3” cylindrical block of pine 1.5” diameter at a distance of about 2” from the outlet of the fuel tube. Significant removal of material from the wood block occurred after only 20 seconds of exposure to the HTL, as shown in Figure 5. A similar test on an identical block of wood using an oxy-acetylene torch did roughly the same amount of damage to the test block, and while precise measurement of the HTL flame temperature has yet to be confirmed, it would appear that it is comparable to an oxy-acetylene torch.

Figure 5. 3” diameter wood test sample after 20 second exposure to the HTL. 
*Figure courtesy of Donald Pratt.*
Figure 6: Test setup using the HTL to destroy a simulated IED explosive charge (loose-fill ammonium nitrate-based explosives).  
*Figure courtesy of Donald Pratt.*

Figure 7. Complete destruction of the simulated IED explosive charge.  
*Figure courtesy of Donald Pratt.*
Figure 8. Test setup using the HTL to destroy a Pakistani P3 Mk2 anti-tank mine. 
*Figure courtesy of Donald Pratt.*

Figure 9. Nothing remained of the P3 Mk2 anti-tank mine after exposure to the HTL. 
*Figure courtesy of Donald Pratt.*
Figure 10. Test setup using the HTL to destroy a PG-2 grenade.  
*Figure courtesy of Donald Pratt.*

Figure 11. Penetration of the casing of the PG-2 grenade by the HTL.  
*Figure courtesy of Donald Pratt.*
Figure 12. Test setup using the HTL to destroy a Soviet TM-62M anti-tank mine. 
*Figure courtesy of Donald Pratt.*

Figure 13. Remnants of the TM-62M anti-tank mine after exposure to the HTL. 
*Figure courtesy of Donald Pratt.*
FIELD TESTS IN AFGHANISTAN

After obtaining these initial results, it was decided that there was sufficient justification to go ahead with field trials where the HTL could be tested on real mines and UXO. After discussion with HALO staff, Afghanistan was selected as a suitable site for testing, as it supplied access to range facilities, availability of live ordnance, and access to a well-established local office, which provided expertise, technical assistance, and infrastructure. In April 2018, the prototype HTL was taken to Afghanistan, where Pratt, Torbet, and Afghan HALO staff performed tests on four different types of ordnance at the HALO explosives range north of Kabul.

The first test was conducted using a variety of loose ammonium nitrate-based explosive materials placed in a plastic container, simulating an improvised explosive device’s (IED) main charge, shown in Figure 6. An acrylic fuel tube was installed and the HTL was connected to a tank of compressed oxygen through a two-stage regulator and a metering valve. The regulator was adjusted to 5 psi. The HTL was placed approximately 2” from the plastic container and an electric match, locally sourced in Kabul, was inserted in the end of the fuel tube. Oxygen flow was established, and the electric match ignited. The flow of oxygen was allowed to continue for about 30 seconds and then shut off. Observers at 500 meters communicating by radio reported smoke and flames, which persisted for several minutes. After the requisite waiting period, the test site was examined, and it was quickly determined that the explosives had been completely consumed by burning, leaving only a small amount of residue from the plastic container, as shown in Figure 7. It was clear that the HTL had ignited the explosives and stimulated combustion to the point where they were sufficiently engaged so that when the HTL was extinguished, the burn continued until the explosives were fully consumed, without causing detonation.

Figure 8 shows a plastic-encased, unfuzed P3 Mk2 anti-tank mine used for the second test. Setup of the HTL was very similar to that used for the first test, except that the oxygen flow was allowed to continue for about two minutes, long enough for the 1” diameter and 4” long acrylic fuel tube to be completely consumed. Observers reported a great deal of smoke and flame, which persisted for a longer period of time than during the first test. Figure 9 clearly shows results similar to that of the first test; the mine, including the case and all of the explosive material, was completely consumed. The photograph also shows that the intensity of the flames from the burning mine melted and separated the hose connecting the oxygen tank to the HTL. However, since the oxygen had been turned off two minutes into the test, the hose did not continue to burn. The metal parts of the HTL

Figure 14. Staff at the Halo Afghanistan HQ in Kabul carry out further testing of the HTL on sheet steel. Figure courtesy of Donald Pratt.
Figure 15. An Afghan EOD specialist using the HTL to destroy a simulated IED during a training session.
*Figure courtesy of John Montgomery.*

Figure 16. The HTL shortly after ignition burning through the plastic casing of a simulated IED explosive charge.
*Figure courtesy of John Montgomery.*
were slightly scorched, but otherwise undamaged. The hose was simply trimmed back and reattached to the HTL, after which testing continued.

The third test was performed on a Soviet-era PG-2, as shown in Figure 10.9 The HTL was aimed at the side of the case where the main charge was located, to try to avoid setting off either the fuse or the booster. As can be seen from Figure 11, the HTL made a hole in the case roughly 35 millimeters in diameter, and ignited the explosive material inside without detonation occurring. With no easy way to safely examine the inside of the grenade, it was difficult to assess the state of the main explosive fill, fuze, and booster, so the decision was made to ensure the complete destruction of the grenade using a small explosive charge. After examining the remnants, it appeared that the fuze and booster had been consumed by the burn initiated by the HTL, but this could not be established for certain. More testing on RPG-type ordnance is indicated.

The fourth test was made on an unfuzed TM-62M anti-tank mine, which has a metal case.10 Considering that the prototype HTL with 1” diameter and 4” long fuel tubes has a maximum burn time of only two minutes, the team were unsure of its ability to penetrate the case and fully deflagrate the explosive material. As shown in Figure 12 the HTL was placed at an angle to the case to reduce the possibility of the HTL flame reaching the booster charge before the outer HE explosive was fully engaged. Shortly after completing the HTL triggering sequence, the observation team reported smoke and flames, which continued and increased after the oxygen supply to the HTL was cut off. During this test, the mine emitted loud and varied roaring sounds. After examining the remnants, we surmised that these sounds were made by the hot gases from the burning explosive material exiting the case through the hole made by the HTL. Smoke, flames, and noises persisted for at least ten minutes after the HTL was extinguished. Subsequent examination of the remnants of the mine revealed complete destruction of the explosive material, as shown in Figure 13; all that remained was a tattered metal case filled with ashes.

With these encouraging results on targets containing live explosive fill, the question of how well the HTL could penetrate steel plate was briefly investigated at the HALO office in Kabul, shown in Figure 14, where the HTL was found to be capable of cutting a 10–15 millimeter hole through sheet steel several millimeters thick in under 20 seconds. Following these successful tests, the decision was made to take advantage of an opportunity for HALO EOD staff to be introduced to the HTL. A number of Afghanistan national staff were participating in an EOD training course at the same time that the HTL field trials were underway, and the HTL was somewhat hastily incorporated into that course and used during a number of training tasks against “dry targets” (i.e. non-explosive dummy devices), as shown in Figures 15 and 16. This provided an additional opportunity to uncover operational challenges that might present in the field and to make a first pass at incorporation of the HTL into EOD task procedures. Back at the Collaboratory, testing is underway to further establish operational parameters, but it appears quite likely that the HTL will prove suitable for the penetration and destruction of thin-cased metal ordnance.

**OPERATIONAL SAFETY CONSIDERATIONS AND STANDARD OPERATING PROCEDURES (SOP)**

As well as being technically functional, a key concern for the end user is that the equipment is at least as safe as other EOD methods as well as being operationally practical. While the testing was conducted under the tight control of the Afghanistan program’s demolition range safety procedures, HALO is still establishing the SOPs for how the HTL will be deployed operationally once out of the prototype stage.

A primary safety consideration is that although a high order detonation is unlikely while using the HTL, it must still be considered as a possibility. Also, the HTL will require placement in close proximity to a potentially hazardous item of explosive ordnance. Any EOD operator must take both of these into account when deploying the equipment. Principals such as minimal time at target, initiation from a protected shelter or safe distance, personal protective equipment, safety distances, equipment emplacement, etc., must mirror those of conventional EOD techniques when a high order is expected. In addition, the HTL induces a burn the duration of which will depend on the nature of the target and environmental factors. A detonation could occur at any time during the burn, particularly if the explosive ordnance is fitted with a fuze or booster. As such an igniferous soak will be required following use of the HTL before the EOD operator can approach the target, confirm successful destruction, and collapse any cordon.11

For field purposes the HTL will need to be initiated remotely to ensure no positive EOD action takes place while the operator is in the vicinity of the target area. During field testing of the initial prototype, two methods were employed to achieve this: placing the tank on a short hose near the target, leaving the oxygen running, returning to the firing point (protected bunker) and initiating the burn using an electric match on a length of firing cable, and alternatively, running a long hose (80+ meters) from the tank at the firing point to the fuel tube. In the latter case, both controlling the oxygen flow and initiating the burn were conducted from the firing point, which required two people. Clearly, neither of these methods would be particularly practical in the field as the setup is a relatively complex procedure and control of the oxygen flow is somewhat haphazard. Additionally, when the longer hose is employed, there is the potential for the hose itself to become a conduit for the propagation of flame back to the firing point, if a violent burn or high order should separate the venturi tube
and provide a source of ignition for the oxygen-filled hose. Thus, one of the key future developments will be a means of placing the equipment in its entirety in the vicinity of the target and initiating the procedure from the firing point. A longer venturi tube and protective stand will also assist with safe placement against more challenging targets. Work on this has already begun, and the next prototype will likely employ a smaller tank fitted with an electronic delay timer connected to a solenoid valve to control the flow of oxygen, all of which could be located near the target to simplify the procedure.

SUMMARY, CONCLUSIONS, AND POTENTIAL FOR FUTURE USE

After successful demonstration of the proof of concept in the laboratory, the prototype HTL has been tested under actual field conditions and found to be quite effective for consuming explosive material by deflagration. The ability of the HTL to quickly penetrate metal several millimeters thick makes it suitable for both plastic and metal encased ordnance. Apart from exposing a suitable target surface, using the HTL does not require contact with the ordnance that is to be destroyed, reducing the risk to the EOD operator during set up. If a device does function during the burning process, the parts of the HTL exposed to the explosion are inexpensive and easily replaced. The HTL is simple and inexpensive to make, and consists of parts and materials that are not regulated, and can be shipped without difficulty, and will pass easily through airport security. Pressurized gaseous oxygen of sufficient quality can be readily sourced virtually anywhere in the world. Thus the HTL has great potential for becoming an inexpensive, effective, and practical tool for the destruction of explosive ordnance in a variety of situations, particularly those where the use of secondary explosive charges is expensive or impractical.

In the short term, HALO anticipates that the HTL will be particularly suited for deployment against thin, plastic-cased IED main charges (especially following mechanical clearance operations), thin-cased cluster munitions, or smaller sensitive devices such as grenades on tripwires where explosive donor charge placement is more challenging. In particular, the HTL is expected to be well suited for use in locations with security concerns such as Syria, Iraq, and Ukraine.

The HTL concept is not patented and is hereby released as open source, with the intent that it will be widely used to hasten the day when all people in all places may walk the earth in safety. Comments, questions, suggestions for improvement, and potential applications are invited.

FUTURE WORK

Parametric studies of fuel tube geometry are underway to determine the optimum size and shape for each category of ordnance to be destroyed. Precise measurement of the oxygen flow and tests carried out at various flow rates are expected to lead to the development of an automated system for controlling the flow of oxygen. Continuing field testing on different types of live targets will yield a better understanding of the required flame characteristics and burn duration required to insure complete destruction of various types of target UXO and allow a detailed SOP to be written for each.

Based on the information obtained during the field trials described previously, a new prototype is being developed with a smaller oxygen tank that is placed closer to the device being destroyed. The flow of oxygen is regulated by a timer-controlled valve, allowing a set delay and precise burn time. Once the HTL is in position, the user simply starts the timer and returns to a safe position. After the set delay time, the user triggers the electric match and the rest of the sequence is carried out automatically. Depending on the size of the oxygen tank and the chosen burn duration, several burns can be carried out with a single fill and refilling the small tank in the field from a larger tank is quick and easy. Also, the decision was made to go with single-use fuel tubes on this second prototype, and a variety of diameters and lengths are being tested to determine the optimum tube size for each specific type of explosive ordnance to be destroyed.

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1. Any national ammunition stockpile consists of a range of function-specific stockpiles. There are many types of individual ammunition and explosive stockpiles within a country, that are under the control of separate organizations (e.g., the police, military (both active and reserve), border guards, ammunition production company holdings) and make up a state's national ammunition stockpile. These include: a) operational ammunition and explosives; b) war reserve ammunition and explosives, c) training ammunition and explosives; d) experimental ammunition and explosives (if a producing nation); e) production ammunition (if a producing nation); and ammunition and explosives awaiting disposal (unsafe or surplus stocks). See UNODA (2015), mod. 1.30, para. 8.


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5. The BiH case study was made possible through the support of PM/WRA.


12. UNODA, 2015, mod. 09.10.


14. NATO, 2007, p. 34.


17. UNODA, 2015, mod. 01.10, para. 6.1.


19. Enabling processes are used to direct, control, and support LCMA and include the management of resources, the environment, and quality control. See Haskins (2006), sec. 6.1.


21. UNODA, 2015, mod. 01.90.


27. NATO, 2009.


30. UNODA, 2015.


32. UNODA, 2015, mod. 01.10, para. 4.

33. UNODA, 2015, mod. 02.10, p. v.

34. UNODA, 2015, mod. 02.10, para. 6.1.

35. UNODA, 2015, mod. 02.10, paras. 6-13.

36. UNODA, 2015, mod. 01.30, para. 8; mod. 01.40, para. 3.18.


41. Author interview with a senior political advisor to the Commander of EUFOR, Sarajevo, 25-26 May 2016.


45. SAF, 2013b, p. 4; OSCE. 2014. ‘Bosnia and Herzegovina, Croatia, Montenegro and Serbia Take Ownership of Regional Arms Control, Dayton Peace Agreement Article IV Annex 1/B: Mission accomplished.’ Basel, 4 December.


47. UNODA, 2015, mod. 07.20, para. 4.


49. UNODA, 2015, mod. 01.40, para. 3.275.


52. Author interview with senior military advisor to the commander of EUFOR, Sarajevo, 10 October 2016.


54. EUFOR Sa, 2013, p. 8.


Increasing Efforts in SSMA: What Does it Take? by Hofmann, Paunila and Prizeman [from page 15]

1. This article does not necessarily reflect the views of the United Nations Organization.
2. Geneva International Centre for Humanitarian Demining (2018), Towards security, peace and sustainable development: The state of play in safe and secure management of ammunition (Geneva: GICHD). This study was commissioned by the Swiss Federal Department of Foreign Affairs.
10. At the international level, for instance, the 2001 UN Firearms Protocol, the 2003 Protocol V to the Convention on Certain Conventional Weapons or the 2013 Arms Trade Treaty. At the regional level could be mentioned the 1997 Inter-American Convention Against the Illicit Manufacturing and Trafficking in Firearms, Ammunition, Explosives and Other Related Materials, the 2003 Document on Stockpiles of Conventional Ammunition of the Organization for Security and Co-operation in Europe, the 2006 Convention on SALW, their ammunition and other related materials of the Economic Community of West African States or the 2013 CARICOM Crime and Security Strategy.
13. For instance, the UN Firearms Protocol considers complete round, and components (including cartridge cases, primers or propellant powder) as being part of ammunition. Others however, including the ECOWAS Convention on SALW, their Ammunition and Other Related Material, do not include parts and components, but cover munitions that are not fired or expelled from a small arm or light weapon. See Saferworld (n.d.), Ammunition and the ATT: Options for and implications of its inclusion (Geneva: UNIDIR), p. 3.
14. OSCE Ministerial Council (2017), Decision No. 10/17: Small Arms and Light Weapons and Stockpiles of Conventional Ammunition, OSCE Doc. MC.DEC/10/17, p. 3.
17. UNGA (2017b), op. cit.
Shattered Lives and Bodies: Recovery of Survivors of Improvised Explosive Devices and Explosive Remnants of War in Northeast Syria by MSF

1. Names have been changed.

How Iraq Is Changing What We Do: Measuring Clearance in Urban Environments by Lodhammar

1. Stabilization definitions vary but generally it is understood to be a combination of military, humanitarian, political and economic activities that together bring stability to areas affected by violent conflict. In Iraq, the word stabilization is most often associated with the Funding Facility for Stabilization, managed by the United Nations Development Programme in collaboration with the Government of Iraq.


1. IEDs used as substitutes for conventional landmines in a ‘belt’ configuration to defend a combatant position during a conflict meet the International Humanitarian Law (IHL) definition of landmine.

1. Note: The IMAS Review Board has agreed to develop an IMAS on Improvised Explosive Device Disposal (IEDD). The need to clarify a standard of clearance where ‘depth’ is not a suitable measurement is being considered.

1. Based on unconfirmed reports.

5. Economic theories differ as to ‘how much’ for ‘how many’ and ‘how soon’ when setting objectives and guidelines for societal welfare and distribution of individual benefits. In his essay What Utilitarianism Is, John Stuart Mill defined utility as “the Greatest Happiness Principle, (which) holds that actions are right in proportion as they tend to promote happiness, wrong as they tend to promote the reverse of happiness.” In his theory of efficient economic allocation, Vilfredo Pareto argued that no one individual should be made better off while making at least one individual worse off. Other economists have suggested that “Pareto improvements” consider offsetting compensation for those disadvantaged by one government improvement that favors others so as to maintain a “Pareto efficient outcome” also considered the basic theorem of welfare economics.

6. Just as IMAS should include guidance on a standard for clearance in a 3-dimensional environment, so, too, should IMAS include a standard for threat assessment to ensure that organizations are properly considering risks.

References
1. MMG Limited (MMG) is a global metals producer based in Melbourne, Australia. MMG is listed on the Hong 1. Baghdad Daily Situation Report (Unclassified), British Embassy, 30 June 2018.
3. Kubis, Cable CZX-086, 8 July 2018, UNAMI, Baghdad, Subject: The importance of mine action for Iraq’s recovery.

Sepon Supports UXO Clearance in Laos by Aneka and Valent

8. Transient electromagnetics, (also time-domain electromagnetics or TDEM), is a geophysical exploration technique in which electric and magnetic fields are induced by transient pulses of electric current and the subsequent decay response measured.
10. LXML has achieved 0 UXO-related incidents or injuries that would require medical treatment, including any minor injuries such as bruises and minor cuts.

References
1. MMG Limited (MMG) is a global metals producer based in Melbourne, Australia. MMG is listed on the Hong Kong Stock Exchange (HGEx:1208) with a secondary listing on the Australian Stock Exchange (ASX:MMG). Sepon is an open-pit copper mining operation in Laos. The name of the company in Laos is Lane Xang Minerals Limited (LXML), of which MMG owns 90% and the Lao Government 10%. More info at www.mmg.com.
2. National Regulatory Authority (NRA) is a public institution of the Lao Government. It is responsible for regulation and coordination of all UXO operators in the country working on the impact of unexploded bombs, artillery shells, grenades, landmines and like ordnance.
3. The overarching aims of the NRA are to enable all people in Lao PDR to live free from the threat of UXO, help promote national development, and see UXO victims fully integrated into society and ensure their needs are comprehensively met. More info at www.nra.gov.la.
4. UXO Lao (Lao National Unexploded Ordnance Programme) was established by the Lao Government with the support of NUDP, UNICEF and other stakeholders in 1996. UXO Lao is working in the nine most impacted provinces nationwide, clearing land for agriculture and community purposes as well as other development activities. More info at www.uxolao.org.
5. Cooperative Orthotic Prosthetic Enterprise (COPE) was established by the Lao Ministry of Health in 1997 to ensure that people with physical disabilities have local, affordable access to a quality, nationally-managed rehabilitation service. More info at www.copelaos.org.

THE HYBRID THERMAL LANCE: A PROMISING NEW TECHNIQUE FOR THE DESTRUCTION OF LANDMINES AND UXO BY DEFLAGRATION BY PRATT AND TORBET [ FROM PAGE 46 ]
3. In some areas there are generally no issues with thermite importing and licensing; however, thermite becomes difficult to obtain once it is “weaponized” as an EOD tool.
5. Phone interview with Douglas Pratt of Pratt Hobbies, Inc.
6. Wood was chosen mainly because the use of hazardous materials (explosives in particular) is strictly controlled on the Messiah College campus. Wood, while it does burn, degrades relatively slowly while burning, and thus makes for a good comparison of the ability of the HTL to degrade a combustible material.
7. These were homemade explosives recovered from the field.
8. The P3 Mk2 anti-tank mine contained approximately 5 kg of TNT.
9. The PG-2 contained a TNT/RDX based shaped charge
10. The TM-62M anti-tank mine contained approximately 7.5 kg of TNT.
11. The term “igniferous soak” refers to a safe waiting period following EOD action involving a burn. HALO’s SOPs for any EOD burning mandate a 30-minute wait from the last signs of fire or smoke.
12. Such items are often mounted on stakes or trees above ground level. Placing an explosive donor charge in these instances, particularly in the vicinity of tripwires, is challenging. Although the use of EOD tools such as shaped charges can mitigate this to a degree.
**EDITORIAL**

**Landmine Free 2025: A Shared Responsibility**

Achieving the goals set forth by the Anti-personal Mine Ban Convention (APMBC) continues to be an international effort as organizations work to clear minefields in countries around the world. On 4 April 2017, during a reception of the 20th anniversary of Diana, Princess of Wales’ visit to a minefield in Angola, Prince Harry launched an initiative to promote these goals: Landmine Free 2025. Through the cooperation of multiple organizations, the world has seen significant progress in humanitarian mine action but needs the additional support of donor governments and private supports to realize the commitment made at the 2014 Maputo Review Conference of the APMBC: clearance by 2025. What steps can the international community take to achieve this goal? How are organizations contributing to Landmine Free 2025? Which lessons learned can we share to improve our ability to collaborate and achieve a landmine free world?

**SPOTLIGHT**

**Central/South Asia**

How do Soviet-era munitions and landmines affect the shared and disputed borders in Central Asia? What kind of explosive contamination have past wars and conflict left behind in South Asia? What remains to be cleared and how are local populations affected? Do sociocultural considerations impact clearance efforts in these regions? And what advice do organizations operating in Central/South Asia have for those seeking to work there? Of particular interest are: Afghanistan, Kazakhstan, Kyrgyzstan, Nepal, Sri Lanka, Tajikistan, Turkmenistan, and Uzbekistan.

**FEATURE**

**Unmanned Aircraft Systems in Mine Action**

Increasingly, the humanitarian mine action community leverages unmanned aircraft systems (UAS) for various uses within the field. How has drone technology impacted HMA activities such as battle area clearance, landmine detection, and survey? What opportunities do UAS offer organizations and what kind of concerns do they raise? How can these devices ensure the successful release of land and what steps should we take to ensure this technology is implemented appropriately into HMA?